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Ellos
A case study in Operations Management and Packaging Logistics

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Abstract

This thesis deals with Packaging Logistics and Operations Management at the mail order company Ellos in Borås. Since 1997, Ellos belongs to the French group Pinault-Printemps-Redoute and is the largest mail order company in the Nordic countries. Today, four different brands, Ellos, Josefsson Josefine, La Redoute and Catalog Mail Outlet are handled and distributed from the facility in Borås. A fifth brand, Enjoy, also belongs to the group, but has a separate distribution department.

The handling of four different brands has made the packing area full of packaging material and there are also a lot of movements involved. This makes the utilization of the floor space critical. The purpose of our thesis is to optimise the flow of packaging material and the surrounding routines in order to create a better utilization of the floor space.

To reach our purpose, we have used different methods such as observations, interviews, own practising, experiments and simulation. We have found connections to our field within theories of Operation Management, Packaging Logistics and Simulation.

We have found options to re-design the packing area and the surrounding routines. This involves changes in the batch processing, optimising packaging varieties and reducing movements.

Key words: Mail Order Industry, Operations Management, Packaging Logistics, Simulation

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Göteborg January 9, 2001

Eva Hansson Merit Olsson

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1 Introduction

This first chapter introduces the reader to the thesis contents. First, we will briefly describe what the mail order business is since our case study takes place at Ellos, which is the largest mail order company in the Nordic countries. We will then give a background and a definition of the problem we are asked to deal with, and also how we dispose our work throughout the process.

1.1 Background

The first semester of our education, we were on a site visit at Ellos in Borås. They showed us the company, and we were impressed by the extensive process needed, from goods arrival all the way through picking and packing, to send a parcel from Ellos out to the final customer. The logistics in this company is very interesting, since it is such an important part of the business. When the thesis work came closer, we again came in contact with the people at Ellos, and now they were interested in having us do our thesis as a project in the packing area. This was a very challenging offer, since we think that mail order companies will have the opportunity to grow, especially because of Internet shopping becoming more popular. It is easier for an established mail order company to switch to Internet sales than for a new Internet company, because the mail order companies already have the infrastructure and logistics needed. (Helgesson) We would like to introduce the reader to the mail order business and the market shares in Sweden. Then we will present Ellos AB as a part of the French group Pinault Printemps Redoute.

1.1.1 The mail order industry

Mail order is a commercial retail enterprise carried on mainly by means of postal services. This means that customers order general merchandise from illustrated catalogues sent to them several times a year by post, and receive their parcels by parcel post. All goods are sent to the customer on an approval basis and on a system of extended credit. (Beaver 1981)

The first person that entered the mail order industry in Sweden was John Fröberg in Finspång. He started his business in 1879 by selling visiting cards, and employed a person to walk to the customer with the delivery. Other mail order companies started around the country, and in the beginning of 1890, Fröberg started to look for agents all over Sweden. The agents were mostly young teenage boys, and this idea was fruitful since the distance between manufacturer and customer became too far. Through these agents, the selling was again built on personal contacts, and the agent became the in-between link. (Postorder 1988)

The main products were textiles and household goods, but in the beginning it was more common with gifts, novelties, ornaments, or other things that could give the customer a feeling of luxury, escape from reality, or even status. The catalogue and the competitive prices became the main advertising and customer relation. Because of the nice pictures, illustrations and texts, the catalogue turned out to be a dream-book for those people who could not afford expensive books. The catalogue was for free, or in some cases the customer paid for the stamps. (Postorder 1988)

Around the Second World War, the mail order business began to decrease because the character of the industry had changed. The competition increased due to structural changes. The communications and the infrastructure were improved, and the number of stores increased. Therefore, it became much easier for people to go shopping, so they did not buy via mail order as much as before. However, after this crisis in the industry, it again increased in the 1960s. This time, it was not only the people on the countryside that used the mail order services. The way of shopping also became interesting for the people in the city suburbs, since the women were to a large extent working and hardly had any time left for shopping. Sitting at home became a convenient alternative to rushing around downtown with children and heavy bags. (Postorder 1988)

In the 1990s, there was a brief recession in the mail order industry, but it is now increasing again. 67% of the Swedish households have shopped by mail order

within the last 12 months, and this is an increase of about 3 percentage units. The retail industry has however increased even more, so the mail order industry is still loosing market shares to the retail industry. Today, the mail order industry stands for around 2,5 % of the total retail industry in Sweden. This figure includes the grocery industry. Without the grocery stores, the mail order industry has a market share of 5,8 %, and those companies altogether had a turnover of about 8000 million SEK last year. Below, the market shares in four specific areas are shown for the mail order industry versus retail industry. (Helgesson)

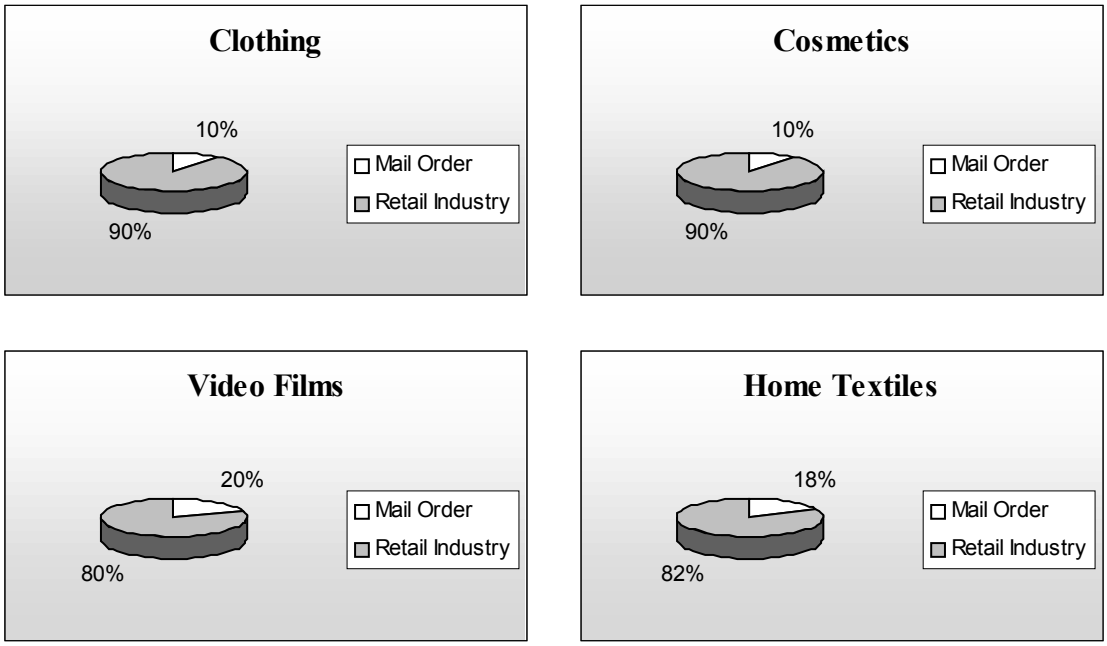


Fig. 1.1.1 The market shares for mail order in different niches. *Source: Helgesson, 2000*

The main part, 75 %, of the Swedish mail order companies have joined Svenska Postorder-föreningen, SPF, which is a group of interest to handle issues important to those companies. These members together had a turnover of about 6 billion SEK. SPF has been around for 27 years, and they have certain requirements a company must fulfil in order to be a member. An example is that the company must be a joint-stock company with a neutral economic revision. All companies in the SPF must be serious and economically stable. (Helgesson)

The people within the mail order industry are a bit frustrated about all the focus on the new Internet companies. They think that media has put light on those companies as new, modern and fast, and only tell bad things about the traditional mail order industry, such as being boring, slow, out of fashion and having bad quality. However, recently there has been a recession in those Internet companies, and all of a sudden, the traditional industry is appraised because they have all the knowledge in customer relations, payments, ordering, returns and distribution. The Internet companies thought that the only thing they needed was a good name, but now it has shown that the large, well-established traditional mail order companies win in the long run. (Helgesson)

Even though there is a category of mail order companies that has men as the main target group, like Hobbex, Micro Bildelar AB and Clas Ohlson, the typical mail order customer is a woman with family. The customer has in general about 3 or 4 different catalogues at home and is not very loyal to one brand. The typical buying situation is sitting at the kitchen table having a lot of catalogues to look in, either with a couple of friends or with members of the family, and the buying process is something associated with having fun. This situation has made the customer relation part a bit troublesome, as has the launch of the catalogue on the Internet. The customer still thinks that having a couple of catalogues on the table to browse through while drinking coffee is the most convenient way to order. (Helgesson)

1.1.2 Company Presentation

Ellos AB

Ellos AB is a mail order company in Viared near Borås. The existing facility was opened in 1978. However, Ellos was founded in 1947 by Olle Blomqvist, and he used his own first name spelled backwards to name the company. He started the enterprise as a spare-time job in his own house, but in the post-war time in Sweden, mail order was one of the few forms of distribution that worked. This made his enterprise become a full-time job in 1951. In 1955 he employed his first employee, and the turnover reached 1 million SEK in 1956.

(Ellos Annual Report 1999) Today, Ellos has around 1400 employees and a turnover of about 3 billions SEK. (Borgerud)

As well as a lot of other industries, the mail order business has gone through an era of structural change. In 1988, all the shares in Ellos were sold to ICA Invest AB, and in the end of 1996, Ellos acquired the company Josefssons that offers similar products. In 1997, the French group Pinault Printemps Redoute bought Ellos, which we will tell more about in the Redcats-section below. (Ellos Annual Report 1999)

The Ellos facility in Viared

At the moment, five different brands are distributed from the Ellos facility, which is the only facility within the Redcat group in all Nordic countries. The brands are Ellos, Josefssons Josefine, La Redoute, Catalog Mail Outlet Mail Outlet and Enjoy. All of these have their own catalogue and their own profile, but since they all belong to the same company, the different departments try to co-operate when it is possible, using the principle of best practice. (Gustafsson)

The **Ellos** brand covers most kinds of goods such as clothing, furniture, home textiles, television sets, toys etc. The main target group are women above 40 years old with a family. The items have good quality at a competitive price. (Faintreny*)*

The **Josefssons Josefine** brand offers clothing, make-up and home textiles, but does not have furniture. The typical customer is a woman with children who is

30-39 years old, or is mentally being in that age. The goods are of good quality at a competitive price. (Gustafsson)

The **La Redoute** brand is concentrated on clothing with high quality, high fashion at a higher price than the other two. The typical customer is a woman interested in fashion with a continental style, and the age matters less here. (Faintreny)

The **Catalog Mail Outlet** brand has a low price profile, and is actually a sales catalogue for the surplus from the other brands. The target group is those customers looking for low prices, and Estonia is a large market. (Faintreny)

Enjoy is a brand that concentrates on home entertainment and sells for example CDs, videos, and computer games. (Borgerud) This brand is handled in a separate department and, because of that, we do not include it at all in this study.

Redcats

Redcats Nordic AB is a subsidiary completely owned by Redoute CH SA, which is a part of the French group PPR, Pinault Printemps Redoute. This company is on the French stock market and has its headquarters in Paris. The PPR is a young group founded in 1963 by Francois Pinault, who still owns the company. In less than ten years it has become one of the leading companies in Europe when it comes to specialised distribution. The ambition is to build one of the leading world-wide groups in specialised distribution. Specialised distribution means distribution of all goods except food. (PPR Annual Report 1999)

The group is unique because it is a multi-line retail and wholesale group. The broad mix of businesses makes it less sensitive to changes in the economic cycles, and makes it less dependent on any one market or product family. All the business activities are united by a strong corporate culture. This culture is focused on the special relationship to the customers and on satisfying them,

common management principles, and well-known brands that are a market leader in their respective categories. (PPR Annual Report 1999)

Redcats focuses on asserting its role as a global player in catalogue sales. It has 18 catalogues, which gives a market presence extending over 18 countries. In 1999, a decisive milestone in the implementation of the group's strategy was made by adopting a new name – Redcats – which combines "Red" for Redoute and "Cats" for catalogues. Redcats' strategy focuses on (PPR Annual Report 1999):

- External growth and integration of its subsidiaries
- Organic growth
- Renewing product offering
- Developing e-commerce
- Attracting new talents and motivating employee teams

The group is divided into four areas: Retail, Credit & Financial Services, Business to Business and Luxury Goods. This is shown in detail in the figure below. (PPR Annual Report 1999)

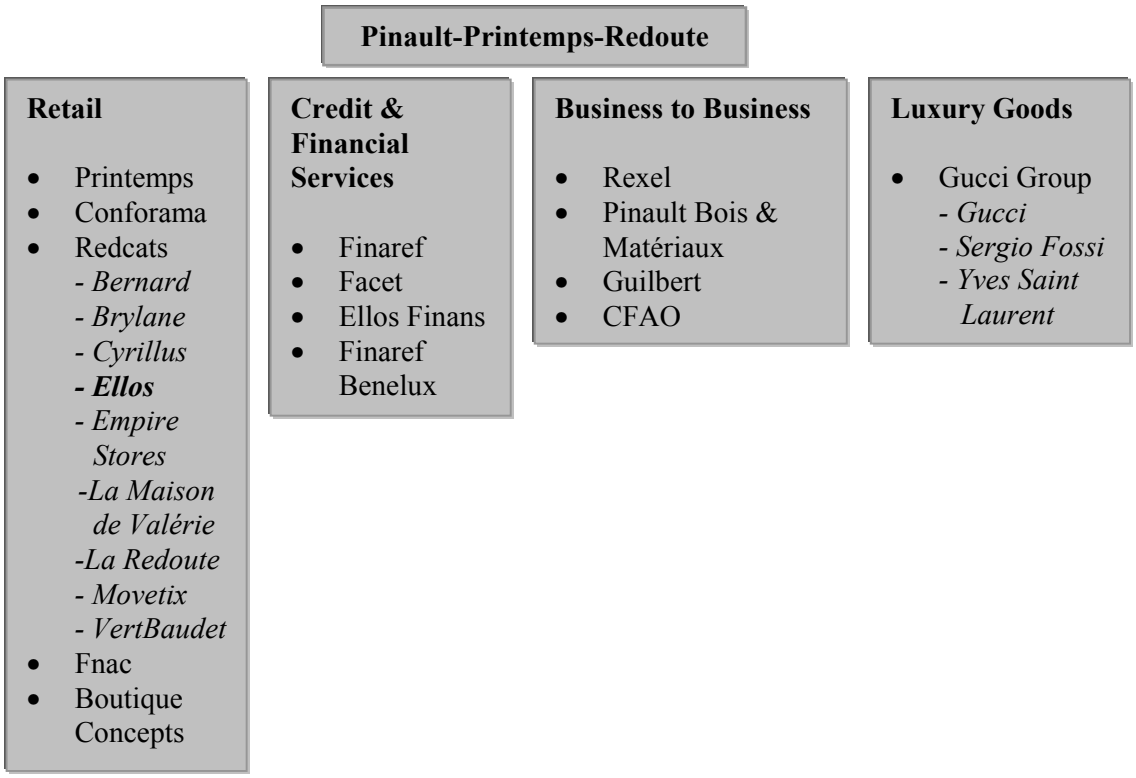


Fig. 1.1.2 The PPR Group. *Source: PPR Annual Report 1999*

1.2 Problem Discussion & Definition

The company site in Viared outside Borås was originally designed to take care of the Ellos brand only. However, since the acquisition of Josefssons and the new French ownership, there are five brands, and probably there will be even more brands in the future. The current brands are Ellos, Josefssons Josefine, La Redoute, Catalog Mail Outlet, and Enjoy, and these brands are operating in five different markets: Sweden, Norway, Denmark, Finland, and Estonia.

Below is a picture of the process all the way through the company. This model is a brief description of the different steps in the flow of goods, to give the reader an understanding of where our problem area is within the organisation. The framed area in the bottom of the model is the area we are dealing with.

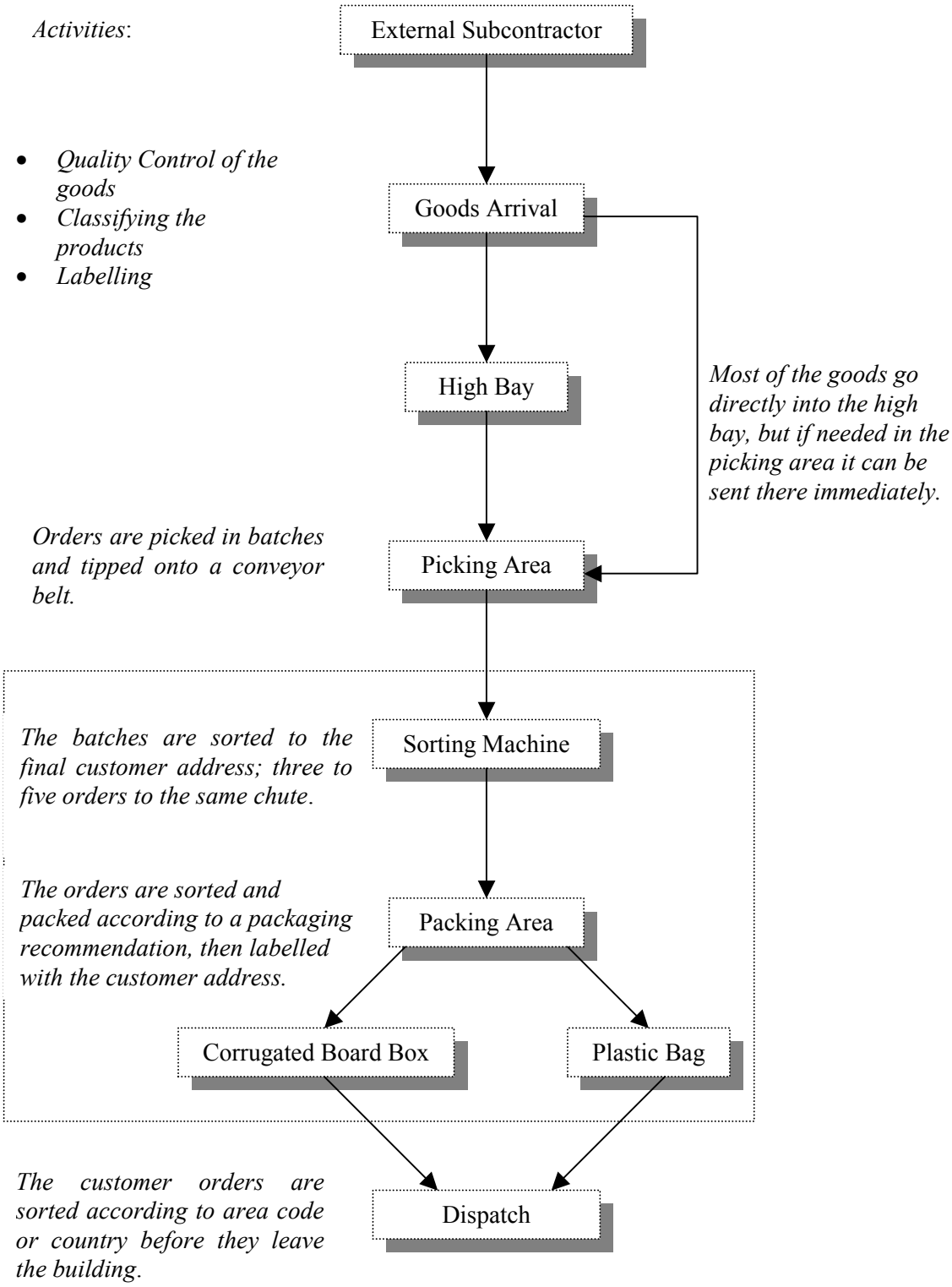


Fig. 1.2 The product flow. *Source: Borgerud*

First, the goods arrive by truck, most often in containers, to the facility in Viared and are there checked manually in terms of quality, weight, length, height and width before it is palletised. All pallets and boxes are labelled with barcodes and registered in the system to make it possible to track the items all

the way through the processes. Most of the pallets go directly into the high bay, but if needed in the Picking Department, they can be transfered there immediately. The boxes on each pallet are put on the picking shelves, and they can be put wherever there is a free spot. The person who puts the box in place reports the location by using a barcode registration. Through this registration, the box can be traced through the computer system.

The staff in the picking area gets their picking orders in the morning. The customer orders are split into batches that run in intervals of about 30 minutes. This means that the same person does not pick all the items in a customer order. When the picking staff have picked all the items in one batch, they empty their picking-trolleys on a conveyor belt, and the items are sent out to the sorting machine.

One of the sorting stations by the sorting machine

Here, the items come on a conveyor belt and are fed onto the sorting machine at eight spots, and at each of those there is one person who put the items so that the label will face upwards. The reason is that there is a dot-code on the label, which tells the automated sorting machine where to send each item. The items are automatically sorted to different chutes, and in this process, all the items in an order are sent to the same chute.

The sorting machine

The sorting machine has 252 chutes divided on four packing sides. Each chute takes 3-5 orders depending on the order size. The order size varies according to a seasonal pattern with orders containing many, and often large, items around Christmas, and smaller orders and items during spring and summer. Each chute is split into one upper shelf and one bottom shelf. At the end of the chutes, there are packing tables. The table is moveable, and there is one person at each table who takes care of the orders in 6-8 chutes.

A packing table with one trolley on each side

There are normally two orders on the upper shelf of the chute, and three orders on the bottom shelf, which means they have to sort two or three orders at a time. To make this sorting easier, the labels have special information. Each item in one order has a symbol, for example #. Next to this symbol, there is a number, and this number tells how many items there are in this certain order. Each batch number is printed on the labels, and in addition, the different batches have different colours on the labels. If there is one item with another colour, the packing staff knows that this item does not belong to any of the orders in the chute. This special design of the labels makes it easier to avoid mistakes. When all the items in an order are found, the packing staff puts them into a corrugated board box or a plastic bag. There is a packaging recommendation written on the order invoice, which the packing staff puts in the package. This is to help them to choose the right packaging.

The order invoice with packaging recommendation and address label

Then, the packing staff puts the customer address label on it before sending it on the conveyor belt to the goods departure area. There are two conveyor belts on each packing side, one for boxes and one for bags. The boxes go through a strapping machine before they are manually sorted into postal crates. Then the

boxes are sorted by country or by area code. The plastic bags are sorted the same way, but they do not need to go through the strapping machine.

The orders are packed in boxes or plastic bags of different shapes and sizes, and the packaging is different for each brand. It is viewed as being very important from a marketing perspective to have a special design for each brand, because the packaging can be seen in a lot of places along the way to the final customer, and is a valuable marketing channel. From a production perspective, on the other hand, there is a strong focus on logistics, and the distribution department wish there could be a uniform packaging for all brands. However, the different brands have different target groups, and these target groups do not know that the different brands are packed at the same place. This makes it very hard to find some kind of packaging that can be used for all brands.

There are boxes in 3-9 sizes, depending on brand, and plastic bags in 3 different sizes for each brand, except for La Redoute who only use the smallest bag. Because of this, the packaging material takes a lot of space in the different steps in the production flow. First, when the pallets arrive, they must be stored in a four-storey high pallet rack. Then the pallets are placed in different locations in the packing area, or part of it is put on shelves there, and finally the packaging is stored in two trolleys connected to each packing table. Before, when only the Ellos brand was packed in the facility, there was only one trolley at each table. The extra trolley makes it narrow between the different packing tables, and this is viewed as irritating by the packing staff. This is because they pack with individual speed, and then they bump into each other.

The packing staff also has to pack some leaflets in each package. These leaflets are both advertisements from other companies that pay for the service of distributing them, and the different brand's own advertisement. The leaflets must be in easy reach for the packing staff and are unique for each brand name and each country. For the people working in the packing area, this means that there is a lot of packaging material and leaflets to deal with. Forklifts do the supply of packaging and leaflets, at the moment two electric forklifts and one manual. These have their routes just behind the packing staff in isles that are very narrow. In addition, there are tables along each packing side, where the

packing staff put non-complete orders. Non-complete orders occur now and then for different reasons, most often because items get lost somewhere on the way out to the sorting machine, and then the missing item often show up in the following batch. However, sometimes it does not, and then the non-complete orders will need special treatment. One person at each side handles these non-complete orders, and this person uses a kind of bicycle to transport him/herself and the items. All this makes the utilization of floor space and packaging critical. The floor space available is too crowded at the moment, with a lot of movements and storage close to the packing staff.

A lot of packaging material is stored close to the packing tables

At the moment, Ellos can deal with the incoming orders, but they forecast that the number of incoming orders might increase. They have a large and rather expensive sorting machine, and they have once considered buying one more, and were very close to doing so. But, at the last minute, they realised that such an expansion would cause too much idle capacity and would not be efficient, and they still do not think this is the way. Instead, they have tried to organise the production in a way that will cope with daily demand. For example, they have introduced a five-hour shift in the evening. The introduction of the new

brands, especially La Redoute, went very fast, and this may have caused the logistic solutions being a bit rash. The routines surrounding the packing might not be as efficient as they could have been. Since there might be more brands coming in, Ellos needs possibilities to expand, but with the current routines, they fear that the capacity will probably not be enough for that. This is why they asked us to look at the situation and see if there were any improvements that could be made. They want us to investigate the packing routines, the packaging supply and surrounding activities. In addition, we were asked to see if there was any alternative packaging, or if the current packaging could be modified.

According to this problem discussion, we have been able to formulate a main problem and three sub-problems, and they are as follows:

Main problem: There is a lot of packaging material and a lot of routines in the same area, which makes the utilization of the floor space critical.

- Is the process of controlling the batches the optimal solution?
- Is the floor space utilization and the packaging variety optimal?
- Is it possible to re-arrange any of the routines connected to the problem?

1.3 Purpose

Our aim is to create a better organisation of the routines in the packing area at Ellos and to find the optimal mix of packaging material to achieve more space around the packing tables, and even in the packing area as a whole. This may result in less packaging material, other kind of packaging material or different types of handling of the packaging material. It may also be necessary for us to make changes in surrounding activities if we see that such changes can be valuable to optimise the packaging supply. The investigation has mainly a logistics perspective on strategic, tactical and operational levels. We also have to take some marketing aspects into consideration, but this is not the main focus. The thesis is mainly written for the people at Ellos, but since we are also

giving a description of the company and the routines there, it is possible for someone outside the company to understand what it is all about. We have one main purpose and three sub-purposes:

Main purpose: Optimise the flow of packaging material and the surrounding routines in order to create a better utilization of the floor space

- Developing new ways of allocating the items in each batch.
- Finding an optimal mix of packaging varieties and qualities, and an efficient flow.
- Investigate if it is possible to make any improvements in related routines.

1.4 Limitations

We were asked to re-design the packing department in the production flow in order to achieve a better utilization of the floor space, and also try to reduce the packaging variety. We have to consider that the company wants to expand and therefore our solution must be flexible. We do not necessarily need to make the new design more cost efficient, and we do not have to make any investment calculations. However, we are asked to give reasonable suggestions, and not suggestions that will be impossible to implement because of huge investment requirements. In the packaging industry, there are several types of materials used, but since Ellos use only plastic and corrugated board, our investigation about new packaging will only be within these two material. Other material such as glass, metal or wood are not of any interest in this study. As mentioned before, we have a logistics perspective, but there are some marketing perspectives to consider as well. The marketing perspective is something we take into consideration in our work, but it is not included in our purpose, so we do not go deeply into this.

We will again present the different areas in the purpose, and in connection to each area we will describe the limitations.

- *Developing new ways of allocating the items in each batch.*

In the recent system, all orders are more or less randomly distributed to the different chutes, without taking into consideration the size of the order or the single items. We want to investigate if it is possible to change the way the orders are distributed by the sorting machine, and give a suggestion of what this distribution would look like. The system that directs the orders to the chutes is a very complex computer system, and we will not go into how an actual change in that system will be performed. We will concentrate on designing the surrounding routines needed if this change is implemented.

- *Finding an optimal mix of packaging varieties and qualities, and an efficient flow.*

Today, there are five brands that are packed and distributed from the Ellos site in Viared, and all brands have their own profile of the packaging due to marketing value. However, one of the brands, Enjoy, is packed and distributed separately and will not be included in this study. The packaging for the different brands makes the packing area very narrow, because each packing staff has to have all kinds of packaging next to the packing table. We will investigate if there are any possibilities to reduce the number of packaging sizes or to find a packaging of a different material that might use less space.

- *Investigate if it is possible to make any improvements in related routines.*

There are a lot of routines in the packing area that interact heavily with each other. A re-design of one routine will cause a chain effect on surrounding activities that take place in the same area. We have tried to isolate the routines that are close to each other and are having a large effect on the floor space utilization. We will concentrate on the packing area of the facility, and will not make any investigations in the picking area or in the goods departure area, even though these are closely related. Of course, we have to consider what effects our suggestions will have on other departments, but we will not go into other departments to make changes. We will probably have to take into consideration different ergonomically aspects, since the problem area is labour intensive and

automate is only an opportunity in a few cases. However, there will just be a brief mention of these.

1.5 Definitions

There are some words and definitions that are very specific to the mail order business. We will below give a short explanation of those frequently used throughout our work.

Batch – the production is run in intervals, batches, and every batch is about 30 minutes long. This is the time the packing staff has to complete the packing and also the time set to sort the following batch.

Chute –a compartment where the items are being sorted in. Each chute has two compartments and contains 2-3 orders each for every batch. One person takes care of 6-8 chutes.

Chutes containing sorted items

Crate – the distributors, mainly the post office and ASG, requires that the parcels are packed into crates that can either be of steel or of corrugated board. This since it will ease their handling.

Leaflet – advertisment that Ellos sells to different external companies. It can also be internal advertisment, for example financial services.

Packing staff – the people that performs the packing task.

Packing table – the table every person has to perform packing at. On each side there is a trolley connected, where they store all the corrugated board boxes. The plastic bags are stored in compartments under the table.

Picking department – this is the area where the items are picked from the inventory. The picking is also performed according to the batch system. All items that are to be included in one batch will be put on a conveyor belt at the same time. The conveyor belt transports the items to the sorting station.

Sorting machine – this is the machine that sorts all the items into customer orders. During one normal day the sorting capacity is 105 000 items, equivalent to 25 000 orders. It has a speed of 1,86 m/sec and contains 186 sorting cells.

Strapping machine – in order to seal the lid and the bottom of a box, the box goes through a strapping machine. One or two white straps automatically seal the box.

1.6 Outline of the report

We have divided the empirical study in three parts A, B and C, connected to each of the sub-problems and sub-purposes. Each part has its own chapter, which includes an analysis at the end of each chapter. The three parts follow the three different levels within Operation Management, strategic, tactical and operational.

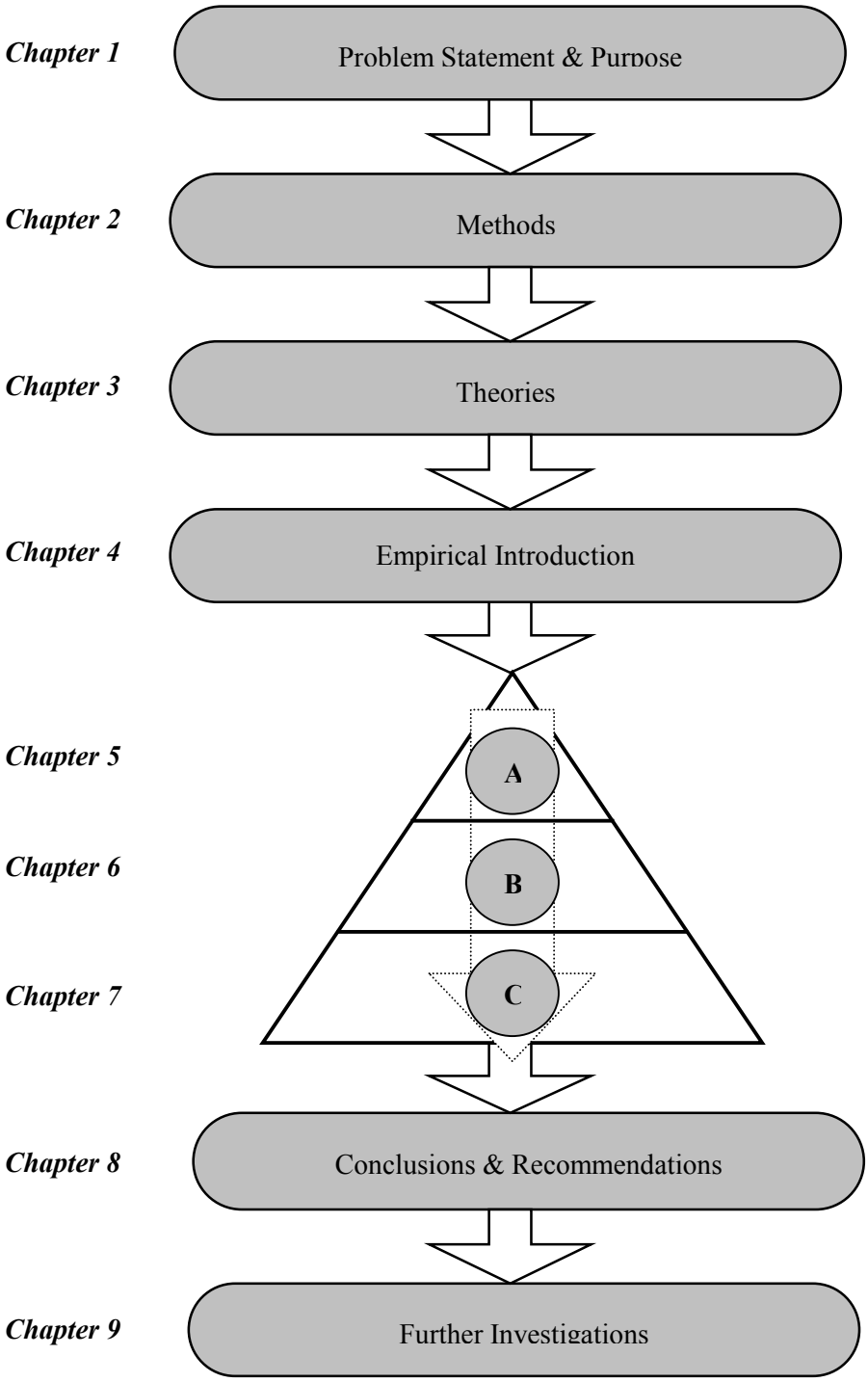


Fig. 1.6 Outline of Report. *Own model*

2 Methods

In this chapter, we will describe the methods we have chosen for this study. We have one main research method, even though it has influences from other methods as well. The methods for data collection, as well as analysis, differ for the different areas. At the end of the chapter we present our working model, where it is shown how all the parts of the problem correlate, and how we intend to treat them one by one.

2.1 Methods for Research

There are three main methods: Exploratory, Descriptive and Causal Research. Of these three methods we find the exploratory research method the least suitable. The reason why we do not think it is an exploratory research is that the problem was well defined and the problem area has been investigated before. (Gill 1997)

The people at Ellos asked us to make some further investigation because they wanted new ideas in an old problem area. This makes our work of both a descriptive and causal character, because we have to describe the existing processes thoroughly in order to give the reader an understanding about the problem to be able to follow the work. However, we have one main problem with three sub-problems that we think are related to the main problem. The aim is to see how these sub-problems correlate with the main problem, which makes the study focus on the causal research method.

If a single case is studied in depth, it is a case study. A case study focuses on details and gives deep explanations, but it does not say anything about that specific case in relation to others. The case study can either be done with a cross section approach or a time series approach. Within the cross section approach, there are two approaches, the survey approach and the experimental approach. In the survey approach, the reality is studied and registered as it is, without the observer interfering with it. Often, the results are shown in

diagrams and tables. In the experimental approach, the observer tries to design the reality in a way that throws light upon the problem area. (Lekvall 1993)

Case studies often have a qualitative character, and this means that the data collected and the results are not expressed in numbers, which is the way to do in a quantitative study. (Lekvall 1993) Our study has mainly a qualitative approach, because we are mostly working with things that cannot be measured or presented in numbers, even though we use numbers and statistics in some cases. However, we have one part, the simulation, that is quantitative, and we will tell more about this in section 2.3 Methods for Analysis.

Since we are going deep into the problem that is specific for Ellos, we consider this being a case study. The study is divided in different parts, and we use different approaches in each part. At the beginning of the study, we used a lot of survey approach in the data collection process, and further on we used a more experimental approach. However, the main approach is a causal research design with a lot of descriptive and experimental elements.

We also consider our study to have an inductive approach, because we have a very practical problem which we are studying with the help of our own models. We then search for applicable theories to this problem. The approach is not purely inductive, because we do not develop our own theories. We use existing theories to draw conclusions about our problem area. (Gill 1997) We will present the theories further on in Chapter 3, but we will present the different methods we have chosen to solve the problem and reach our purpose here. These methods are simulation and true experiments.

2.1.1 Experiments

There are three kinds of experiments, the true, the laboratory and the simulation. In the laboratory experiment, you create an artificial environment where it is possible to control all the input data. The advantage with this method is the ability to control the input, and that it is possible to eliminate

almost all disturbing factors, or at least isolate them and see the effects they have on certain behaviour. The laboratory experiment is considered to have a high internal validity, but a more questionable external validity. The true experiment is the opposite of the laboratory experiment. This experiment is done in the real environment and is considered to have high external validity, whereas the internal validity is low since it is hard to control disturbing factors. The simulation experiment is a model of the real world, which gives the opportunity to vary the input data and study the different effect those have on the result. (Lekvall 1993)

We will make two experiments in this thesis, one simulation and one true experiment.

Simulation

QBM is a scientific method for modelling and simulation, and stands for Quality Based Modelling. Since the problem is often vague at the beginning of the process, the QBM method focuses on using the simulation as a tool for problem solving. This method is iterative, which means that it sometimes might be necessary to build a completely new model after a while. (Lind 1997)

When working with this method, the following stages are used in the process (Lind 1997):

1. **Determine the purpose**
2. **Describe the system**
3. **Identify the problems and their relations**
4. **Identify goals and their structure**
5. **Build the model**
6. **Validate the model**
7. **Make model experiments**
8. **Put the results together and arrange presentation**
9. **Validate the result**
10. **Present conclusions and recommendations**

Through the description of the system and the purpose of the modelling it is possible to identify the problems in the specific situation. These problems should be listed and drawn in a picture to show the relations between them. When doing this, it is possible to see which problem is the cause of the others. Then this list is used to create a list of goals, and the goals must meet the purpose of the modelling. The goal list shall also be drawn in a picture, where the hierarchical structure and the relations between them are shown. (Lind 1997)

The model characteristics shall only specify things that meet the purpose, and this is true even when it comes to determining the level of abstraction, which we will refer to further on as limitations. There are also limitations depending on the modelling technique, the time and resources available. (Lind 1997)

Simulation models most often require some random behaviour, and this is implemented in the model through a probability function, which makes it possible to generate random numbers that follows a specific distribution. When the decision is made that random numbers of a certain distribution are needed, it is very important to test that those numbers are good representatives from the distribution. (Lind 1997)

There are several advantages in using the simulation technique. First, as mentioned before, we do not have to make any investments in equipment. With simulation, we are able to test how a suggested change will work and after that make a decision whether it is good or bad. Second, we can elaborate with the time and the people needed in the process and analyse this in different ways, and we can understand why things happen. There might be some events in reality where it is hard to understand what causes certain behaviour. In a simulation, you can isolate different events and see what happens in different situations. You can also be able to identify constrains. Third, it is an opportunity to explore the different possibilities in the system without interrupting the daily work in the real system. Fourth, it is a good way to visualise a plan and make it easy for others to understand, and this is a good tool for preparing for changes in the future. And finally, it is possible to specify

requirements when designing a system, which means that it is possible to make wise investments. (Banks 1998)

The disadvantages are that it requires a lot of training to build a model. Simulation is an art where the skills come through experience. It may also be hard to interpret the results, since most outputs are random variables based on random inputs. Because of this, it can be hard to determine whether the output is a result of system interrelationships or randomness. Overall, the analysis can be very time consuming as well as expensive, and the simulation itself may not be sufficient to make a decision. Sometimes it is even inappropriate to use the simulation technique at all. This is true when there is a possible or even preferable analytic solution to the problem. (Banks 1998)

We chose to make a simulation as one experiment as we found this was a suitable tool. We chose this one because we wanted to control the input data, and also because there was no practical possibility for us to do a true experiment. The reason why we could not make a true experiment is because today, the computer systems are not built this way. Another reason is that we would have to interrupt the daily production and this makes it too complex, too time consuming and too expensive.

True Experiment

Our problem area also includes suggesting new ideas. In order to test these, we chose to make true experiments. These experiments are done with a small group, and following up in terms of asking questions about the opinions in the group. We chose to perform the experiments with a small group, since a large experiment would have interrupted the production. The reasons why we had to do a true experiment were because of quality and durability, and the smoothness in the working process. If just analysing the situation and asking about people's opinions without really trying the idea, there is a risk of failure when implementing it. Since there are so many people that are affected by the outcomes of a new idea, we think it is necessary to test it on a small group to really understand the strengths and weaknesses it brings. This understanding is, according to us, impossible to achieve without performing a true experiment.

The good thing about experiments is that you immediately see if there is something wrong that needs adjustment. The disadvantage is that it is expensive. In order to make it less expensive, it is possible to pick a small group or a small part of the production to be in the test. But this might not show all the consequences the new idea might have when you include all the steps or all the people. Something that works fine with a small group might be a catastrophe with a large group. (Lekvall 1993)

2.2 Methods for Data Collection

Data should be collected when needed, and it is necessary to use different sources. Direct observation, interviews, manuals and work descriptions are examples of suitable sources. The major problem with written information is that it often contains unnecessary data and is organised in a way that does not suit the modelling purpose. (Lind 1997)

There are two types of data, primary and secondary data. We have used some different methods to collect the data we needed, and these are literature search, observations, personal interviews, and site visits. The methods for collecting the data are presented here.

2.2.1 Primary data

Since we mainly have an inductive approach to our work, we put much emphasis on obtaining as much knowledge as possible about Ellos. The problem is very specific for Ellos, and this means that most of the data we need is possible to get there. Most of the time we were working at Ellos, so we had the opportunity of asking questions along the way when they occured. We made a lot of observations and unstructured interviews in the beginning to get a clear picture of the organisation and the different processes. We have also been going through an introduction program to get a more holistic view of the company, not only the Packing Area. We have seen the Goods Arrival, the

Picking Department, the High Bay, and the Order Return among others. In addition, we have been talking to subcontractors in the packaging industry to get information and ideas. The subcontractors we have been visiting are Stora Enso in Skene and Draken in Reftele.

We have also got information from benchmarking in terms of site visits and one exhibition. We made one site visit at Haléns in Borås, which is a mail order company in the same sector as Ellos. Another site visit was made at Total Logistik in Viared, a company that takes care of storing, sorting and packing for a number of different companies. We also went to the Scan-Pack exhibition in Göteborg, which was a great opportunity for us to learn about the packaging industry and the different technologies there are. Here, we could also ask all kinds of questions and make some valuable contacts.

We have also been collecting data in order to perform a simulation model in the software called Planimate. This data has been collected through time studies and information from databases in the internal system at Ellos.

Using this mix of data collection methods is called the triangulate method. This means that you can use methods that are questionable, but still have some interesting features, together with more respected methods. (Svenning 1996) Since we have a large problem area that contains a lot of routines and processes, we need different methods for each in order to get the appropriate data. Some of the data collection has been performed in a rather informal way, for example we can just go in to the person next-door and ask a simple question, or have a discussion during lunch.

Observations

Observation can be both quantitative and qualitative oriented. In observations, it is important to avoid taking part of the things observed. However, when being careful and listening to people with respect to their knowledge, it can be useful to participate in the observation. The participating observations are unstructured, and they shift from looking, listening, asking questions, and acting. The observations can be hidden or shown in different levels. For

example, you can let everybody know that you are making observations, but you can avoid telling them what you are really looking at. (Svenning 1996) The observations must be made under normal circumstances, and the people observing may not affect the result. (Rubenowitz 1980)

We have made observations of the packing area. Everyday, when we have been at Ellos, we took a walk in the production area to see what happens from time to time. It has been a great advantage for us to be able to do this, because as soon as we needed to see "the reality", we could just go out there and have a look. We joined the different groups for a couple of days. This gave us a better understanding of what the working situation is like, and this is the participating part of our observation. When participating like this, there is a risk that we loose objectiveness. We might loose perspective because it is possible that we start to like some people and listen more to these. (Svenning 1996) However, we do not consider this as a problem, because we have not had the opportunity to get to know people that much in the packing area, where the observations take place.

The good things about observations are that you can look at a situation with quite objective eyes, and you get impulses you would not have got if someone told you about the things happening. You can see things that people might not be willing to say. The bad things are that you may not understand everything that happens, and you can draw completely wrong conclusions about a situation if you do not talk to anybody about it. It is only possible to study the way people act, not the way they think or what they know or their values. The observation can only give answers to what is happening right now and says nothing about what has been or what will be in the future. (Lekvall 1993)

Personal Interviews

Making interviews is a method that many people prefer to use. The personal interview is a lot more flexible than other kinds of data collection methods. It is possible to ask follow-up questions and to get a more holistic view of the respondent and his/her values and knowledge. People normally prefer to talk instead of reading and filling out a form with standardised questions. In spite of

this, it is questionable to use only interviews in an investigation. The main reason for this is the problem of interview-effects. It is very hard to be objective when interviewing, and it is hard not to affect the answers the respondent gives. The results of several interviews might as well be hard to put together and generalise from. (Rubenowitz 1980)

Personal interviews can be done in different ways, and the two main ones are structured and unstructured. In the case of an unstructured interview, there is no schedule. Here, the respondent is allowed to associate freely and talk as much as he/she wants about a certain topic. In the structured interview, the interviewer has a structured form of questions, and the same questions are asked to each respondent. Either the respondent has to choose from a certain number of answers, or the question can be of an open character, where the respondent can answer the question freely. The latter most often gives a more comfortable conversation, and is the most preferred kind of interview. (Rubenowitz 1980)

We decided that personal interviews would be preferable in our problem area. We figured that the probability of getting enough information and satisfying answers through a questionnaire would be low, and since we have been situated at Ellos, we were not limited by time or resources to perform the interviews. We did not use a tape recorder when doing any of our interviews. The reason why is because we think that the tape recorder could make the respondent nervous or irritated, and might reduce the willingness to talk about some issues. We argue that people are more talkative when they know that the things they say is only heard once. Instead, one of us was asking the questions while the other was writing down the answers. The purpose of those interviews was to get an indication of what the heart of the problem was, and also get different opinions about the problem area. We also tried some of our own ideas on those referent persons to see the reactions about it. We are aware that people often react in a negative way when it comes to changes, but still we think it was interesting to get a hint of whether it is an idea to work on or not.

There are eight groups in the packing area, and we wanted to hear their opinions about the packing area. Because of the problems with interrupting the

production and the number of people working in the area, we could not talk to everyone. Therefore, we asked each group to choose one referent person that we can make deep interviews with. This method of selecting the population might give some misleading information, because we do not know if the referent person really represents the opinions of the group. On the other hand, it would be impossible for us to pick out the "right" people as well, because we do not know them and we do not know the structure of the different groups. The interviews are of a structured character with open answers, because we want the respondent to talk as much as possible about our questions.

We also do a lot of unstructured interviews along the way. Because we are situated at the Ellos facility, we have the possibility to ask questions to the right people right away when a problem shows up. We also have a lot of daily informal discussions, for example during the coffee break. This we see as very important to get a holistic view of the situation.

2.2.2 Secondary data

There are several problems when it comes to finding the appropriate theoretical framework. First, it can be hard to find relevant literature, because it is hard to know what to look for and where to find it. Second, it can be hard to choose suitable theories out of the literature. Often, the literature does not apply perfectly to the problem area, and in the beginning, when the problem formulation is vague, it is hard to know what will best suit the problem. Third, it might be hard to know whether the intended investigation will contribute to anything new in the studied area or not. Sometimes, it is possible that the problem is already investigated, and in that case, it is important to define what perspective the investigation have. Maybe the new research will give new knowledge just because the perspective is different. (Svenning 1996)

In order to find the right literature from the start, it is a good idea to ask tutors, teachers, other students or other people. The interaction with other people is important, not only in the literature search process. New knowledge and new angles to a problem are best developed together with other people. (Svenning

1996) We got some tips about literature from these sources, and most of the literature we could find at the Economic Library at Handelshögskolan, Göteborg. This secondary data is books about operations management and packaging logistics. The problem with the secondary data we found is that it is always written about production. In most cases, it is possible to make the production of a product very efficient, because there are a lot of identical products passing through the system. However, at Ellos, all the customer orders are unique, and therefore you have a lot of steps that are hard to automate. However, we found that the books were useful anyway, because we can use the structure and the theories that are common for all kinds of industries and apply it in our work.

2.3 Methods for Analysis

The difference between qualitative and quantitative research is not as big as one would think. The analysis and interpretation of a qualitative study often has a subjective character, and the methods and techniques for this mostly have a loose structure and are not well specified from the start. This is something natural because of the character of the study. However, the quantitative study is also subjective, even though one might think it is objective just because it is possible to analyse from absolute numbers. (Lekvall 1993) In this study, the main analysis is having a qualitative character, but since we have a simulation part, it also contains a quantitative part. This quantitative part is important for the rest of the study, but it is not the main analysis.

The experiments in a qualitative model are directed towards understanding the behaviour of the model by looking at the influence the different objects have on it. There is no standard for analysing experiments of this kind. (Lind 1997) Since there is no written standard for how to deal with the analysis of a qualitative study, this chapter mostly deals with the analysis of the quantitative part. Even though this is not the main analysis, we have to go through it thoroughly.

In a quantitative model, there are several different combinations of parameter values that can be tested, but in a large model, it is not possible to include all different combinations. Therefore, it is necessary to decide which combinations will create significant result with a minimum number of experiments, according to the purpose of the simulation. If the model has a random behaviour, the number of experiments to be done, with the decided combinations, should also be set. Each experiments should have the same set of random numbers, so the start values for the random number generator must be determined and documented. (Lind 1997)

To guarantee that the simulation model can handle the different values, a sensitivity analysis should be done. It is preferable if the values can be both increased and decreased, and the analysis should be performed with the same sets of random numbers as in the main experiment. The most common is to change one value at a time, to be able to isolate what result will be of each parameter. (Lind 1997)

Quantitative models can create an enormous amount of output data, especially a computer model, and this result must be put together and presented in a way that is understandable. Examples of this are diagrams and pictures, tables that are easy to read, and mean values of interesting figures. The result must also be validated in order to draw conclusions from it, and this can be done with some statistical methods. An example of this is to use confidence intervals, which gives the reasonable limits that the values vary within. After all this, the result can be used as a basis to draw conclusions from. Here, it is important to be clear about the purpose to avoid moving outside the target area. It is not allowed to draw conclusions about something that is not covered by the purpose of the model. (Lind 1997)

It is important to know how many runs we need to do with the model in order to achieve a result that is possible to draw conclusions from. To test if we had enough runs, we used confidence intervals. We used confidence intervals in the analysis as well when comparing the alternatives. This is the qualitative part of the analysis, but we made a qualitative analysis of the model as well, because we do not think that it is possible to solely trust numbers. As mentioned before,

the rest of the analysis in the study is qualitative, and we will use our working model showed in the next section when proceeding through this process.

2.3.1 Working Model

We have developed our own working model, and we are mainly going to follow this model when we are analysing the problem and the suggested solutions.

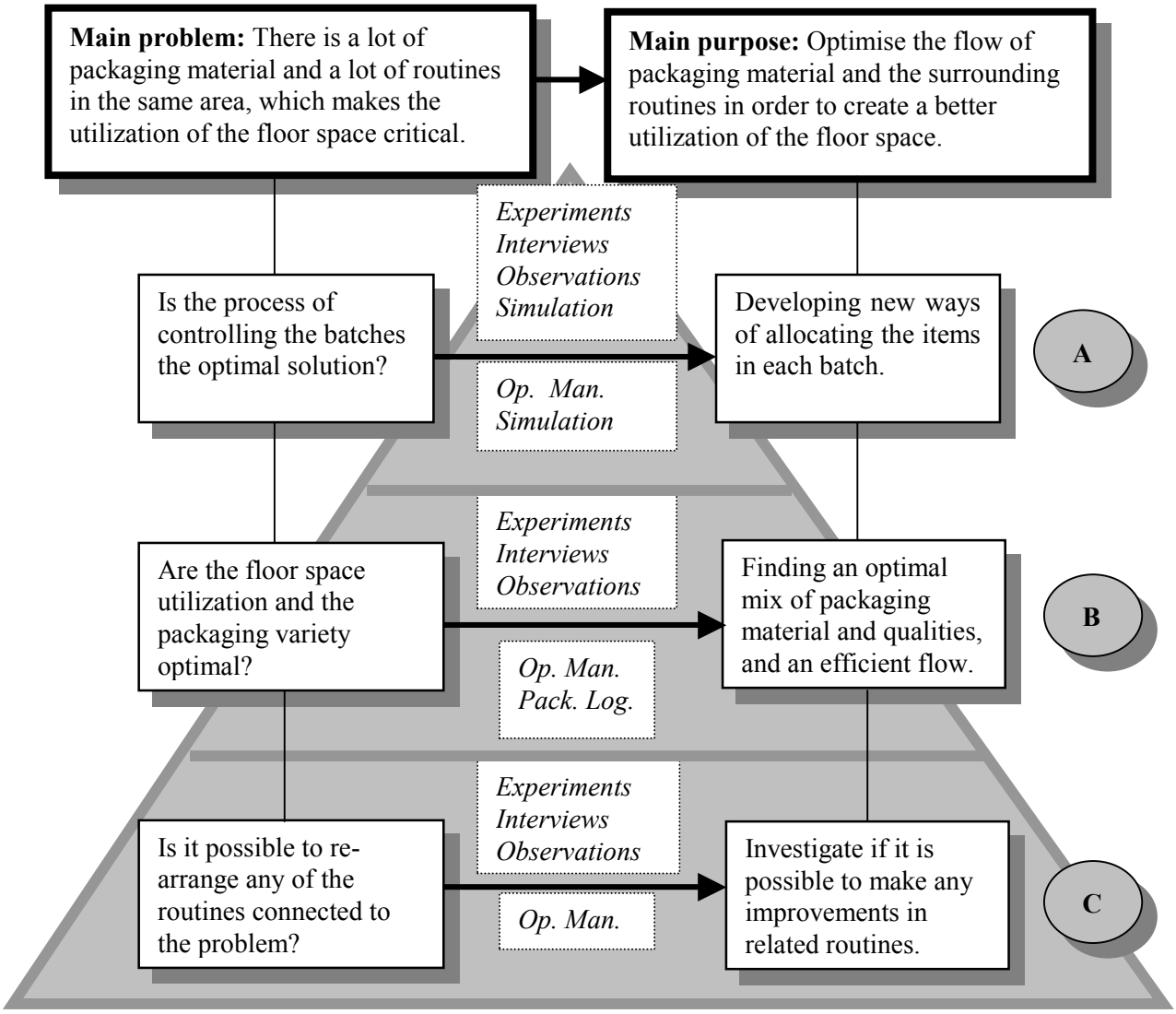


Fig. 2.3.1 Working Model. *Own model*

This working model combines the problem, the purpose, the different theories and the chosen methods. The main purpose and the main problem are those squares with shadow and a thick frame, and the smaller ones with shadow are

connected to the main purpose and main problem respectively. Next to each sub-problem, within dotted frames, we show the theories and the methods used for each sub-problem in order to reach the sub-purposes.

Next to each sub-purpose, there is a letter. This letter shows in which part of the empirical study the specific sub-purpose will be handled, and each part has its own chapter, since they follow the different levels in Operations Management. In connection with each sub-purpose we will also make the analysis of it, and when performing the analysis, we use the methods and theories described in Chapter 2 and 3 respectively. This means that we do not have a specific chapter for the analysis. Instead, we have chosen to make one analysis for each of the purposes in immediate connection to the empirical part. In the chapter with conclusions, we put all three problem areas and their related purposes together in order to reach the main purpose.

2.4 Validity & Reliability

In order to inform the reader of our view of how reliable our results are, we discuss the issues of validity and reliability in this section. This is our way of telling the reader how trustworthy the contents are.

2.4.1 Validity

Validity is a measurement of the conformity of what a measuring instrument is supposed to measure and what it really measures. (Körner 1996)

An investigation captures the reality more or less accurately. There are a lot of factors that will work together. The observations, the interview technique and the openness of the respondent, and the experiments shall create wholeness in the study. There are a lot of factors that can affect this. The validity consists of one internal and one external part. (Svenning 1996)

The internal validity deals with the study itself and the direct connection between the theoretical framework and the empirical study. That is, the interviews shall be performed with relevant people and the experiments shall have enough samples to answer the questions. The external validity concerns the study with all its contents in a wider perspective, that is, if it is possible to generalise from the study. If the study does not have internal validity, this means that it does not have external validity either. However, the opposite might not be true. (Svenning 1996)

In our case, we do not have the intention to achieve a high external validity, since the target group is the people working at Ellos. We put a higher focus on the internal validity, since we want to present a result that is applicable on Ellos.

According to the simulation, validation means that the model is checked to make sure that it is a sufficiently close picture of the real system and for the modelling purpose. It is important to evaluate what the consequences of the differences between the model and the reality will be, considering all the limitations and simplifications. Viability is the time perspective of the validity of the model and answers the question if the model will work well during a reasonable time. Discontinuity in values of the parameters could be an indication that the model is not sufficiently stable, and the sensitivity analysis can also give hints about this. When determining the premise validity, it is checked that the premises the model is built on are well known and accepted facts. Comparing the behaviour and the output from the model with what has happened in the historical system can be an important validity test as well, and the ambition is that the model should be able to say something about the future. Limitations and simplifications are things that influence the behaviour of the model, and this affects the technical validity. In case the model builder has any doubts about the model, he/she should state this, and this determines the subjective validity. The total validity should be an overall view of the model, how it works as a whole. The results must also be validated to be able to draw conclusions out of the model. In order to validate the results, it is suitable to use some statistical methods. (Lind 1997)

Since Planimate and the figures used at Ellos are well established, we think that those measurements are reliable. The critical factor is what data we put into those instruments. We have to be very careful when we estimate the time it takes to pack an order. However, we have discussed the different numbers thoroughly with people at Ellos who work daily within the operations, so we think they are trustworthy.

2.4.2 Reliability

Reliability deals with how reliable the measurements really are, that is, how much the hazard may affect the result. High reliability means that the measurement is done several times in the same way without turning out with very different results. (Körner 1996)

Things that can make the reliability low are, for example, wrong samples, interview-effects, problems with standardisation in interviews and problems in interpretation. In order to achieve higher reliability, there should be clear definitions of the concepts used in the study, especially in interviews. It is also important to have several indicators to measure a phenomenon important to the study. When getting information from separate sources, the data is more reliable. The demand for reliability is higher in a quantitative study, because a qualitative study is more exemplifying than generalising. (Svenning 1996)

We have different parts in our study, which have different types of reliability. The simulation part is a quantitative experiment, which needs high reliability. The other parts are more of a qualitative character, which makes it harder to define the degree of reliability. However, since the study is made for Ellos, and we have got the data from people at Ellos, we judge this to be reliable for its purpose. We have tested the model, both towards the real system and running it several times, and the behaviour has been stable, so we consider it to be reliable.

3 Literature & Theoretical Framework

In this chapter, we describe our theoretical framework that consists of three sections, Operations Management, Simulation, and Packaging Logistics.

3.1 An introduction of chosen framework

Since we have three main areas of investigation, we will need different theories for these. However, the three theories are not isolated to one empirical area each. As can be seen in figure 2.3.1, the theory of Operations Management goes through all parts. Then, Simulation is specific for part A, and Packaging Logistics is specific for part B. Since the theory of Operations Management has influenced the whole thinking when performing the investigations, analysis and conclusions, we start our theoretical presentation with this. However, first of all we will introduce the reader to some thoughts that, according to us, represents the way of thinking in the chosen literature and thereby in this thesis.

Operations can be of two categories; movements that do not add value and movements that add value. The first category is actually a kind of waste. The second category is some steps in the process where you actually work with the product. **Waste** consists of all unnecessary movements that are done in order to complete an operation, and those should therefore be eliminated. Examples of this is waiting time, piling products, re-loading, movements and so on. So, the goal is to eliminate the reasons of waste. (Shingo 1994)

Transportation is a movement that does not add any value to the product, so in a way it is a kind of waste and it only costs money. When automating transportation, you just transfer one kind of cost to another. Instead, you should try to eliminate transportation as much as possible. This reasoning is also true for storage. The most important is to improve the facility layout before you start to mechanise or automate. Going the other way is completely useless. “Transport rationalisation” and “rationalisation of the transport work” are two concepts of completely different dimensions. Using fork lifts and conveyor

belts is not transport rationalisation, it is only rationalisation of the transport work. True transport rationalisation aims at eliminate the need for transportation as much as possible, for example through a rational facility layout. (Shingo 1994)

3.2 Operations Management

*"**Operations management** is the management function that is responsible for all the activities directly concerned with making a product. It is responsible for collecting various inputs, and converting them into desired outputs"(Waters 1996, p19)*

Ever since people started to work together to reach a common goal, operations management has been an important ingredient, but since the industrial revolution, it has grown most rapidly. Operations management is the tool behind the technical improvements that makes production efficient. It is the way to plan and organise how the technology and machinery will be utilised the most. The productivity in an organisation depends on both the right technology and the right way to manage it. In management, it is important to rely on knowledge and skills instead of intuition when making decisions. In the 1980s, the Japanese companies were leaders in operations management, concentrated on high quality, high productivity and customer service. (Waters 1996)

There are four stages in which to tackle problems in the area of operations management, and these are:

Observation – managers realise there is a problem and that it is necessary to find a solution. They analyse the problem, collect the data needed, set objectives, and discuss various ideas.

Formulation – people with appropriate skills review the data, build models of the current situation in order to find solutions and give suggestions of alternative actions.

Analysis – managers examine the different alternatives and evaluate different parameters to find the best decision and then make recommendations.

Implementation – managers make the final decisions and implement the new solution. They monitor the actual performance and collect feedback. They also keep the results up to date to see improvements or mistakes.

The decisions necessary to make can be of different importance and have different consequences in the organisation, and therefore, they can be classified as **strategic**, **tactical** or **operational**. Strategic decisions are long term, high-risk decisions that needs a lot of resources, and are made by senior management. Tactical decisions are medium term, less risky needing fewer resources, and are made by middle management. Operational decisions are short term with a low risk, using few resources, and are made by junior management.Examples of issues at the three different levels are listed below, and we will focus on those issues shaded in grey:

Decision Area	Typical operations decisions
Strategic Decisions	
Business	What business are we in?
Product	What products are made?
Process	How are products made?
Location	Where are products made?
Capacity	How large should facilities be?
Quality management	How good are the products?
Tactical Decisions	
Layout	How should operations be arranged?
Planning	When should a new product be introduced?
Quality assurance	How is planned quality achieved?
Logistics	How should distribution be organised: what transport should be used?
Maintenance	How often should equipment be maintained and replaced?
Staffing	How many people should be employed and what skills do they need?
Technology	What level is most appropriate for planned production?
Make/buy	Is it better to make or buy components?
Operational Decisions	
Scheduling	In what order should products be made?
Inventory	How much should be ordered and when should orders be placed?
Reliability	How often does equipment break down: what can be done to improve this?
Maintenance	When can maintenance periods be scheduled?
Quality control	Are products reaching designed quality?
Job design	What is the best way to do an operation?
Work measurement	How long will an operation take?

Fig. 3.2 Types of decisions. *Source: Waters 1996*

Operations management includes inputs, operations and outputs. Examples of inputs might be raw materials, money, people, machines, time, and others. Operations include activities such as manufacturing, assembly, packing, serving, and training, among other things. Outputs are goods, services, staff wages and waste materials. (Waters 1996)

When wanting to describe the details of a process, it can be useful to draw a process chart. This can be done by asking questions like (Waters 1996):

- What operations are done?
- What is the sequence of these?
- Which operations can not be started until others have finished?
- How long does each operation take?
- Is there any idle time?
- Are products being moved?

The next step is to make improvements in this process, and then there are some questions as well:

- Why are things done like this?
- How might things be done better?

To start with, it is a good idea to classify each operation as one of five different definitions:

- Operation, where something is actually done
- Movement, where products are moved
- Storage, where products are put away until they are needed
- Delay, where products are held up
- Inspection, which tests the quality of the product

3.2.1 Facility Layout & Layout Design

The processes in an organisation must be arranged physically as well, and this is called facility layout and layout design.

"Facility layout *is the physical arrangement of equipment, offices, rooms, and so on, within an organisation. It describes the location of resources and their relationship to each other."(Waters 1996, p. 248)*

Facility layout is about how you arrange the working space and can be divided into three levels: (Vonderembse 1996)

Highest level: How should the departments or work groups be arranged? Which departments or groups should be located close to each other, and which can be farther apart?

Middle level: How should people, equipment and storage be arranged within the departments or work groups? How large should the department be? How much equipment is needed, and how should it be arranged?

Lowest level: How should each work space within the department be designed in order to make it possible to do the tasks efficiently and effectively?

All those issues in the three levels are related, because the space needed for each person at the work place is a function of how well the individual working space has been designed. One objective of facility layout is to provide convenient access between two groups or departments that integrates a lot in the process. In some cases, departments may need the same resources even though they do not interact with each other, and this is also a reason to locate them physically close. If departments have little to do with each other, they should be separated when possible. The reason for this is that everything that has to move around the facility costs money. The goal is for the management to minimise these costs without reducing overall effectiveness. (Vonderembse 1996)

"Layout design *aims to organise the physical arrangement of facilities so that operations run as efficiently as possible."(Waters 1996, p. 249)*

There are mainly two objectives with layout design. The first is to arrange a process and its facilities in a way that achieves the desired output using a minimum of resources. The other objective is to arrange the facilities available in a way that makes the maximum output. These objectives have a number of related questions that, for example, tries to figure out how much space is required for each operation and how the space shall be arranged. It is also necessary to consider what equipment and what kind of service are needed in a certain area, and so on. There are also constrains in every organisation, and

these must be considered. The main constrain is that there is only a certain amount of space for each operation, and the others might be:

- The design of the product
- How much capacity is planned
- What types of processes
- The total space available
- Other site constrains
- What kind of materials handling equipment
- How much capital there is available for investment
- What need there is for service areas
- What the communications and the information flows look like
- Safety needs

One method used to plan the layout is called systematic layout planning, and this contains a subjective view of how close different areas should be. For example, a noisy area is desirable to keep away from an area where it is necessary to have a quiet environment, even if these two areas have a lot of movements in between. The most common reasons for different kind of decisions are:

- Sharing the same facilities
- Sharing the same staff
- Ease of supervision
- Ease of communications
- Sequence of operations in a process
- Customer contact
- Safety
- Unpleasant conditions

The different aspects can be put in a matrix that shows the degree of importance of having two operations close together and the reason why. This way of designing a layout is rather informal.

3.2.2 Job Design & Work Measurement

Job design is the best way of doing a job, and **work measurement** is how long the job will take. The aim of an organisation is to make the employees working as productively as possible and the definition of this productivity is:

Output / labour input = labour productivity

The productivity can be improved if the processes are designed in a better way. Another factor is motivation, which makes people work faster. The aim of job design is to reach a better way of doing the same job through using better methods, tools, materials or techniques. The performance of an organisation depends on the performance of the employees, so the most efficient way to improve the productivity is to create conditions that allows the employees to work efficiently.

"**Job design** *describes the tasks, methods, responsibilities and environment used by individuals to do their work. It aims to find the best possible way of doing a job."(Waters 1996, p 513)*

Roughly, there are two groups of people involved when it comes to job design – workers and managers. Both of these groups must get their needs satisfied, even though these needs are completely different. Managers want the workers to achieve high productivity, good quality and service targets at a low cost. The workers want to interact with other people, they want to be recognised, appreciated and rewarded in the right way. So, the two main objectives are:

- To meet the productivity, quality and other goals of the organisation
- To make the job safe, satisfying and rewarding for the individual

People give higher productivity when their work is rewarding, so the money spent in carefully designing the job shall not be seen as a cost, it shall be seen as an investment. Both of the groups must be satisfied, and in order to do this, there are three elements to look at:

- **Physical environment**, where the job is done. Here, it is important to consider factors like ergonomics, light, temperature & humidity, noise & vibrations, air pollution, and safety.
- **Social environment**, which affects the psychological condition of the worker. This aspect may include training, supervision & help, knowledge about policies and rules, a clear statement of expectations, and credit for a good work.
- **Work methods**, which are the ways to do a job. The job can be broken down in very small parts, micro-elements, and this is the most detailed level of planning. These micro-elements can be analysed individually in order to find the most efficient way of doing the whole job. When analysing them, it is helpful to ask questions when trying to improve the job. Examples of questions are: Why is this done? How? Why in this way? Can anything be excluded? Or done at another time? Or automatically? Can there be another layout? Other tools? Even though this level of analyse is important, the broader view of the job is of main interest, and this includes things like job rotation, job enlargement and job enrichment. Job rotation is used to prevent people from being bored or injured. Job enlargement combines several simple jobs into a larger one, and this is also done in order to create some variation. Job enrichment gives the worker more responsibility, which makes the job more interesting.

"Work measurement *finds the standard time needed to do a job."(Waters 1996, p. 524)*

The standard time can be used for a variety of purposes, and examples of these are capacity planning, estimation of workforce size, finding the costs for different operations, setting wages, monitoring the performance of workers, and schedule the production. It is not an easy task to find out how long time it takes to do a job. Different people need different time to do the same thing. Repeating the same job several times means that each repetition will take different time. To move around this problem, the basic work content of a job shall be found, and this gives the minimum time needed to complete the job. This time gives the perfect process where no time is lost, all materials are

delivered on time, and no interruptions occur in the work. The job will take longer time in reality because of the following:

- Poor design of the product
- Operations are inefficient
- Poor management
- The operator can be inefficient of various reasons

The standard time avoids these kinds of complications by giving the basic time needed for a certain job. When measuring a particular job, the basic time is used, and then time can be added depending on circumstances in order to get closer to the actual time. The **actual time** is the time it takes for an operator to finish the essential parts of a job. The **normal time** is the time needed to perform the job at a standard rate, which is an average time a worker needs for a job. The **standard time** is the total time allowed for a job. In order to find the normal time, there are several ways to go:

- Using historical data. It is important to know when the historical data is measured, because changes may have occurred that makes the data non-reliable.
- Estimate the time, when there is no historical data. This can be done through looking at similar jobs.
- Do time studies. This is the most common way to find the standard time.

3.2.3 Our use of Operations Management

Operations Management is used through all problem areas in this thesis, and serves as a way of thinking. Since this work is very practical and specific for Ellos, we do not follow the theory exactly when it comes to the different bullet points. The theory serves more as a guideline and a checklist we can turn back to in order not to forget anything essential. In everything we do, we have to think in terms of reducing time and movements, and eliminating unnecessary operations. When dealing with the problem areas, we have used figure 3.2 to divide them into the different parts. Operations Management goes through all

parts, but at different levels. In part A, the discussion is mainly on a strategic level, in part B there is a focus on the tactical level, and part C mostly deals with the operational level.

In terms of inputs, we will focus on the packaging and the people working in the packing area. The operations performed in the packing area are many, and they interact heavily with each other. We will focus on completion routines and packaging supply routines. The output is the parcels that are ready to be delivered to the final customer. Ellos has a well-developed system for job rotation and is working towards key figures in order to motivate the staff, and this makes the theory of operations management suitable.

In section 3.2.1, we presented three levels, the highest, the middle, and the lowest level of facility layout. We view these levels being similar to the triangle of strategic, tactical and operational level, and those levels are found in figure 3.2.

3.3 Simulation

Simulation is an imitation of a process or a system in the real world, and it is an indispensable methodology for solving many real-world problems. This method is used to describe and analyse the behaviour of a real system and ask what-if questions about it. It can be very useful to use the simulation as a guiding tool when it comes to how the real systems shall be designed, which means that both existing and desired systems can be modelled with simulation. (Banks 1998)

Simulation as such is not optimising. It is a tool for testing ideas. However, through developing good ideas and reject the bad ones, it is possible to come closer to an optimal solution. (Savén 1988)

When doing a simulation, this can be summarised with six key words (Savén 1988):

- **Production system** – this is the situation that will be simulated
- **Goal** – often the goal is to have some kind of base for decisions.
- **Model** – this is a functional description of the production system through a computer program and input data. It is not possible to describe a production system exactly as it looks like in reality, but all the simplifications must be done with awareness.
- **Simulated time** – this is the time that exists for the model. The simulated time is most often a lot faster than the real time.
- **Dynamics** – the dynamics in the corporation between different parts of the production system is often illustrated as random variations. Since a simulation is dependent on random variations, the result will also be randomly and must be treated in a special way.
- **Experiment** – making experiments has the purpose of comparing different alternatives in order to be able to improve them or turn them down.

The strength in simulation is the possibility to analyse the entirety in a complex production system with the desired level of detail. Simulation might be necessary to use in order to develop all types of production systems that are too complex to analyse with other methods. Simulation gives a structured way of working and knowledge without any risk. It is possible to try wild ideas under realistic circumstances, without disturbing the production or making large simplifications. This means that all the mistakes can be done in the computer instead of in the real system. However, the simulation is not the solution to the problem, it is a tool that must be used correctly in order to give a good result. A successful simulation project requires both knowledge about the production system and understanding about simulation. The person who does the simulation model must be able to understand and question the model in order to discuss and improve the result. (Savén 1988)

Simulation is often used as a tool for decision making. The data collection is a large part of the work with simulation. However, it is important to remember that the main part of the data collected is required for a correct decision, even if the simulation is done or not. (Savén 1988)

Discoveries are made all along the way of a project, and some of the changes might change the original direction, while others cause a change in heading. When working in such a dynamic process, it is very important to work with well-founded principles. Without such principles, there is an increased risk of failure. The presented principles serve as guidelines for conducting a successful project, and the purpose is to emphasise the role of practical management in a successful project. The principles are as follows (Banks 1998):

1. **Problem formulation** – define the problem to be studied, and write down the problem-solving objective. This is the most important step in the process, because it is guiding the rest of the project activities. Then there are some more things to keep in mind:

   A strong finish begins with an effective start. The first impressions are important, and it is important to establish confidence towards the people who want the problem solved. Take all needs into consideration, and focus more on benefits and functionality than on technology. Make the participants feel that their ideas are being heard, and inspire them to come up with even more ideas.
   Work on the right problem. There is nothing less productive than finding a solution to the wrong problem.
   Manage expectations. It is easier to correct an expectation now than to change a belief later. It is important that the expectations of the client are properly set and continually managed.
   The right solution starts with the right questions. Use proactive questions to force new thinking, and ask open-ended questions.
   Do not look for a simulation without first listening to the problem.
   Keep people informed, for the journey is more valuable than the solution.
   Be careful not to be too eager in the beginning.

2. **Model Conceptualisation** – this part involves dividing the system into different parts, then adjust these into a simulation model. To do this, there are two guidelines:

Advance the model by formulating it backward. Running into model building without first clearly setting its direction is a waste of time.
If you never fail, you do not succeed. Go beyond the limits, because this is learning.

3. **Data Collection –** this activity is often repeated, because additional data are needed, as the modeller understands the system more and more. Two guidelines are:

Do not take for granted that the data is correct. Consider the source, what is collected, when it was collected, and how.
Make assumptions. This might be needed to keep the project moving forward, when pieces of information are missing.

4. **Model Building** – the model is constructed according to the concepts and guidelines established earlier. However, it is possible to build different models out of the same concepts.

Focus on the problem. Focus on the problem more than on the model.
Start simple. Add detail, do not start with it. Do not let the model become so complex that the client looses the ability to implement the solution.
It is better to work with many milestones than with one absolute deadline.
Review. Take time to look over the project from time to time, and restructure it.

5. **Verification and Validation** – the actions of the model are tested to see if the data is processing correctly, and the performance of the model is compared to the actual performance.

Control changes – expect and plan for changes, and get all the change requests written down.
Be mindful of the client's perceptions – listen carefully to the perceptions of the client in order to avoid errors when building the model.

6. **Analysis** – this involves making conclusions of the experiments done in the model, and is done in six steps:

   Let the model work for you. The model is built to stimulate thinking, and this is of great help when you want to study the system from different perspectives.
   Question the output – if it does not make sense, it is necessary to check it out.
   Understand the limits of the model – the model does not decide anything, it is the people working with it that make the decisions. The simulation is only a tool in the decision-making process.
   Know when to stop – the ultimate truth is not affordable.
   Present a choice – When the client makes a choice from different alternatives, there is a greater chance of satisfaction.
   Sell success – report success early and often, and do not hesitate to put light on the positive things going on.

7. **Documentation** – the model is built to be used, and to be able to use it, it is necessary to have a good documentation. This makes it possible to extend the model later on, if that is desired. There are two things to think of:

   Follow the set standards.
   Report progress – this means document, document and document.

8. **Implementation** – the project must lead to some concrete action by the client, because this is the final judgement of the work. In order to cover all aspects, these guidelines are offered:

   Only promise what can be delivered – and make sure you deliver what you promise.
   Have a winning attitude – wanting success and expecting it is not the same thing. Success is an attitude.
   Teamwork – focus on the possibilities, not the different personalities.
   Involve key persons – they should be involved in order to prevent the project from being refused.

Structure presentations – present messages that are clear, interesting and relevant.
Advocate improvement – be a change agent, having a bias for action.
Follow up – a project never ends. It just goes into another phase.

3.3.1 Our use of Simulation

We use simulation as a tool for proving that our idea with a special packing station would not decrease the efficiency in the packing operation. This is a tool that makes it possible to proceed with confidence in the ideas that relies on that the special packing station can be implemented. The use of simulation is used specific for part A in the empirical study and analysis.

Since most of the theories about simulation are similar, we decided to use a model found in the book of Savén to describe the model in the analysis in chapter 5. However, we have used the QBM method when building the model, but this detailed information is to be found in the appendix. The steps in the theory of Banks are more of a project management character, so we have used these as reminders and good words along the way, but not followed them too closely.

3.4 Packaging Logistics

Packaging logistics is defined as:

"Aiming at developing (creating) packaging and packaging systems that support the objectives of logistics to plan, implement and control the efficient and effective materials flow."(Johansson 1997, p. 19)

The packaging issue is cross-functional, since the packaging is handled in several parts of the logistics chain. Even within the company, the different departments have their special demand. The marketing department demands a packaging that looks nice and has a proper size. The production wants the

packaging to be as easy as possible to handle through all processes. The purchasing department focuses on secure supply at lowest possible cost. So, there are a lot of different requirements of how the packaging should be designed, and those are often contradictory. However, the issue can be divided in three main functions, and these are Flow, Market, and Environment. All these three integrate and even contradict each other, so the hard work is how to get the optimal trade-off between the different requirements. (Johansson 1997)

Flow functions

- Facilitate goods handling
- Identify the product
- Protect the product

Market functions

- Meet consumer demands
- Design, layout
- Communication

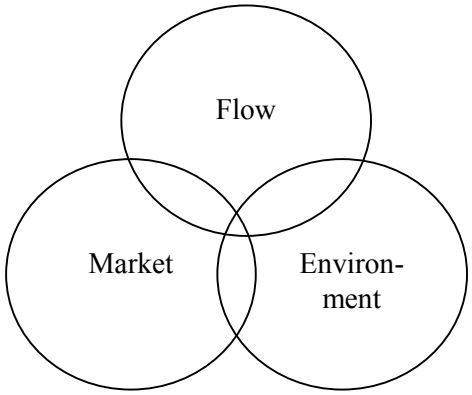


Fig. 3.4 The three main functions of packaging. *Source: Johansson 1997*

Environmental functions

- Re-usable
- Facilitate re-cycling
- Reduce consumption of packaging material

The flow function consists of the features of the packaging that contribute to a more efficient handling in the distribution or in the consumer end of the chain. Packaging supply, packing, internal materials flows, distribution, unpacking, disposal and return handling are things included in this function. Packaging logistics belongs to this function.

In the market function, things like design, layout, ergonomic aspects or other things creating value for the product and the brand, are important features of the packaging.

The environmental function aims at reducing the bad effects on the environment. Issues like trying to use less input for the same output and increasing the re-use of material falls into this function.

The area of flow functions, where the packaging logistics belong, can be developed further according to the three main areas.

- **Facilitate goods handling**

  Volume efficiency – this can be split in two parts, internal and external filling degree. The internal part deals with how well the space within a packaging is utilised. This is a function of how the package is designed and what shape the product has. When using standardised packaging with fixed sizes, the internal filling degree might not always be optimal. The external filling degree tells how well the packaging fits the others. For example, if the size of the package is adapted to the size of a pallet in some way, this means high external filling degree. To reach the optimal volume efficiency, both of these aspects must be considered.

  Consumption adaptation – in order to keep the costs low, it is important to have a high turnover of the packaging. There shall not be a lot of packaging in storage, because this ties up capital. It is also important that the package is used and not thrown away. The quantity of packaging shall be adapted to the consumption, and it is desirable to have flexible packaging.

  Weight efficiency – the packaging shall have the lowest possible weight, because volume and weight limit the amount possible to transport. The weight is even more important when the packaging is handled manually. What is considered reasonable here depends on how the packaging is lifted, and how frequent this occur.

  Process integration – the packaging must be integrated in a process. This means that the packaging shall enable rational packaging. The handling operations shall be as few as possible and be easy and fast to perform. The necessary operations include opening, filling, sealing, labelling and

palletising. The requirements for handling might differ depending on whether it is manual or mechanical. A mechanical handling normally requires more accuracy and higher repeatability, while manual handling is more tolerant to variations. It is desirable to reduce the storage of empty packaging, and reducing the number of packaging models can do this. Methods to reach a reduced assortment can be standardisation, packaging made of flexible, shape-independent materials, and adoption of new products to existing packaging. One way of standardising the packaging is to use semi-manufactured packaging. This means that the same packaging can be used for different purposes since it gets the final appearance when it is filled.

Handleability – the packaging must be easy to handle for both the people working with it as well as for the final customer, who might carry the packaging to his/her home. It shall also be adapted to all kinds of conditions that can be expected to occur along the way, since this eliminate the need for re-packing.

- **Identify the product**

  Distribution is something that needs to go fast, so the packaging must allow the identification of product and destination to be easy. The packaging design itself in terms of size, colour and other signals are important factors that help promote and sell the product.

- **Protect the product**

  This is one of the basic functions of the packaging. The packaging should protect the product from the surrounding conditions, and the distribution environment shall be protected from the product. Increased quality demands on products also increases the demand of protective packaging. Different kinds of transportation cause different demands on the packaging. The packaging should also protect against loss, pilferage, theft, and manipulation of the goods during distribution. Packaging that is adapted to all parts in the distribution process eliminates unnecessary handling and the risk for

damage, but it is important not to be too ambitious. Too much packaging may be too expensive, and there is a point where it is less costly to allow some damage than to pack for zero damage.

3.4.1 Our use of Packaging Logistics

Packaging Logistics is specific for part B in this study. The Flow-functions are within the area of packaging logistics, and those are the ones we will study. There are two packaging materials used at Ellos, and those are corrugated board and plastic, so we concentrate on those two.

When it comes to packaging, we will also look at the internal movements and storage, which is highlighted in part C. We will see if there are any steps in the process that are unnecessary and possible to eliminate, and this is the connection to Operations Management at an operational level.

4 Introduction to the Empirical Study & Analysis

This chapter is an introduction to the three following chapters. Here, we go deeper into the working model and create a new model out of it that explains each problem area more thoroughly.

Our problem definiton gives a broad description about the flow of the items from arrival at the premises in Viared to the final distribution to the customer. In this part of the thesis we will deal with the parts that is connected to the packing task. To give the reader a reminder of our problem area, we again show it here:

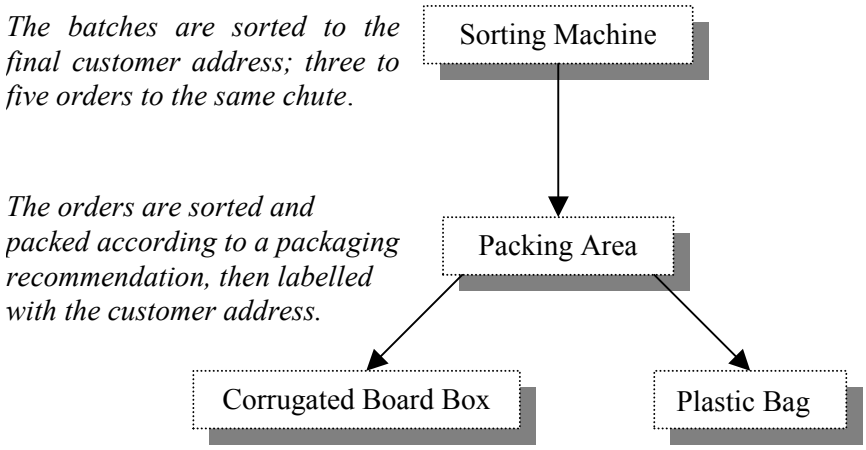


Fig. 4a Problem Area. *Own model.*

In the model below, we have broken down the three sub-problems into the different areas and routines that we have been looking at. The sub-problems are the squares with a shadow and it is possible to see how the different areas interact with each other. We have divided our study into three chapters, in order to give the reader an easy overview.

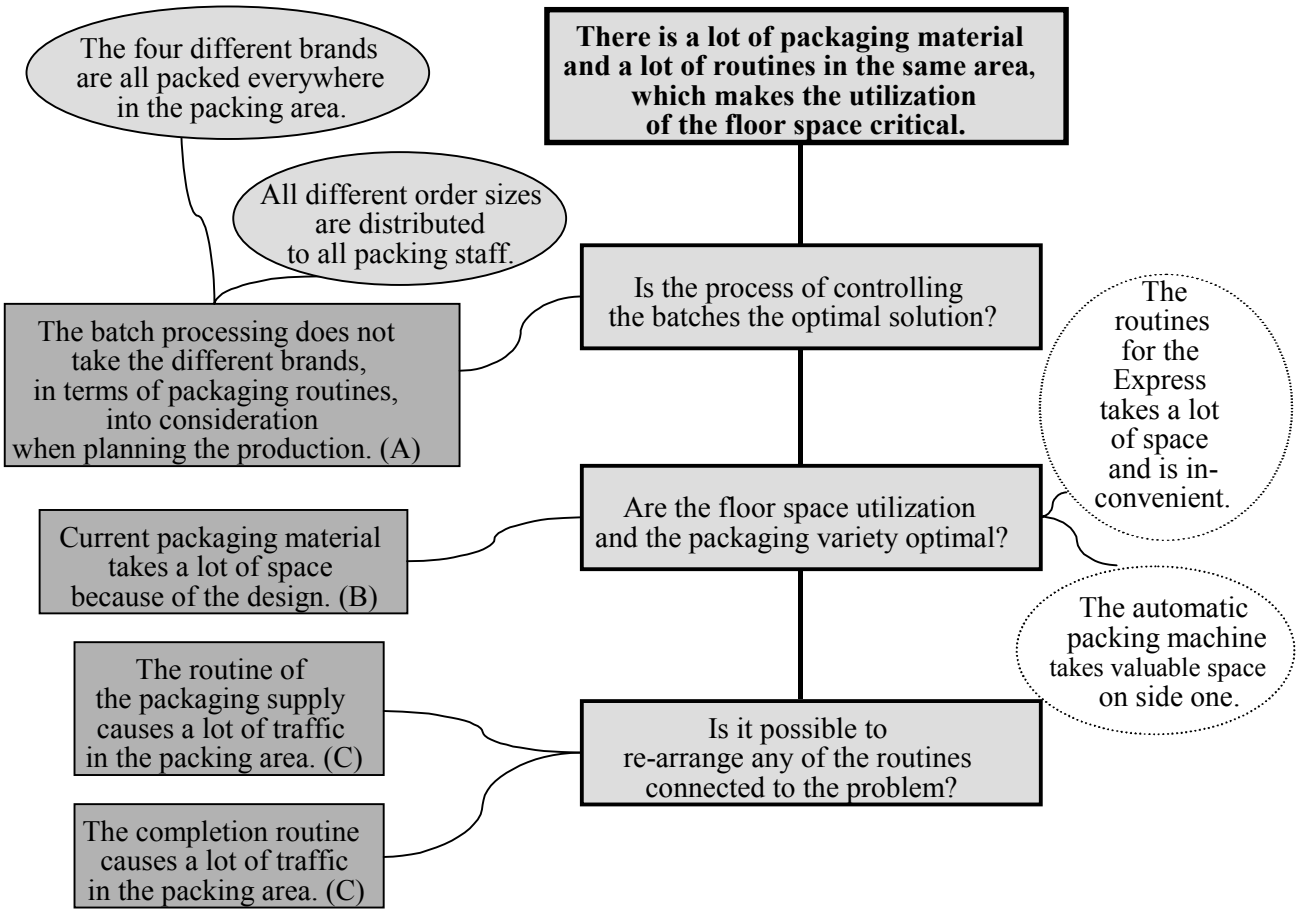


Fig. 4b Problem Relations, *Own model*

5 Part A – Batch Processing

In this part, we apply the Operations Management theories to the batch processing, and one of our studies of this process includes using simulation. First, we will mainly concentrate on the strategic and tactical levels of Operations Management. The strategic level deals with how the computer system can be built in order to control the whole distribution flow. The tactical level deals further with how the operations should be arranged, for example in which order the different batches should be run. The simulation is used as a tool for analysing possible changes of the current batch processing.

5.1 Batch system

Introduction

During one day, the sorting machine handles around 105 000 items, or approximately 25000 orders. This requires a large flow of packaging and puts a high focus on the handling routines. The variety of order items differs from underwear and t-shirts, to carpets and vacuum cleaners, and the number of items per order also differs. However, there is an annual average of 3.7-4.5 items per order. The order structure also follows a seasonal pattern, which means that in the summer the orders mostly contain summer clothes, while near Christmas there are a lot of larger items like toys and lamps. During our time at Ellos, we also had the possibility to verify this since our study started during the summer, when the orders mainly consisted of summer clothes. In November, the orders included a lot of bulky items.

The batch system

The packing area consists of four packing sides with a total of 252 chutes. The production is run in batches. Every batch takes approximately 30 minutes to complete. This is the time limit for the packing staff to complete the packing, and it is also the time set for the sorting machine to sort the following batch. The number of orders equals approximately 1200 in each batch, and every

chute will receive 3-5 orders depending on season, product brand and work pressure. During one batch, one person takes care of approximately eight chutes.

Computer control

The batch planning system controls how many orders, which brand and which country to pack on each of the sides. It is computerwise possible to control the distribution to each of these sides, which means that it is technically possible to perform packing of different brands and different markets on every side. It does not control how many items each order has or which order types to put in the different chutes. Instead, this is done on a random basis and it means that the number of items can differ quite remarkably. However, there is a parameter that takes the volume into consideration in order to utilize the chutes as much as possible. This volume consideration means that the large items are distributed to the chutes first, so more or less all chutes get some large items. All sizes of orders and all orders with different packaging recommendations can turn up in any chute. In order to be prepared for this, every packing table must carry all varieties of packaging material. The largest box, KK2, here called Jumbo Box, is not possible to store on the packing trolleys. Instead, this one is stored in a couple of different positions on each side. The handling of this box is also different from the others. It requires adhesive tape to seal the lid, but often the packing staff also seal the bottom for extra protection. Each packing table is supposed to be equipped with a roll of adhesive tape, but the staff complained that they almost always had to search for this. This box must also be transported to the distribution area with a forklift due to the size.

The batch planning

The planning of the next days' batches start after lunch when the process owner gets a forecasting report from the sales department. During the afternoon he makes a rough plan for the next day. There is another forecast report around 17.00 hrs and the final report follows at 21.00 hrs, when the call centre is closed for the day and it is possible to make the final planning.

The batch planning is based on the different departure times for the different brands, markets and products. For example, there is an Express Delivery service that is always packed first thing in the morning. The orders to Finland are picked up every day at 12.00 hrs. There are a lot of different aspects to take into consideration when doing this scheduling. The main part of the batches belongs to the Ellos brand. La Redoute mostly have 1–2 batches per day and Josefssons Josefine 3-4 batches per day. The Catalog Mail Outlet brand is only run occasionally and has to be handled separately in the computer process.

Special handling

All brands and all types of orders can be handled on all four sides, except for the Ellos Express that must be handled on side one. This is because the handling is done in a special way and it requires more floor space. The Express concept includes a 48-hour service, which means that the customer can collect the parcel within 48 hours after ordering. The parcels are delivered to certain stores instead of the post office, which is the most common pick-up place. The distribution from Viared to the store is performed by ASG, and they require the orders to be sorted in huge pink bags, one or more for each store. The orders are still sorted in the sorting machine, but the ready parcels cannot be put on the conveyor belt, instead they are put into the pink bags at the packing staff's table. These pink bags are then sorted into different crates. This handling contains a lot of constrain and Ellos considers it a routine that needs to be changed in the near future. However, this routine is, on Ellos recommendation, left outside the boundaries of our study since it would be too complex.

Most of the single orders are handled separately in an automatic packing machine. This machine is loaded with plastic that will automatically be sealed. The item, together with the invoice, is put on a band that adjusts the plastics according to the size of the item. The items are still sorted through the sorting machine, but those single orders are sorted into eight of the chutes. From these chutes the orders are manually moved to the automatic packing machine, located next to side one. During one batch around 200 orders are handled in this machine.

5.2 Simulation

The batch process just described is the one we will simulate. We want to know what will happen if it would be possible to direct certain orders to certain chutes. It is currently not possible to direct the orders computerwise, so if this should be implemented, it requires changes in the computer system. We do not know how large such a change would be or how much it would cost. This means that we cannot do a test practically without these changes, and this makes a simulation very suitable here.

Data Collection

To start building the model, we have to use a lot of input data. In order to perform a correct data collection, we tried to investigate what kind of data we required and how we would find it. We have determined that the following data are needed:

- Percentage of orders requiring the different packaging varieties
- Time needed to pack the different orders

We have chosen the period October 1999 – September 2000 for our data collection in order to be as updated as possible, and during this period, we have studied how much of each package use is distributed over the year. We also studied how much time is required to pack each variety, and from this we decided to group the different packaging into five different groups. We made the groupings according to which packing varieties are similar in packing time and also near each other in size.

- Plastic Bag: includes all plastic bags
- Small Box: includes K1, K1S, K2 and K4
- Medium Box: includes K7 and K17
- Large Box: includes K10 and K11
- Jumbo Box: box KK2

The nine different boxes

The two groups of packaging that we aim to direct to special chutes are Large Box and Jumbo Box. More detailed information about the different packaging is to be found in Chapter 6.

Packaging %	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Plastic Bag	72,9	58,3	58,8	65,8	71,9	75,2	50	75,2	76,4	46,3	49,5	54,8
Small Box	17,7	27,5	28,5	25,3	19,7	18,8	41,8	15,6	15,2	37,4	39,5	36,4
Medium Box	8,3	9,6	8,3	6,7	6,3	4,9	6,4	7	6,5	12,4	8,5	6,6
Large Box	1	4,2	4,1	2	1,9	1,1	1,6	2	1,8	3,5	2,3	2,1
Jumbo Box	0,1	0,4	0,1	0,1	0,1	0,1	0,1	0,3	0,1	0,4	0,2	0,2

Fig. 5.2 Packaging ID. The use of packaging distributed over one year. Data input for the period Oct 1 – Sep 30, Ellos only. *Source: Ellos Database*

Data for the distribution of the different packaging varieties are collected from the data base system at Ellos. The figures found in this database are based on the packaging recommendations given for each order. This is the only way to find these statistics. But, as the packing staff does not always follow these recommendations it cannot be trusted completely. We had a discussion with Harry Odqvist, the Packaging Supply Manager at Ellos, and compared his purchases during the year with the statistic. He has also acquired a fingertip

feeling for consumption. Together we decided to make one adjustment in the statistics. The purchase of the Jumbo Box over the last year comes to approximately 7000. The recommendations show almost the double. When interviewing the staff, they informed us that the packaging recommendation often are wrong. A common fault is that a jacket is measured in its full length and the recommendation is based on this, but in reality it will be folded together and can easily fit into a Medium Box. The Jumbo Box also requires special handling and therefore the packing staff tries to use a smaller package if possible. Based on the above, and in conjunction with the Supply Manager, we decided to add 50% of the use of Jumbo Boxes to the Large Boxes. We judge that the amount of orders with packaging requirement Jumbo Box still has to be within the category for the special packing station.

The time needed for packing the different bags and boxes are based on two sources. First, Ellos has a time measuring that the batch system is based on. Second, in order to verify and test the given values, we have performed a small time study in the packing area. The numbers in the Ellos study are based on a handling time for the plastic bags and a handling time for the boxes. Then a time unit of 4.2 sec is added for every item. The average number of items in an order is 3.5–4.7, but here we calculate with three orders, just to get a comparison.

The time study made by Ellos looks like this:

Plastic Bag	25,8 sec
Box	33,6 sec
Per item	4,2 sec

The order consists of three items and if we use the above data, the average time will be:

Plastic Bag	38,4 sec
Box	46,2 sec

Our own study was performed in the packing area where we timed different persons in order to get both experienced and new staff, persons that were quick and persons that were more slow. People have different ways of working during a batch, some wants to be ready as quickly as possible in order to have a coffee or go to the bathroom, while others use their time and work at a normal pace. The distribution of the different packaging varies as showed in table 5.2. This means that we had to spend some time in the area in order to get a sufficient number of measuring for all types of packaging.

We realised that the results we got showed too quick handling to be true. There are always some surrounding tasks that are very hard to measure, for example sorting items in each chute in order to organise and identify the orders, and pulling the chute doors in order to receive the items belonging to the next batch.

We found the measure per unit a bit misleading, as an order in the summer mostly includes small items, but in the winter there are more bulky things. The small things are easier and quicker to pack than the more bulky things.

Packaging	**Min**	**Mean**	**Max**
Plastic Bag	11	18	34
Small Box	14	24	45
Medium Box	17	32	59
Large Box	20	43	62
Jumbo	75	92	113

Units: seconds

We compared our result to the time study made by Ellos and then we again had a discussion with the packaging supply manager. The study made by Ellos used the same base time for all types of boxes. We did not agree with this. Our opinion, after our study, is that the larger boxes must have a longer base time. For example, the K11 box is not possible to put straight from the packing table on to the conveyor belt. It must be carried around the trolley in order to find enough space to place it on to the conveyor belt. Together with the packaging supply manager we decided to modify the result and, in general, we added 15 seconds to our result, shown on the next page.

Packaging	Min	Mean	Max
Plastic Bag	26	38	49
Small Box	29	46	60
Medium Box	32	50	74
Large Box	35	58	77
Jumbo	90	107	128

Units: seconds

5.3 Analysis Part A

Below we analyse the batch planning on the strategic and tactical levels and present the results and our analysis from the simulation project.

5.3.1 Batch system

When studying the batch planning we saw that it does not follow a pattern where the same brand is packed on the same side or sides all the time. The main numbers of batches belong to the Ellos brand and its different markets, and are normally being packed on all four sides. The Josefssons Josefine brand is most often being packed on sides three and four, but occasionally also on sides one and two. When the Josefssons Josefine brand is being packed on one or two sides, Ellos is packed on the other sides. The picking process at the picking department is common for both Ellos and Josefssons Josefine, so this combination does not include any extra sorting procedure. The La Redoute brand, however, is picked separately and is mainly being packed in one or two batches on all four sides.

In one day (November 15, 2000) side four completed 21 batches. This is a typical production schedule during a day when also Catalog Mail Outlet is handled. The scheduling was done in the following way:

8 batches of Ellos – Norway and Denmark
1 batch of La Redoute - Sweden

6 batches of Josefssons Josefine - Sweden
1 batch of Ellos - Sweden
5 batches of Catalog Mail Outlet

This uneven scheduling causes a constant need to change packaging brand varieties. To be prepared for packing all brands all packing trolleys are filled with packaging material in all varieties. Before, when having only the Ellos brand, there were fewer varieties and it was also enough to have one trolley connected to every packing table. When the other brands were included in the process, it was necessary to have two trolleys connected to each packing table.

The number of items in each batch differs a lot. This since the orders are randomly distributed and no consideration is taken to the number of items in an order. One batch with the same number of orders could contain 1200 items, while another could contain 1450 items (one packing side, November 15, 2000). However, it is known which period has a high percentage of larger orders and then there are less orders in every chute instead.

Today, all types of orders with all types of packaging recommendations are randomly distributed within the brand into the chutes. This means that all packing staff must be prepared with all packaging sizes. The three largest boxes, out of a total of nine different varieties, stand for only on average 6,4% of the order recommendations (all brands, Ellos Database), and the largest one needs special handling. This makes it interesting to see if it is possible to dedicate these to certain chutes. It could limit the number of different packaging varieties on each packing trolley. This could also mean an improvement from an ergonomically point of view, as the larger orders will be handled only in certain places. Some orders only contain one large item, for example a cloth hanger. Often, we learned by studying the order structure, these items already have sufficient packing and could be sent without any extra packaging. The address label will then be stuck onto the package. This saves money because extra packaging can be eliminated. However, the brand will not be visible, and this might cause a loss when it comes to a marketing aspect. When studying this kind of order, we have seen that they are not very frequent,

so we do not consider this being a significant loss from a marketing perspective.

Could there be advantages in terms of packaging supply and handling by implementing a special packaging station for these orders? To see what will happen, we will use the simulation model we describe in the next section.

5.3.2 Simulation

We have chosen to use the simulation programme "Planimate" to build our model. In order to conduct our simulation project we have used the different steps in Quality Based Modelling. We will describe our work process below and more details can be found in the Appendix x.

Since the purpose, the problem relations and the goals that are stated for the thesis are also valid for the model, we start directly in step 5 in Lind's method. Our measuring instrument, the simulation model in Planimate aims at investigating the possibility of letting orders with packaging recommendation Large box and Jumbo box go to a certain number of chutes and be handled in a special way, without decreasing the current efficiency. Our hypothesis is that if you have a special station where the orders with packaging requirement Large box and Jumbo box are handled, the surrounding routines will be possible to handle in a more efficient way.

Building the model

We will build our model representing one of the four packaging sides in order to get a clear view of the system. It will also be easy to show for someone without knowledge of simulation tools. The building of our model is based on the material oriented model below and the flow model in the Appendix. We will shortly describe the different steps below.

Eight chutes are the normal amount of chutes one packing staff is supposed to handle during one batch. Each chute normally contains five orders, which in

this case will be 40 orders in each queue. All the packing staff will start packing at the same time, when the batch starts. They have a set time limit by which all orders must be completed. It does not matter which order is packed first, because there is no priority.

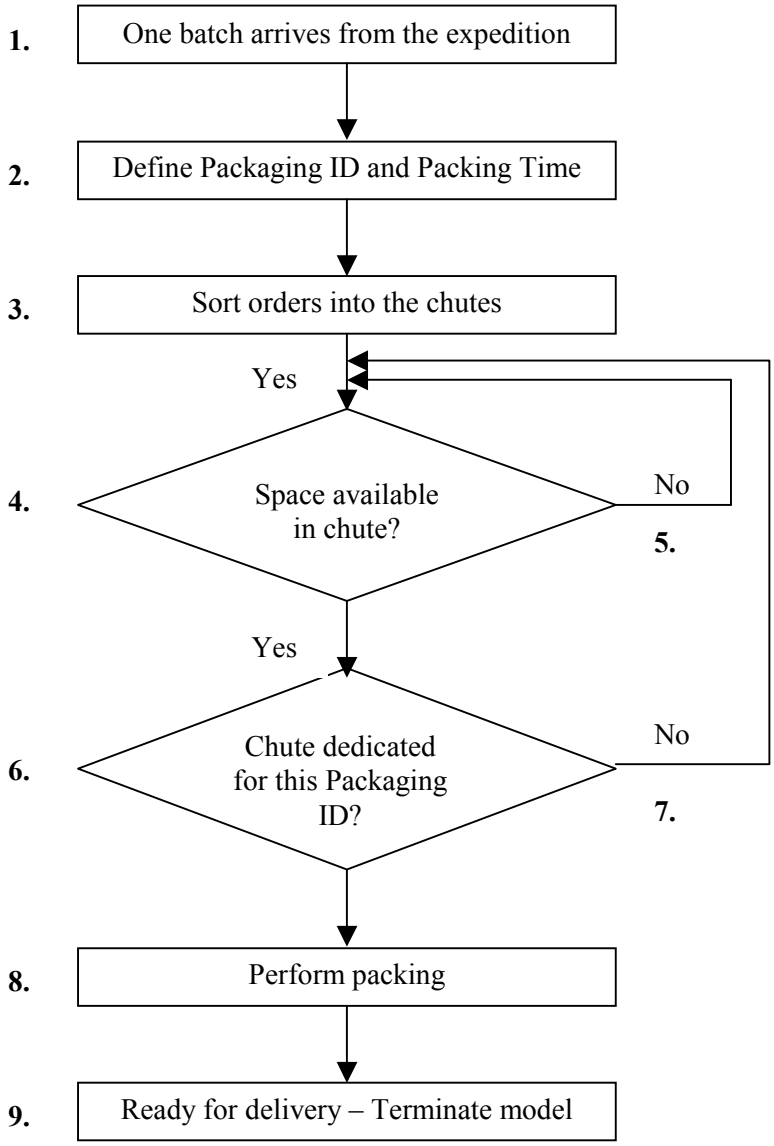


Fig. 5.3.2a Material Oriented Model. *Source: Savén 1988*

1. Each batch contains 320 orders that will all enter the system at the same time. No new batch will be let into the system until the present batch is completed.

2. Here, the different orders are given their identity in terms of Packaging ID and required Packing Time. In our model, the order first receives a

Packaging ID, based on the monthly distribution table. Then based on a triangular distribution taken from the Packing Time table, the order also receives the required packing time.

3. Each order gets a chute number that tells the system to which of the chutes the order can be sent. The order will be sent into the chute that the system has determined. The system makes a loop through the table in order to put the order into a chute. In the current alternative all types of order can go to any chute, and the loop will start from the top of the table. For example, if the first order is a Plastic Bag it will search for the first available chute dedicated to Plastic Bags. The distribution pattern for the different chutes and packaging can be viewed in the Appendix.

4. If the determined chute is available, the order stays there.

5. If an order cannot find an available chute, it will go back again to get a new chute number.

6. There is a parameter in the system that tells to which chutes the different orders are allowed to be sent. For the current alternative, all ID:s can be handled by all chutes, but in our other alternative we will direct some ID:s to certain chutes. The order finds a chute where it has the permission to go. If the order has the permission to be handled here, it stays.

7. If the order does not find a permitted chute, it goes back to get a new chute number.

8. A server represents each packing staff member. These eight packing staff represent one side of the packing area. The time set for the batch is the maximum time for the packing staff to complete the work. Each order has an attribute that tells the packing staff how much time is required to complete that particular order. The time depends on the size of the order and the packaging. We have determined a mean time, with a min and max value.

9. When the orders are packed, it means that they are ready for delivery and then they leave the model.

The two alternatives

With our model we will simulate two different alternatives:

- The current situation. All orders will be split by random into the different chutes.
- The alternative situation. The orders requiring the larger boxes will have certain chutes dedicated for them, the other orders will be randomly distributed between the rest of the chutes. If there is idle capacity in the chutes dedicated to larger boxes, these will be filled up with other type of orders.

The purpose of the model is to test if our alternative can be introduced without any decline in efficiency. This means that all orders will still be completed within the set batch time. Our mission is not to increase the number of orders being packed during a batch, since our task is not to increase capacity. But, if this can be proven it will come as an extra option. Our main aim is to reduce the number of packaging varieties for the packing staff. Since the larger and bulky orders mainly occur from the Ellos brand, we have decided to base our simulation on Ellos statistics only.

After collecting all necessary data, we had to decide how to make the distribution into the different chutes. In today's system, the different types of orders are randomly distributed. This means that every chute can receive any type of order. The orders are also evenly distributed between the chutes.

In the alternative simulation, we have dedicated chute number eight to Large Boxes and Jumbo Boxes. However, this chute will not always be filled up only by these two packaging varieties. To maximise the utilization, the other packaging varieties can go to chute eight as their last alternative when the other chutes are already full. In case chute eight is also full, Large Boxes and Jumbo Boxes will be directed to chute number seven. All orders will get a chute, since

we do not send more orders into the system than it is possible to handle. In reality, when the sorting machine has finished the sorting, every order has a place in a chute.

For both alternatives we want the same number of orders to be sent into the system, 320 orders for every batch. But, when we send all large orders to the same place, we think it is necessary to put fewer orders into these chutes in order to make sure that this packing staff can keep the same time to complete the batch as all the others. We decided to add one extra order to chute number one up to seven, and take away the same amount from chute number eight. In figures, this means 41 orders in every "normal" chute and 33 orders in the "large box chute". Tables concerning the distribution to the different chutes can be viewed in the Appendix part about the simulation.

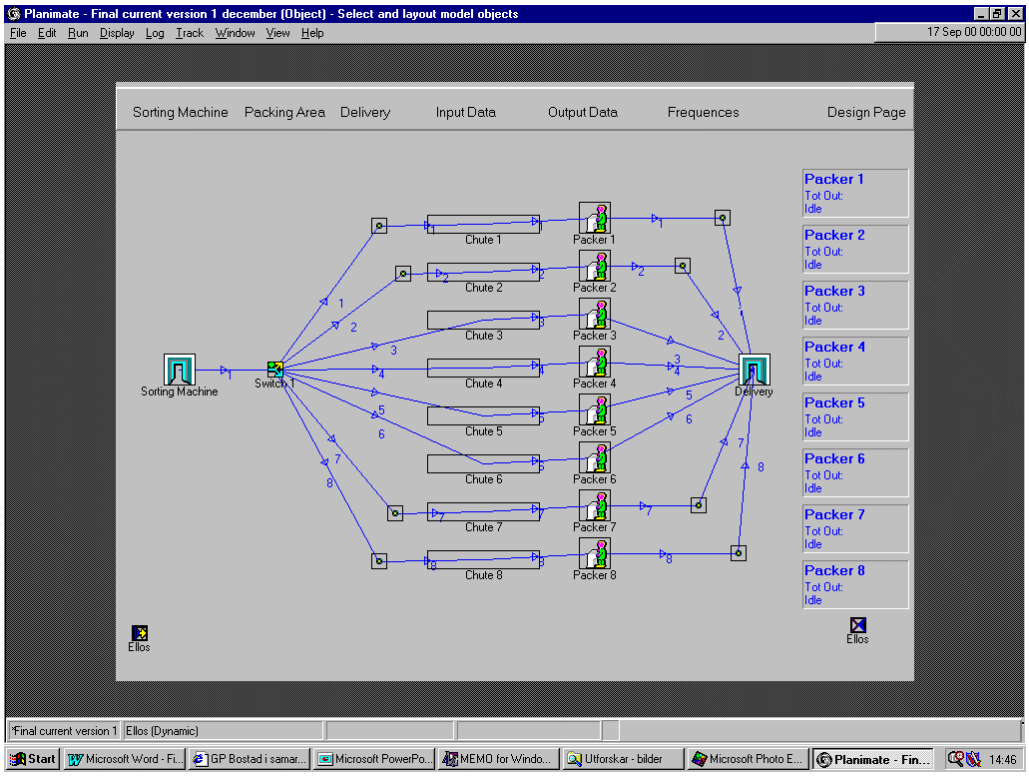


Fig. 5.3.2b *The main panel in our simulation*

Running the model

Before making our final simulation, we run the model in order to see if the result would be near the current batch time. The result showed that a batch time of approximately 30 mins was needed and this is what the reality looks like.

We also made a sensitivity analysis where we put in extreme values in order to make sure that the model still worked properly.

We realised that it would be unnecessary to simulate a number of runs for every month. Instead, we decided to choose three different months that would be representative for the distribution pattern and for the work burden. We chose one month with few large orders, one with a large number of large orders and one month that would represent an average. The months chosen are November 1999, June and August 2000. In order to get a sufficient base for our analysis, we decided to do 40 runs for each month, and for each of the two alternatives. This decision of 40 runs is based on confidence interval calculations that showed that this number of runs was sufficient. In the figures below we show the distribution of the different order types for the two months representing the most and least percentage of the larger boxes, November and June.

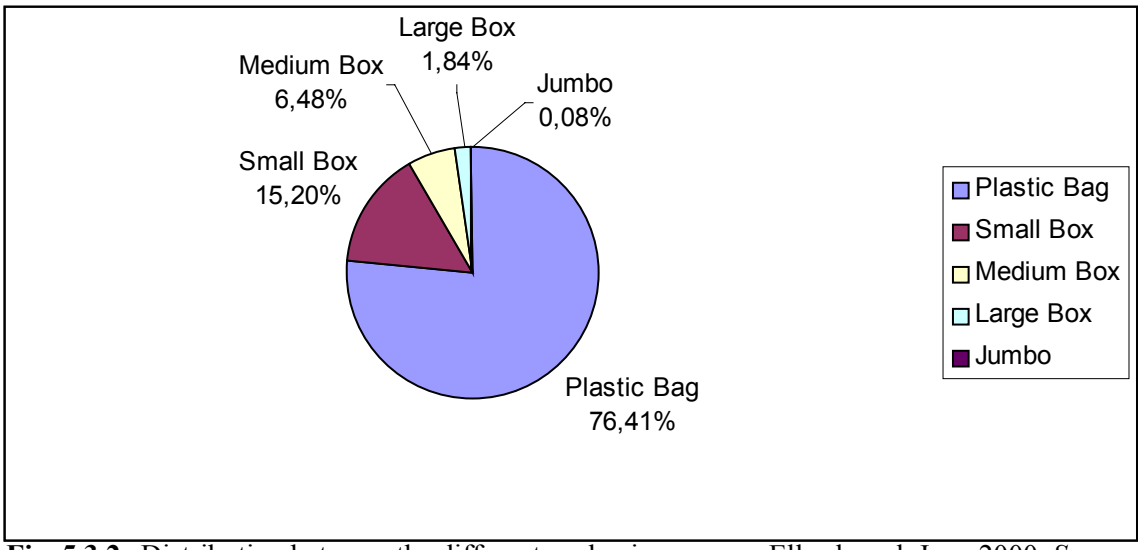


Fig. 5.3.2c Distribution between the different packaging groups, Ellos brand, June 2000. *Source: Ellos Database*

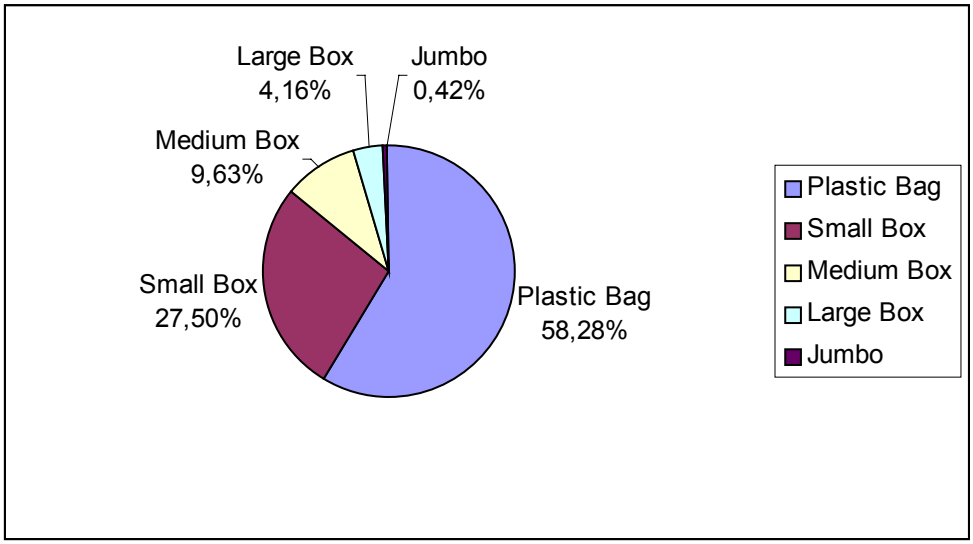


Fig. 5.2.3d Distribution between the different packaging groups, Ellos brand November 1999. *Source: Ellos Database.*

Analysis of the runs

To analyse the result of the 40 runs for the three months, we have used calculations of confidence intervals. As mentioned before, we do not aim at increase the productivity and the capacity in the sorting machine, but we want to make sure that our suggestion does not decrease it. So, the confidence interval calculation shows whether there is a big difference between the two alternatives or not.

First, we have calculated the mean and variance for each of the alternatives and for each month. The calculations of mean and variance can be found in the Appendix. This is the information we need in order to get the confidence interval. We have used a calculation that compares two different means and variations (Körner 1987). We formulate a null-hypothesis as follows: there is no difference between the two means. If the number zero exist in the interval between the max and the min, then you can not say that there is a significant difference between the two alternatives. This means that you cannot reject the null-hypothesis. (Mendenhall 1978)

June	Current Alt. 1	Suggested Alt. 2	Difference
Mean	1671,1415	1683,6967	-12,5552
Variance	1412,3789	1019,6479	

(m1-m2)-1,96*√((var1/n1)+(var2/n2))	9,05830753
(m1-m2)+1,96*√((var1/n1)+(var2/n2))	-34,168708

As we can see, number zero is present within this interval, and this mean that we have proven with statistical calculations that these two means do not have any significant difference.

August	Current Alt. 1	Suggested Alt. 2	Difference
Mean	1776,4462	1777,1315	-0,6853
Variance	1266,044	1230,9668	

(m1-m2)-1,96*√((var1/n1)+(var2/n2))	21,2150615
(m1-m2)+1,96*√((var1/n1)+(var2/n2))	-22,585662

These calculations show the same thing as for June, and say that there is no difference between the alternatives.

November	Current Alt. 1	Suggested Alt. 2	Difference
Mean	1781,784	1780,8489	0,9351
Variance	2001,6806	3885,6167	

(m1-m2)-1,96*√((var1/n1)+(var2/n2))	34,5629466
(m1-m2)+1,96*√((var1/n1)+(var2/n2))	-32,692747

Here, we see the same thing as for June and August.

In each of the calculations, there is a zero within the interval. This means that there is no significant difference between those two alternatives.

The reason why we did this test was that we wanted to make sure that our suggested alternative would not decrease the efficiency, that is, leading to longer batch times. In order to make sure that we do not draw the wrong conclusions, we did not make any changes at all in the time it takes to pack the largest orders. This was our intention at first, since our idea was that the large orders will require less time when they are packed at a special packing station. But since we were not able to measure this time, we did not want to make a simulation with faked times. The reason for this is that we do not want to show a suggestion that might be a lot better than the present situation, in case it will not work as desired in reality. For our analysis, it is sufficient to know that we do not give suggestions that make anything worse, since our main objective is to change the routines surrounding the packing staff and the sorting machine, not the working speed or capacity.

5.3.3 Analysis Summary

The contents of this chapter mainly deal with operations on the strategic level, that is, in the top of the triangle in our model. We have analysed the way the batch system is planned and the possibilities we see for changes. The result from our simulation has given us positive indications, which makes it possible for us to suggest new alternatives in the conclusion part. This will, partly, be a condition for making changes on lower levels. The next chapter will lead us down to the tactical level, where we deal with packaging logistics.

6 Part B – Packaging

The packaging has different purpose for different types of enterprises. For a manufacturer, the main features are protection and handling, identification and advertising. A nice packaging might be an incentive for the customer to buy the product. For Ellos, the main purpose of the packaging is to protect the items during the transportation from the distribution centre in Viared to the end customer. The packaging also serves as an advertiser, while laying on the shelf in the post office or being carried home. However, the design of the packaging has less importance, the main thing is to make sure the order arrives without damages. We will start this chapter by adapting the theories from Packaging Logistics to the reality at Ellos. Further this chapter deals mainly with the tactical level in the theory of Operations Management.

6.1 Packaging Logistics

When studying packaging logistics there are three main functions, the flow function, the market function and the environmental function. We will concentrate on the flow function. In Packaging Logistics (Johansson 1997) the flow function is divided into three parts and we will here discuss what is applicable on Ellos.

6.1.1 Facilitate goods handling

- **Volume efficiency** – The computer system determines the volume for every order and decides which packaging to recommend. This is the internal filling degree and the system Ellos has developed makes sure that the rate is high. The external filling degree is, however, not maximised when it comes to the boxes. The different types of boxes do not have a module standard, so when packed into the postal crates there is a lot of air. The plastic bags, however, can be packed tightly and this does not leave a lot of air in-between. For Ellos this is not a main problem for domestic transports,

because this agreement is made according to the volume and the weight of each package, not on the total volume.

- **Consumption adaptation** – It is important to have a high turnover of the packaging in order not to tie up unnecessary capital. Some days Ellos distribute more than 30.000 parcels (bags and boxes) and this means it is very important to have a well-developed ordering system and also have a close co-operation with the suppliers. At Ellos one person is responsible for the ordering that for the most frequent varieties take place every day. We were introduced to another way of ordering at a study visit at Total Logistik in Borås, a company that handles packing and distribution for a lot of smaller companies. They have set a certain re-order point for the different packaging. The supplier comes to the site at Total Logistik and checks the inventory, which means Total Logistik has outsourced the ordering task. Both Total Logistik and their supplier were very satisfied with this arrangement.

- **Weight efficiency** – The packaging must have as low weight as possible, both in terms of transporting and for the handling. This is well developed at Ellos, especially the bags which hardly weigh anything. The packaging is handled many times within the area, both when supplying the packing staff and when being transported to/from the conveyor belts and into the postal crates.

- **Process integration** – It is important that the packaging and the handling are as smooth as possible and well integrated into the system. This is within our main problem area and the parts we will go deeper into.

- **Handleability** – the packaging must be easy to handle during the whole chain. The packaging material is stored on two trolleys on each side of the packing table. It is in easy reach for the packing staff, but carrying two trolleys makes the table hard to push and often they run into the next packing table. The boxes are easy to handle when performing the packing task. They consist of one bottom and one lid and are stored flat. With a two-hand grip they are easily flipped up. The bags are currently taken from a pile

under the table and are easy to open in order to prepare for packing. The package must also be convenient to carry home from the post office or store. The bags all have a handle, but the boxes have straps, however not very convenient to carry them with.

6.1.2 Identify the product

The packaging serves as a free advertising spot when being stored on the shelves in the post office. This also applies when the customer carries the parcel home, when the brand name can be seen in a lot of places.

The value of the different brand names is impossible to measure, but the marketing department consider this to be of such importance that it is currently out of the question to design the packaging in any other way than each brand having its own design. We interviewed Per-Olof Gustafsson, the Marketing Manager of the Josefssons Josefine brand. He emphasised the importance of the building of brand names and the completeness the customer receives from seeing the brand name during the whole chain, from studying the catalogue to ordering and, finally, receiving their parcel. Lennart Helgesson, the Manager of Svenska Postorderföreningen, also verified the importance of this.

6.1.3 Protect the product

The choice of packaging is determined by three variables:

- item value (not total order value)
- weight – maximum weight for a plastic bag is 3,5 kg
- fragileness of the item

Today, between 50-75% (depending on season) of the orders are packed in plastic bags. However, plastic bags cannot be used for all types of orders. First, the orders maximum weight must not exceed 3,5 kg, then all items must have a lower price than 600 SEK, and finally the items must not be fragile. The

volume of the order also determines the packaging choice. Another aspect is that the customer can expect the packaging to be more nice and proper, as the box is viewed to be when, for example, buying an expensive leather jacket.

6.2 The different packaging varieties

When the distribution of the Josefssons Josefine brand was included in the handling at Viared by the year 2000, the focus of the different packaging varieties changed. From handling only one brand, the Ellos brand, they were now handling four different brands, Ellos, Josefssons Josefine, La Redoute and Catalog Mail Outlet.

This means that there is a great demand for different types of packaging material. On each invoice or order settle there is a written recommendation for which packaging to use. When the goods first arrives at Ellos there is a measuring and classification of each item type and this includes volume and fragileness of the item. This is, among other things, used as a base for the packaging recommendation.

A lot of the packing staff have worked at Ellos for a long time and by that acquired an ”eye” for which packaging to use. Some of the people we interviewed said they never had a look at the recommendation, while some used this as a guideline in order not to start packing in one size, and then just realise that they need to change packaging because it does not fit. Some also check to see that the item was right labelled from the expedition, they would suspect something wrong if the recommendation did not match their choice to a close extent. For example, a lamp could wrongly get the label for a pair of socks and vice versa

From start, everything was packed in boxes. In the beginning of the 1970’s, paper bags were introduced. In 1993, these were replaced by plastic bags, which are a lot cheaper and also easier to handle. This also reduced the export transport costs by 40% due to the lower volume. The plastic bags do not leave any extra air when packed in a postal crate. The filling degree of the box is not

always satisfying, which means air is transported. However, as mentioned earlier, it is impossible to use plastic bags for all types of orders.

The plastic bags stand for a total annual average of 67%, and the boxes for 33%. This is heavily seasonal, as summer orders are mostly packed in bags and winter and Christmas things require boxes. In November 1999, 58% of all orders were packed in plastic bags, while the same statistics for June 2000 showed 79%. It is also possible to follow periods where there are certain activities or give-aways that may make the use of a certain type of packaging differ from the normal.

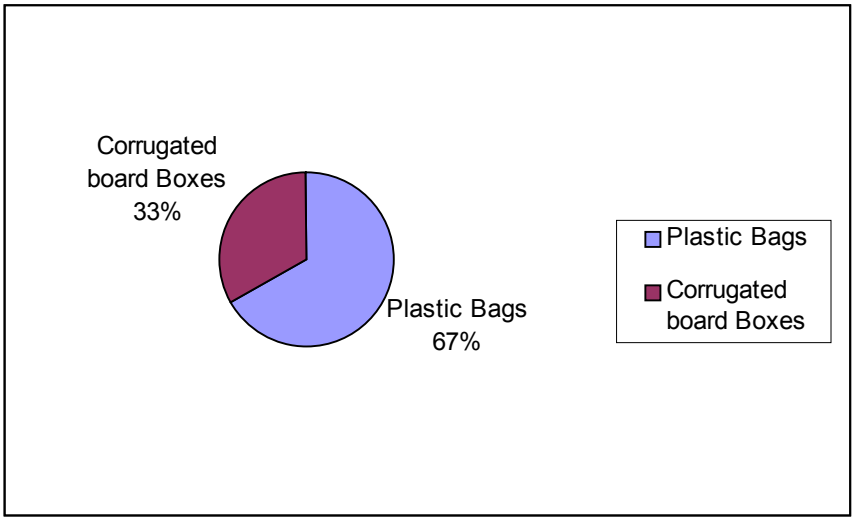


Fig. 6.2a Distribution between plastic bags and corrugated board boxes, all brands, Oct 1, 1999-Sep 30, 2000. *Source: Ellos Database*

There are currently 13 different packaging sizes, plastic bags and corrugated board boxes. However, only the Ellos brand carries all of them.

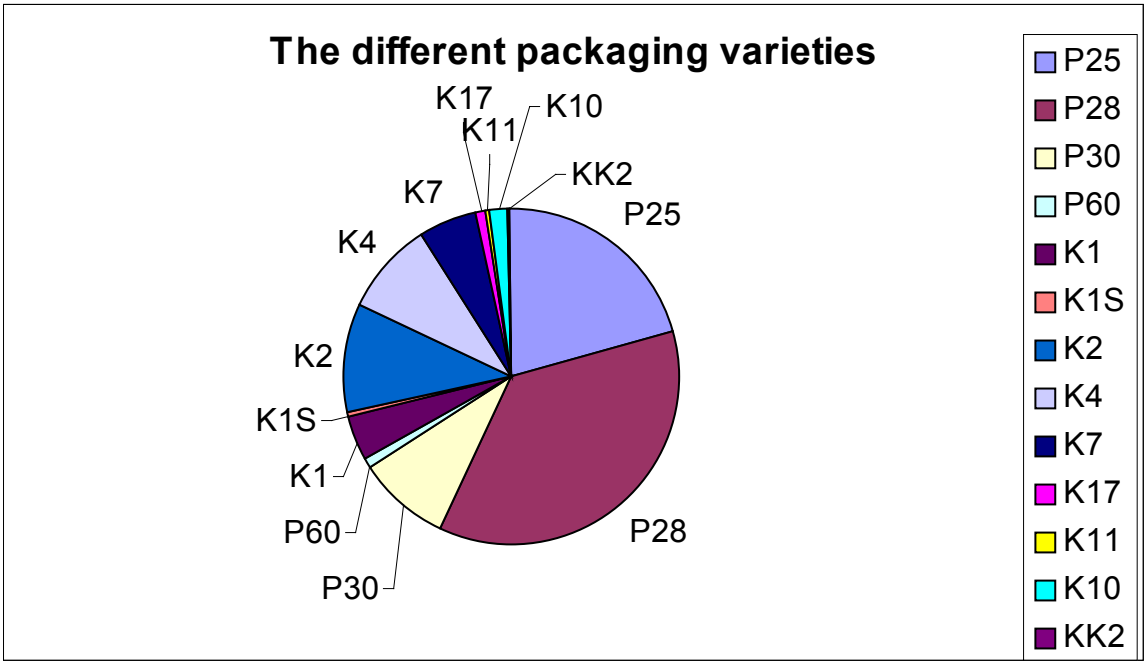


Fig. 6.2b The different packaging varieties, all brands, Oct 1, 1999-Sep 30, 2000. *Source: Ellos Database*

6.2.1 Plastic bags

The introduction of plastic bags has been a success because they are a lot cheaper compared to boxes, they take up less space when being stored, and they are also quite smooth to pack in. There are currently three different sizes of bags, but tests have been going on with a somewhat larger bag called P60. This larger bag may, if it will be used to a large extent, require some changes in the conveyor belt system at a quite large amount of money. However, if it can be found that it is possible to replace a lot of boxes by using this bag, Ellos has declared that they will consider this investment. For example, this larger bag will be suitable for larger textile items such as bedspreads. It is so far mainly being used for Express Delivery, where there is no transporting on the conveyor belt. The opinion from the staff is that this bag is very suitable for this purpose, but if it will be used for the normal packing as well, the sorting of the bags into the postal crates will be very hard.

Variety	Length	Width	Height	Weight	% of annual average of use of plastic bags
	mm	mm	mm	grams	
P25	350	240	70	18	31
P28	450	300	129	26	54
P30	480	320	188	33	13
P60					2

Suppliers

At the moment, there are two suppliers of plastic bags. One of these is a wholesaler, Papyrus, which sells bags that are made in France. The other supplier, Draken in Reftele, is a direct contact and they have their production and sales in Sweden. The latter supplier has recently announced that they would like to change the way of packing the bags for delivery. Now, they are flat packed in a huge box and this ”piling” is handled manually. Instead, they are planning to invest in a new machine that will fold up the bags on rolls. This means that Ellos must consider a new way of arranging them on the packing table. Instead of having the bags under the table, they will be hung on a rack.

In the middle of November, the sales representative from Draken visited Ellos and brought samples of these bags on rolls. The bags are double folded and they must be torn of the roll. This means two new steps in the handling before starting to pack. First, the bag must be torn off, and then unfolded. Some spontaneous comments from the staff were that this would cause work injuries. A sustainable solution for this handling will be studied at the distribution department.

The ”Bubble Bag” Project

We visited the packaging exhibition ”Scanpack” in October 2000. There we contacted the company Sealed Air that, among other products, produces plastics with air bubbles. However, plastic bubbles are mainly used as protection within another package or as protection in smaller envelopes. They had not heard of any company using bags with plastic bubbles in this way our

suggestion was. A contact was established and we made them very interested in our project.

A couple of weeks later, a representative from Sealed Air visited us in Viared, and he brought some samples. One of the bags had large bubbles, which would give really heavy protection. However, this bag seemed to take too much space and would therefore probably not be of interest. The second bag was to our liking. It was a bag designed in the same way as the normal plastic bags, but with a cover of air bubbles. In the middle of November we received 200 samples of these bubble bags. We got a list of all the orders with packaging recommendation K1, and from these we picked out the ones with items suitable for a pilot study. We went down to the packing tables, searched for the invoices and marked them in order to make the packing staff aware of that they should use the bubble bag. We also informed everybody in the packing area about this test, and also asked the ones who actually packed the bag about their opinions. On December 4, we called the customers who received their orders in this bubble bag in order to evaluate our project.

Number of orders sent	55-60
Number of phone calls	48
Number not answering	28
Number of answering	20

Satisfied, no problem	13
Miss the handle	2
Not satisfied	2
More than happy	3

Only two people were not satisfied. One person had ordered a camera at the cost of 149 SEK and thought the packaging was not enough protection. One person was really excited and said that this was “the best thing ever”, she always got boxes and thought they were inconvenient to carry home. Another person also made a remark that it was a lot more volume efficient compared to the boxes.

6.2.2 Corrugated board boxes

All corrugated board boxes come in two parts, one bottom and one lid. They are stored flat and are easily flipped up with one movement. All bottoms are brown and without any print, which means they are neutral and can be used for all different brands. The lids are specially designed for each brand. Of below listed varieties, the Ellos brand carries all of them, the Josefssons Joesfine brand 5, La Redoute 3 and Catalog Mail Outlet 3.

Variety	Length	Width	Height	Weight	% of annual use of boxes
	mm	mm	mm	grams	
K1	401	301	161	220	12,5
K1S	401	301	301	327	2,2
K2	511	301	221	284	31,8
K4	521	396	241	402	27,5
K7	601	501	271	607	16,5
K10	791	391	341	727	3,9
K11	601	501	461	920	1,0
K17	601	501	371	716	4,5
KK2	700	500	500		1,0

Some combinations of different lids and bottoms are possible. The box K17 is a combination of the same bottom as for K11 and the same lid as for K7. The same lid is used for both K1 and K1S. K1S has a different type of bottom compared to the other boxes.

According to our own experiences and the interviews made with the group members. Below we will give a short review of the different boxes.

The two small boxes, **K1** and **K1S**, are mainly used for smaller items such as earphones and cameras, items that require a little bit more protection than a bag can offer. However, all items are supposed to bear a handling where they are being dropped from approximately one metre. These items often have sharp edges that will destroy the plastic bags. The view of the persons we interviewed was that the boxes K1 and K1S are the ones that could most easily be taken away.

The most frequent boxes are **K2**, **K4** and **K7**. They represent an annual average of approximately 75% of the total use of boxes, and these were also the boxes the staff found most useful. The smallest boxes, K1 and K1S, represent on average approximately 15 %. There are four larger boxes, K10, K11, K17 and KK2. These four boxes represent an average of approximately 10 % of the total use of boxes.

The box **K10** differs from the other boxes by being longer. It is required for items longer than 600 mm. This box therefore requires more space on the trolleys by the height, and is also inconvenient to pack for distribution. The opinion from the staff was that this box is difficult to pack together with the other box types, and will often be packed in separate postal crates. While being not so frequent, it takes time to fill up a crate in the dispatch area.

The box **K11** is very hard to handle for the packing staff in terms of being higher than the other boxes. It is almost always impossible to put it straight down from the packing table on to the conveyor belt. Instead, the packing staff must lift it off the table and carry it around their trolley in order to find enough space to put it on the conveyor belt. The staff did not only complain about this, they also complained that it is hard to handle for someone who is not tall enough.

The box **KK2**, which is a Jumbo box**,** differs a lot from the other boxes in terms of handling. This is a neutral box measuring 500x500x700 mm and due to both being infrequent and large it is not stored on the different packing trolleys. Instead, it is stored in two or more locations at each packing side. The bottom and the top are self-locking, but the top lid needs to be secured with adhesive tape. Every packing table is supposed to be equipped with a roll of adhesive tape. The box is too large to fit the conveyor belt system, which means that the box will be placed in the aisle behind the packing staff. Then a forklift will come and pick it up and take it to the dispatch area. When talking to the staff we became aware of their trying to avoid this box as much as possible due to the constraining handling.

Suppliers

Today, the main supplier of boxes is Stora Enso, located in Skene. However, in case something were to happen and also to spread the orders, Ellos give smaller orders to other suppliers, mainly Förenade Well and BigPack. The latter supplier is situated in Poland. The corrugated board boxes currently in use are made of rather thick board. However, there is a new, thinner type of board called mini-board, being introduced by the suppliers. A study is going on at Ellos and some prototypes of this mini-board are currently being tested. Being thinner this means it will take up less space on all levels of storage. It will also lower the transportation costs due to higher volume efficiency.

6.2.3 Promotion items & Give-aways

All the different brands use some kind of promotion items as a way of getting new customers and keeping the old ones. The ways this is handled and the type of promotion items and give-aways vary over time. It is a cyclic system according to Per-Olof Gustafsson, the Marketing Manager of Josefssons Josefine, and you have to change when you feel that the market has reached saturation point.

During the year there are different campaigns going on constantly. In the last year, and with influence from the French market and French ownership, these promotion items tend to be of more size. During the spring and summer the gift was a coffee-machine, and during the fall a weekend suitcase. The aspect is that they should appear valuable. Before, gifts would be more in the range of necklaces and similar things.

This, however, can change the usage of packages quickly. This summer and fall the campaigns were huge successes. Actually, these promotion campaigns were so successful that the suppliers of boxes had a hard time keeping their deliveries. Stora Enso even had to put in some overtime shifts in order to meet the demand. Ellos has very good co-operation with Stora Enso, which was an advantage in this situation. As the summer's promotion items mostly required

boxes of size K2 and K4 the usage of these two have risen incredibly compared to last year. Below are the statistics for August 1999 and August 2000.

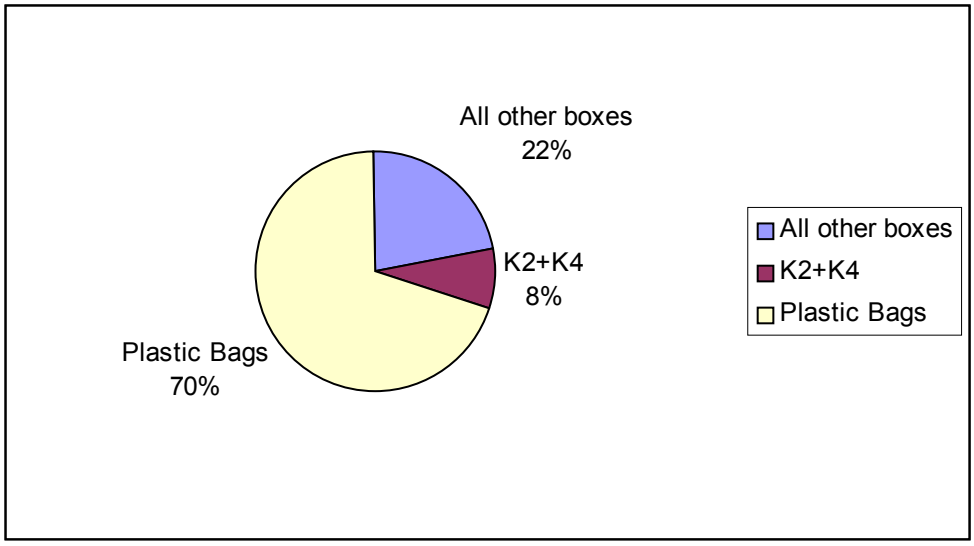


Fig. 6.2.3a Usage of boxes K2 and K4, Ellos brand, August 1999. *Source: Ellos Database*

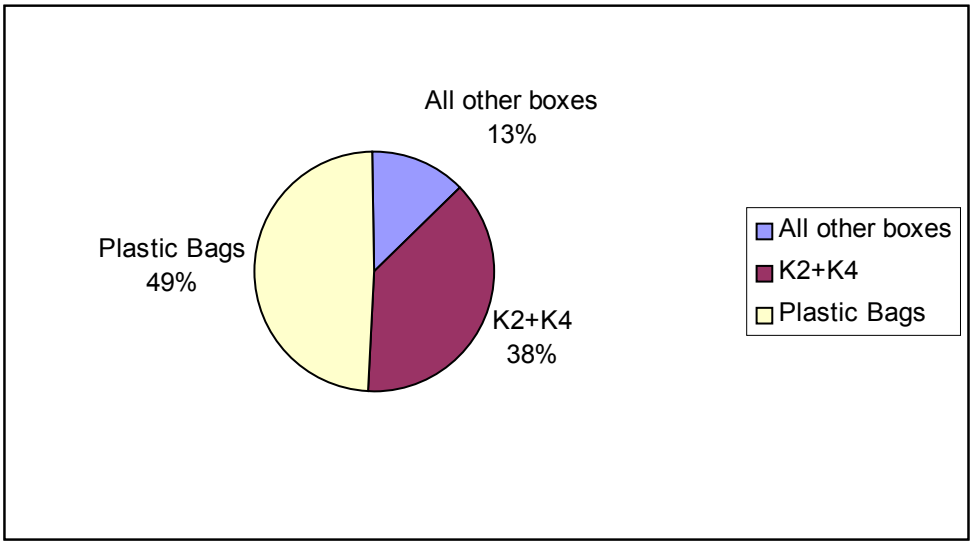


Fig. 6.2.3b Usage of boxes K2 and K4, Ellos brand, August 2000. *Source: Ellos Database*

6.2.4 Design & Image

When looking at the different brands, the larger orders and items mostly occur from the Ellos brand. Josefssons Josefine carry some home textiles such as curtains and carpets, but mainly they carry clothes and some smaller cosmetic items. The La Redoute sells clothes only, but as the marketing niche is set to be more fancy than the other products, it was from the beginning meant that all orders would be packed in boxes. The items are wrapped in silk paper and a sticker is put on top. However, there were a lot of orders containing only a few small items, such as a pair of underwear, and therefore the use of the smallest bag became accepted even here.

6.3 Analysis Part B

After making an analysis of the current packaging varieties by using statistics, purchase, interviews and practical investigations, we think it is necessary to make some changes in order to reach an organised system and a better working environment for the packing staff.

6.3.1 The different packaging varieties

Naturally one would think that the development of a neutral packaging assortment would be the best way to solve the problem with not only having a lot of different size varieties, but also four different brand names. But, as mentioned earlier, the importance of the different brands cannot be ignored. Instead, this puts a focus on investigating the different models and designs and whether it is possible to reduce the number of varieties and/or find other options to optimise the handling for the packing staff.

By analysing the statistics, we could find out the use of the different boxes and bags. The statistics are based on the packaging recommendations. However, this is not always followed. Sometimes the recommendation is wrong, sometimes it is possible to use a smaller size of a package, but sometimes the

packing staff chooses a bigger package just because it is quicker and more convenient. Sometimes the measuring is not done properly. For example, a jacket can be measured by its full length instead of folded, as it will be when ready for packing. Some things are also very soft, and if pushed a little, they can easily fit into a smaller packaging than suggested. The only way to find out the real use is to match the packaging recommendations with purchasing and inventory, and from this make assumptions.

As there is a remarkable difference in price between using a plastic bag and a box we think it is very important that all members of the staff are aware of this. When speaking to the staff we found out that they would often choose a K2 instead of a plastic bag because it is more convenient. There has been an information sheet on the boards before. We think this is an important issue and that the staff must be constantly reminded. The information must be in a way that they can feel they contribute to company savings.

6.3.2 Plastic Bags

When studying the plastic bags and the different sizes we found that the P28-bag and the P30-bag are quite similar in size. The P28-bag is the one most used. When analysing different orders and items, we found that a somewhat larger bag with a size in-between P30 and P60 would be useful. There are a lot of items that are soft and light weight, such as bedspreads and blankets. These do not need the extra protection of a box, they do not exceed the weight limit for a bag, and they do not exceed the value of 600 SEK each.

Bubble bag Project

The test of the bubble bag included approximately 60 orders. We telephoned 48 of these and reached 20 of them. The general view was very positive, only two persons did not approve of the bag. These two persons had ordered cameras, which they thought needed more protection. The cameras were of a cheap brand, and we think that if the customers were aware of the handling an item actually must be able to bear within the Ellos premises, they would probably

not have complained. On the other hand, we got a couple of very positive reactions. These persons were very positive to plastic bags in general, since they found boxes bulky and hard to carry home. One thing that two persons expressed was that they missed a handle to carry the bag. Our prototypes did not have a handle, and this is something that must be discussed with the supplier if the project will go on. The selection and study is, however, too small to draw any conclusions from about the usefulness of this bag, but it gives an indication.

6.3.3 The corrugated board boxes

When talking to the staff, we actually did not really get the impression that all these different varieties were a problem.

The boxes K1 and K1S are the ones we found possible to take away since they are not frequently used. Those boxes were also the ones the packing staff suggested to take away. Instead, our suggestion is to replace the K1 box with the plastic bag covered with air bubbles on the inside. When analysing orders requiring K1, we saw that the orders mainly contained items that would need a little extra protection, most often because they had sharp edges. Often also pre-cut, ready-made curtains were put into a K1 box. We think this could be put in a normal plastic bag instead. The bubble bag will protect the fragile items, take up less space and also be easier to handle. For items still requiring a box, a K2 box could be used instead.

The boxes **K2, K4** and **K7** are frequently used, which was also verified by the staff. We see no need to do any changes with those. Instead, these three boxes will be the base for the box assortment.

The box **K10** is longer than the other boxes and we found out that this box is often used to put only a long, single item in, which leaves a lot of empty space in the box. It often also contains carpets that, in fact, are possible to put on the diagonal, or being bent a bit, and thereby could fit in a K7 box instead. It could also be items that already have sufficient packaging and could be sent without

any extra packaging, for example a clothes hanger. The K10 box also has another disadvantage. It does not fit in together with the other boxes when packed for distribution in the postal crates. Our study does not include this area, but we would like to put emphasis on this aspect also when discussing whether to keep this box or not.

The boxes **K11** and **K17** we find useful for larger orders. Often they can replace the packaging requirement KK2 (Jumbo Box). Three parts will, combined in different ways, make three boxes, K7, K17 and K11.

When studying the handling of the **KK2**/Jumbo Box, we found out that the packing station was hardly ever equipped with adhesive tape, so the packing staff had to find this first. By studying this handling, we found it to be both inefficient and caused a lot of unnecessary movements in the area. Handling an order requiring a Jumbo box means first finding a box, then folding it and putting plastic adhesive tape to keep it together. The bottom does not need to be secured with adhesive tape, but when studying the packing staff, we saw that they almost always did this. Then, after putting the order into the box they folded the top and put more adhesive tape to lock it. Due to the size, this box cannot be placed on the conveyor belts in conjunction to the packing table. Instead, it is put in the aisle behind the packing staff and later on collected by a forklift.

The three large boxes, K10, K11, and KK2 represents 45% of the number of box sizes, but stand for only 6,4 % (all brands) of the use. Since the use is so infrequent and since these boxes are inconvenient in terms of handling, all the three largest boxes, K10, K11 and KK2 are suitable to handle in a certain packaging station because:

- K10-orders can often be packed in a different packaging, both by using another type of box and by packing for example, a single carpet requiring this box by its size, in a plastic package. An item with sufficient packaging can also be sent as it is.
- K11 is too high to put directly from the packing table to the conveyor belt.

- KK2/Jumbo Box requires a lot of unnecessary movements within the area and is heavy and inconvenient to handle.

The K17 box we think can remain at the normal packing tables. This is because only an extra bottom is needed as the K7 lid is already being used.

6.3.4 Promotion items & Give-aways

When studying the flow of promotion item within the past six months, we saw that the fluctuation in the demand for certain packaging varieties was enormous. We compared the use of K2 and K4 during August 1999 and August 2000. In August 1999, these boxes represented 8 % of the total packaging use, but in August 2000 they represented 38 %. This can be traced to the large flow of promotion items. As mentioned, the current vision is to have promotion items that are of value for the customer, which often results in quite large items. According to Eric Faintreney, the CEO of Redcats Nordic, the campaigns during the year 2000 have been a huge success. This also means that the demand for packaging will be different, and it puts a very high focus on being able to forecast such an increase in demand. A close dialog between the marketing department and the distribution department is therefore necessary.

We discussed whether it would be cheaper and/or easier handling by sending these items separately. In fact, the handling could even be outsourced, so that the transport to Viared would be unnecessary. However, this was something Ellos had considered, but due to the construction of the freight agreements it was not interesting. The freight agreements are based on a price per item where the item has an average weight.

One thing that has been tried in order to cut off some steps in the handling is to send the items label-less to the chutes. The items were still sorted in the sorting machine, but the labelling process was deleted.

All the people we had interviews with found it easiest when the promotion items were handled in the normal way, sorted through the sorting machine with

labels on. However, standing at the sorting machine putting each item with the label facing upwards is hard work, especially as the promotion items tends to be quite bulky.

6.3.5 Design & Image

Regarding the La Redoute brand we think it is important to set a certain image standard. We observed and learned from the staff that this bag fits more than the other bags. This is because there is a general opinion that it is a lot of hassle to pack the box with silk paper and therefore they want to avoid it. However, we can understand that it is a waste of money to use a lot of boxes for just one small single item, so our suggestion is to introduce a somewhat more fancy bag than the present. This bag could maybe be a bit smaller to avoid that it will be used when it is not supposed to be. It will still be a lot cheaper, but the customer will still have the impression that this is more fancy than the other brands.

We made one observation that we found most remarkable and could not understand at all when we saw it. When packing things into a plastic bag, there is a strap covering the adhesive tape that you remove in order to close the bag. This strap is, by almost everyone, put into the bag, which means the customer receives this. In our opinion, the customer will receive garbage. When realising how important the brand name on the packaging is, in order to give the customer a total impression, we see this as unacceptable. What is even more surprising is that when visiting Haléns, we observed the same procedure. This is obviously a common pattern, but that does not mean that it is right.

6.3.6 Analysis Summary

This chapter investigates the packaging material and the alternatives that are currently available. If changes can be done on the strategic level (the batch planning system) we have decided on some options in order to optimise the packaging varieties that will further optimise the flow. However, some of the

changes on this level are possible to implement without the changes on the strategic level. Moving on to our last chapter, we will also move further down, to the operational level.

7 Part C - Routines

The third part of our investigation also takes us to the lowest level, the operational level, found in Operations Management. On this level we will deal with the daily routines that includes movements. In Operations Management, we learn that all movements that do not add value to the product are a kind of waste. According to facility layout design and Operations Management, there should be as few movements as possible. When a movement is needed, it should be arranged as smooth as possible. There are mainly two routines that will be dealt with in this chapter, the flow and storage of packaging and leaflets, and the handling of non-complete orders.

7.1 The flow & storage of packaging and leaflets

More than 30.000 orders can be distributed from Ellos during one day. In order to have a smooth flow, it is important that the supply of packaging is handled in an effective and structured way. Below, we will describe the flow from the external supplier to the packing staff's table.

External supply and internal handling

Packaging material for the most frequent varieties are ordered every day. The main supplier, Stora Enso, has a warehouse in Borås from where daily deliveries occur. Due to the volumes, there is a heavy just-in-time focus on the ordering of material. This is in order to tie as little capital as possible and also because of lack of storing capacity at the Ellos premises. On arrival, the first storage will be on a four-storey high rack with double width where the pallets are supposed to be placed. However, as the turnover is so high and the activities so intense, people find it unnecessary to use the forklift and store them in place. Instead, they leave them everywhere in the packing area, which takes up a lot of floor space and makes the area look disorganised.

In the aisles next to each of the four packing sides there are two-storey shelves, and some of these are movable on wheels. In this area the ”for-now-use” packaging material is being stored. There are marked up places for each variety, but this is not always followed, and you can find pallets and piles of material everywhere.

The supply of packaging from the storage area to the aisle shelves is mainly handled by two forklift functions. These two persons continuously drive around in the area to fill up the shelves when needed. This means that there are three steps in the supply chain after the packaging material has entered the Ellos premises. First, it is stored in the four-storey rack, then it is transferred to the aisle shelves and finally, the staff supplies their trolleys from these shelves. There is a lot of movement in the area, both in terms of forklift driving and walking.

Packaging supply

Since we have observed a lot of movements when supplying the packing staff with packaging material, we have studied the need for different packaging during one day. We chose to study Nov 15, 2000, and we chose this day because it is during the high season, and during a period with a lot of bulky items. This day is during a period when there is both a day shift and an evening shift. We observed that the supply and refill of the boxes causes more movements, are more bulky and takes more time than supplying the plastic bags. The plastic bags are refilled in a pile of 100 pieces each time, while the boxes are normally piled in 15 pieces, lids and bottoms separately.

Since most of the batches belong to the Ellos brand and that the less frequently used boxes can also be traced to the Ellos brand, we studied the use for Ellos only. On this day, there were 18 batches of the Ellos brand, and we have calculated with eight packing staff on each side, which means a total of 32 packing staff.

Below, we present the use of different packaging during one day and for one person. The number of refills is based on that the plastic bags will be refilled by

100 each time, and the boxes are being refilled by 15 lids and 15 bottoms every time. Since three of the boxes (K1S, K11 and K17) are not frequently used, the refill cannot be done in whole piles. However, the trolleys would not have enough space to carry whole piles of those anyway. Today, the packing staff supplies the packing trolley themselves, and does not necessary fill up with whole piles every time.

Packaging	Total use	Use/packing staff	Refill/day*
P25	4517	141	1,4
P28	6864	215	2,1
P30	1610	50	0,5
Totalt:	12991		

** 100 bags/refill*

Packaging	**Total use**	**Use/packing staff**	**No of piles**	**Refill/day**
K1	1436	45	6	6
K1S	190	6		1
K2	2039	64	8	8
K4	4128	129	17	17
K7	1979	62	8	8
K17	382	12	1,6	2
K11	93	3		1
K10	1089	34	4,5	5
Totalt:	11336	354	46,1	48
KK2	113	not stored on packing trolleys		

**Each pile contains 15 packages, number of piles=a set of bottom and lid*

The trolleys need to be refilled 48 times during one day, so when having 18 batches there will be an average of 2,7 refills per batch. The plastic bags need to be refilled approximately five times a day.

The packing table

Each single packing table has a trolley connected to each side that stores the different boxes. The plastic bags are stored on shelves under the table. When having only the Ellos brand, each packing table only had one trolley each, but

when the other brands were introduced they found it necessary to have two trolleys to carry all the different varieties. Each packing staff supplies the trolleys in order to have the required packaging. Time for filling up the trolleys is included in the batch time. In general, they supply themselves from the shelves in the aisles. By interviewing some of the packing staff, we found out that they all had different routines for supplying their trolleys. Some people only filled up when they were running out of packaging, while some filled up all the time, after every batch or when they had some extra time. Some people used the filling up as a micro pause needed in order to handle their work which is sometimes stressful.

Leaflets

With every order, one or two leaflets are distributed. This is a kind of advertising service that Ellos sells to different external companies. An example could be a bag from Fuji for developing pictures. In addition, the in-house brands have leaflets with their own advertisement, for example credit account information or special offers. The leaflets are currently stored everywhere in the area, both on shelves on each packing side, and on pallets close to side one. Since the customer is not supposed to know that all brands are packed and distributed in the same place and also that the different brands have different target groups, it is important to have different leaflets for each brand. Then, while operating on the Scandinavian and Estonian market, the leaflets must be adjusted to each country's market. This means that for the Ellos brand alone there will be leaflets in five different languages, and Ellos sometimes have more than one leaflet at a time. The leaflets do not have a designated place on the trolleys, so when changing country or brand, the inaccurate leaflets are either left on the table, or put back on the shelves.

The packing staff receives some of the money the company gets for this type of advertising. However, the general view of the interviewed group was that this is a hassle and they only do it because they receive that extra money. Some even discussed whether there would be any money left for the company if you really took in to account the time required for handling it.

The supply of leaflets from the storage area, in this case from pallets on side one, is handled by one forklift-function, normally a manual forklift. The routine is handled in the same way as for the supply of packaging. However, there is not an organised system on how to supply the packing staff with the required leaflet, instead the packing staff will supply him/herself from the shelves or pallets when change is needed.

7.2 Completing orders

Sometimes, an order is not complete when arriving into the chutes. It can be one or more items missing due to, for example, a failure in the picking routine or that the label is wrong and the item is directed to the wrong chute. A non-complete order will be put together with the invoice on a table behind the packing staff. There are 6-7 tables on each side. Sometimes, when there are a lot of non-complete orders or if it has been some kind of problem, these tables are not enough. Then, a lot of orders can be found on the floor.

It is quite common that the missing item will show up in the next batch. In that case the packing staff will complete the order and put it onto the conveyor belt. If not completed during the next batches, the completing staff will mark the missing item on the invoice and bring the invoice to a central completing station. The items still remain by the packing area and a sign ”PG” – på gång – on its way – will be written on a label. The completing staff travels around on a bicycle on his/her side and back to the completing station continuously. The present system is organised in the way that one person handles all the non-complete orders on each of the four sides.

At the completing station, there is a system of shelves where things that have turned up in the wrong chute will be placed according to the batch it arrived in. When coming with the invoice to the completing station, the completion person will first look here to find a missing item. If not found it is time to place a new order to the expedition department for this item. When there are a number of items on this order list, the head completing staff will send a request to the expedition staff. As soon as they have time they will execute this order and

deliver the missing items. The time window for this handling differs due to staff availability and pressure on the expedition. Then the order will be completed. If not possible to complete, the left over items are thrown in a crate and returned to the expedition.

In total, this movement occupies one completing staff on each packing side, one completing staff especially for Express delivery (in the morning) and one head completing staff, a total of a little more than five full-time employees.

7.3 Group system

Since 1995, the packing department is organised in a station system consisting of eight different stations. There are eight different groups with approximately 10-15 persons in each group. Within the groups, they organise themselves and make sure there are enough staff for every day. They do their own daily planning and holiday planning, and they are even entrusted with the task of recruiting new members of their group. The company set aside money for each group for education and developing, study-visits and also social group gatherings in the evening. They try to create a group feeling by having meetings and also for example sending flowers to someone that is sick during a longer period. Every month they have one meeting during 1,5 hours where they both get information from their supervisor and have their own discussions.

Except the packing task, that is compulsory for all stations, every station has its special tasks. For example, sorting bags and boxes into postal crates and supplying packaging material by forklift. When interviewing people, we found that some tasks are not so popular, for example the sorting function, where all items are put on the conveyor belt with the label facing upwards. Some tasks are more popular, such as driving the forklift. It is necessary to have a licence to do this.

The change of stations takes place once a week, on every Wednesday. The reason why they do not follow a normal week is that they do not need to work

five days in a row with the same tasks. The weekend will be a break in between. Then they also change positions in the area.

7.4 Movements

Different types of movements cause a lot of traffic within the area, and are necessary to keep an eye on all the time, for example, a forklift coming in the aisle. It makes the area prone to accidents. We have determined that the following movements are constantly going on:

- forklift performing packaging supply
- forklift performing leaflet supply
- forklift collecting KK2 Jumbo boxes from the aisles to the departure area
- completing staff riding on bicycles, currently one person on each packing side
- walking to and from the shelves in order to refill the packing table with packaging
- walking to and from the shelves in order to refill and change leaflets

7.5 Analysis Part C

In this part we will analyse the four different routines that we have described. They are all analysed separately, and we end this part with a short summary.

7.5.1 The flow & storage of packaging and leaflets - analysis

When studying the packing area, we found that people do not carry packaging material on their trolleys only according to which brand will be packed the next couple of batches. Instead, they seem to store all brands in no particular order. They find it easier to just leave it on the trolleys instead of carrying it back to the shelf storage, just in case they will need it. But, as we found out when

analysing the batch planning, during one day some of the packing staff can actually pack all four brands.

For example, during our first weeks at Ellos, the Catalog Mail Outlet brand was not packed at all during two full weeks, but we observed that almost everyone stored the packaging material for this brand anyway. One reason for this might be the circulation of groups and that the packing staff do not have the same packing table all the time.

When we studied how the packaging material was moved around in the area we wanted to investigate if there could be a smoother way of handling. There are three movements for the packaging material. First, from the dock to the four-storey rack or in the connecting area, second, from the four-storey rack to the aisle shelves and finally, from the shelves to the packing trolleys. In step one and two it is almost always full pallets that are being moved, but when it comes to filling up the shelves the pallets are often divided within the area. This, because it is not necessary, and not possible to fill up a full pallet in one place. Every packing staff supplies the trolleys from the aisle shelves by walking.

The flow of packaging material from the four-storey rack to the different shelves in the aisles causes a lot of movement in the area in terms of forklifts driving around all the time. Since the area is quite narrow, especially between side two and three due to the shelves in the middle, it is both a puzzle to drive around and it makes the area non-secure in terms of accidents.

Packaging supply

If we can implement a system where it is possible to direct certain order types to certain chutes, it might be possible to change the supply of packaging. Below, we have separated the three larger boxes, according to the discussion in Chapter 5, and directed them to certain chutes. On the studied day, the number of chutes needed would be on average 18 in every batch. We have calculated with 4 orders per chute and dedicated two persons to this special packing station. This day is during a period with a high usage of large boxes, so

therefore this number can be considered almost a maximum. 30 persons will handle the remaining orders.

The calculations below are only very rough, but we wanted to find out what the supply could look like under other circumstances. When having only four different box varieties for the main number of packing staff, there will be more space on each trolley for the other boxes. In order to verify this, we did an experiment where we filled up a trolley with two piles (lid and bottom) of each K2, K4 and K7. The same lid will be used for K7 and K17, so we filled up one pile of bottoms for K17. Our experiment showed that there was enough space in the trolley to fit this.

Since we intend to suggest the implementation of a bubble bag instead of the box K1, we have calculated the number of bubble bags needed. This assumes that it is possible to replace all K1 boxes with the bubble bag, which probably is not possible to a full extent. However, there might be other orders from K1S and K2 that can be put in the bubble bag. We do not know the result and it is not possible to know without doing a more extensive test, but in this suggestion we have assumed that the box K1 will be taken away. The need for K1 or the bubble bag is 48 during one day. Our suggestions also include taking away the box K1S, as this one is not used very frequent, but we have calculated that a K2 will be used instead.

Packaging	Total use	Use/packing staff	No of piles	Refill/day	Refill 2 piles/time
K2 (K1S)	2229	74	10	10	5
K4	4128	138	18	9	9
K7	1979	66	9	4,5	4,5
K17	382	13	1	1	1
Total	8718	291	38	24,5	19,5

With a refill of one pile every time there will be 38 refills per day. However, we think it is possible to refill two piles every time in order to optimise the supply. Then the need to refill will be 19.5 times per day, slightly more than one time per batch.

The refill of the largest boxes depends on how the special packing station will be designed and where it will be situated.

We realise that this calculation must be considered not complete and thorough, but it shows the possibility to probably cut the frequency of supply in half. Therefore, we find it interesting to make a deeper study in order to suggest an efficient way of supplying packaging material, but this will not be included in our study.

Leaflet supply

The leaflets seem to be stored in no order at all, and it is possible to find them everywhere. When studying the batch planning we studied the schedule on one side during one day, Nov 30, 2000. The staff would, if we assume that the Ellos brand have two leaflets, have needed nine different leaflets on that day.

7.5.2 Completing orders - analysis

The non-complete orders take up a lot of space in the packing area, which makes it look quite disorganised. This routine involves a lot of movement in the packing area with four persons constantly moving around, by bicycle and walking, back and forth from their side to the central completing station. After investigating these movements and also the efficiency of the total routine we found it interesting to see whether there could be a more efficient way of handling it.

We found that a central completing area would be an interesting option to look at. To create floor space in the packing area, we think there should be as few movements as possible, and that the necessary ones should be structured. When investigating the non-complete orders on the tables in the area, we found that sometimes they had been left there for quite a long time. This delays the lead-time for an order quite remarkably, and it might mean that this order might not be completed on time for the delivery schedule.

7.5.3 Group system - Analysis

We suspected that the frequent changes would contribute to the disorder within the area and thought that maybe they are missing not having their own ”home” somewhere in the area. However, these suspicions were wrong. Nobody we interviewed had any desire to change this routine. Currently, the different stations vary quite a lot, both in times of work pressure and environment. For example, the Express delivery is always carried out on side one and side four has windows that make those stations brighter. These are some reasons why the staff wants to keep the circulation every week.

By analysing the area we realise that with the current distribution of work tasks it will be unfair to designate a certain group to a certain area. If making changes in this system, it is necessary to make sure the stations are fairly similar by terms of work burden and environment.

Still, we think the system of rotating the different assignments is very good and the daily work will be of more variety. This is very important, because some of the tasks are quite monotonous and heavy, seen from an ergonomic perspective.

7.5.4 Movements analysis

The movements and the way they are performed interact heavily with the other routines described earlier in this thesis. The two main areas that cause most of the movements are the packaging and leaflet supply and the completion. When studying the movements, we think that the following movements include constrains:

- The forklift is a danger when driving around all the time
- The transport from the four-storey rack to the middle inventory is unnecessary
- The movement of the KK2/Jumbo box is unnecessary
- The four completing staff travels all the time to and from the completion station

- The packing staff walk around to find the right packaging and the right leaflets

The changes we intend to suggest for these routines will have impact on the movements, and if implemented the area will be totally different.

7.5.5 Analysis Summary

In this chapter, we have dealt with the operational level, which includes the routines we have found interfere with our problem area. They will be improved if we manage to implement the changes on the two higher levels, but some of them are possible to implement separately.

8 Conclusions & Recommendations

In the three previous chapters, we have analysed the three problem areas according to a strategic, tactical, and operational level. In this chapter, we will continue that discussion by drawing conclusions from these three areas and show the interaction between them. The reader will be able to follow the flow from the upper level down to the lowest level. We have chosen to give suggestions and recommendations that are reasonable from an economical point of view. We could have given suggestions that include large investments, but we want our recommendations to be possible to implement in the near future.

8.1 Introduction

The model below is taken from our working model in order to highlight the different parts of our problem and their relations. They all interact and depend on each other, but we will go through our conclusions and recommendations for each part separately. It is important to keep in mind that A is a prerequisite for B, and B is in turn a prerequisite for C. However, we have based our conclusions on the possibility to implement some parts of the total solution separately in case it is not possible, or not wished, to implement everything.

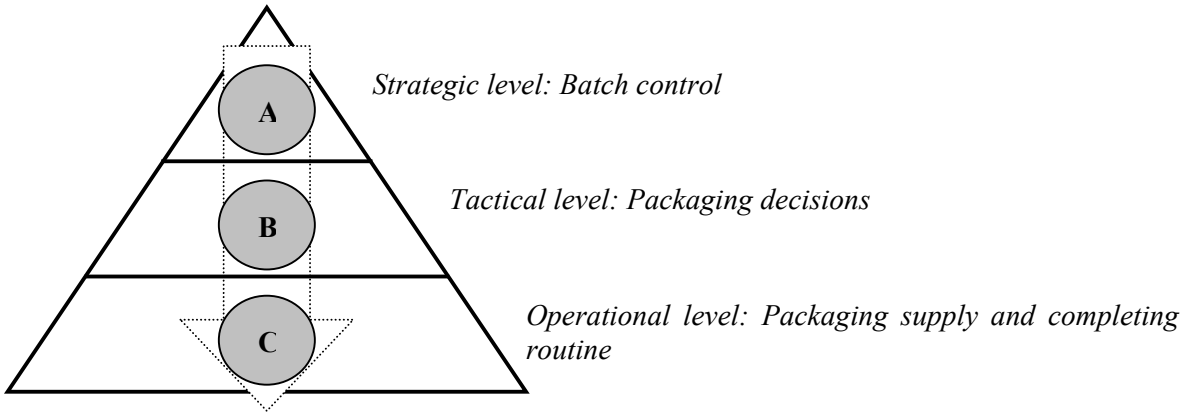


Fig. 8.1 The three levels. *Own model*

8.2 Part A – Strategic level: Batch control

To optimise the packaging flow and to reduce the assortment at each packing table, we suggest a change on the strategic and the tactical level. The batches could be organised in a way other than they are today, and this requires some changes in the computer system. The extent to which this must be done is not included in our study. We present two alternatives of organising the batches, and they can both be implemented separately. However, the optimal solution will be to implement both. The alternatives are:

- Brand control
- Order control

8.2.1 Brand control

The Ellos brand stands for such a high percentage of the batches that it would be possible to dedicate two sides for this brand only. The Josefssons Josefine brand is packed mainly on two sides per batch, but it is not always on the same sides. This could be organised in a way where the Josefssons Josefine brand is always packed on two of the sides, or even more preferable, on only one of the sides. Since Ellos and Josefssons Josefine are jointly picked, this does not mean any extra work for the picking department. The La Redoute brand normally runs in one or two batches over all four sides. Instead, it could be packed on two sides only, but in two different batches. The sorting station is divided into two sides, so this would not mean any extended sorting for the picking department when handling the La Redoute products. Instead of sorting for two different sides they will be sorting for two different batches.

If implementing this, the packing staff will pack more batches of the same brand in a row, or in some cases the same brand all the time. This means that they only need the packaging for one brand on the trolley.

There are limitations that may interfere with the possibility to implement this system in total. The batch planning has the external distribution schedule as a base, and it is like doing a huge puzzle to get all pieces right. There will always be extreme situations where it may be necessary to deviate from the preferred planning. But, if it is possible to dedicate certain sides to certain brands as a base, it will make the handling of packaging material much easier within the whole area.

8.2.2 Order control

All order sizes and all packaging varieties are today handled by everyone. Today the large orders, and orders with bulky items, mostly occur from the Ellos brand, which makes these batches most interesting to look at. The La Redoute brand handles clothes only, so there is less need to investigate this. We want to suggest the following alternative for order distribution:

- Dedicate certain chutes to large boxes and bulky items. Ellos carry nine different sizes of boxes, but the three largest, K10, K11 and KK2 are not frequently used, but must be available for all packers. These boxes also have an inconvenient handling.

We see several advantages with controlling the batches in this way, and they will be a prerequisite for most of our suggested changes on the tactical and operational levels.

To implement this new way of batch controlling, it is necessary to do some changes in the computer system. We are currently not aware of how large and how time consuming this will be, but we know that currently there are some possible steering available.

8.3 Part B – Tactical Level: Packaging

When studying the different packaging varieties, we realised that since the orders are so different regarding volume and weight, almost all boxes filled a function. The boxes also follow a standard that are used for companies other than Ellos, so adapting a completely new selection of boxes with own standard might be costly and also tie Ellos to certain suppliers. Instead of going deeper into finding one or more new boxes that could be universal, we focused on optimising the use of the existing ones. An extensive change in the variety of boxes would require a larger pilot study, and as well as co-operating with the suppliers.

8.3.1 The Different Packaging Varieties

Three of the boxes, K2, K4 and K7, represent 75 % of the use of boxes while the other six boxes represent 25 %. Therefore we suggest to:

- Replace K1 and K1S by bubble bag and K2
- Have K2, K4, K7 and K17 on all packing tables
- Set up a special packing station for K10, K11 and KK2

Since there is such a large price difference (confidential data) between boxes and plastic bags, we also think it is of more interest to further develop the use and design of the plastic bags. The current variety of plastic bags could be completed with one more size, in-between P30 or P60. When studying the orders we found a lot of larger textile items, such as bedspreads and pillows that do not weigh much, but are too bulky to fit in a P30. If wanting to keep the number of bags down, we think it is possible to replace P30 with a ”P40”, since P28 and P30 are fairly close in size, and P28 is the one that is used the most. We also hope that Ellos will continue the developing of our idea with the bubble bag.

8.3.2 The Special Packing Station

Our suggestion is to direct all orders in the Ellos batches with the packaging recommendation K10, K11 and KK2 to certain chutes. In connection to these chutes, we would like to set up a special packing station. Due to sometimes having different markets in the same batch, for example Ellos Denmark and Ellos Norway, it might be necessary to divide these chutes between two sides. However, when this is the case, it might also be possible to control the large orders between the batches, so they still can be kept on one side. We suggest two alternative locations for this station. The first is on side one, close to the dispatch area and close to the packaging supply from the four-storey rack, which reduces the movements within the area. This requires that the automatic packing machine is possible to move, and that the Express Delivery routines can be changed. The second alternative is to place it on side two and three close to the dispatch area. If it is necessary to have a special packing station on two sides, it is preferable to have those close to each other.

The packing staff will have special packing tables in order to ease their work and also to be able to handle some orders specially. For example, some single items are already packed sufficient and can, if the packing is neutral, be sent by just putting the invoice and address label onto the package. Job rotation is important for this task, but this is something that is already implemented at Ellos.

The changes on the strategic and the tactical levels lead to the possibility to do changes also on the operational level. The main chain effect regarding this part is the possibilities to change the routines of the supply and storage of the packaging material and the leaflets. These issues will be dealt with as we move to our third part.

8.4 Part C - Operational level: Routines

If we can implement the system of having only four different types of boxes at the main number of packing tables, the packaging trolleys will have more space

for each kind of box, and can therefore store larger quantities of those remaining boxes. Second, if the test currently going on at Ellos with boxes made of mini-board and micro-board, will be successful this means even more space on the trolleys, since these take up less space. The goal is that all packing tables shall have only one trolley each. If choosing to keep both trolleys, the supply can be even less frequent. The second trolley can also be useful on those sides that will pack more than one brand. However, the main goal is to have only one trolley, since it will open up the area, and the packing staff will not bump into each other's tables.

8.4.1 The flow and storage

We suggest that the supply of packaging material will be done in a different way compared to today's system. It is possible to reduce the steps in the internal packaging flow by taking away the middle inventory. Instead of moving the packaging material from the four-storey rack to the aisle shelves, the packaging material will be moved directly to the different packing tables. The packing staff does not need to take care of the refill of their trolleys and can concentrate on their main task, the packing task.

The rough calculations made in part C, Chapter 7, indicates that there are large options to optimise this routine, and we suggest to go deeper into this to make a more thorough analysis.

Here we present two ways of performing the packaging supply. One of them is possible to implement straight away since the necessary equipment is already available, and this does not include any investment. The second, that we think would be optimal, involves some investments.

- Having one or two persons serving the whole area by forklift. Since there will be more space on the trolleys, it will be possible to refill the trolleys with whole piles every time. The forklift will handle one pallet full of one variety on each round. During the winter season when the use of boxes is great, there might be a need for two forklifts serving the whole area.

- Investing in a manual ”train” that will carry a number of wagons. We have been looking at a system called “Ergo-Björn”. This system has a selection of different “carriers” to which it is possible to connect one or more wagons. These wagons are either standardised or customised. This vehicle is a lot smoother and easier to handle within the area, compared to a forklift. There are wagon models that can handle a whole pallet at the same time. This system can be used to handle other routines at the same time, for example one wagon could carry leaflets. We do not present the ”Ergo-Björn” system more deeply, since the people at Ellos are already familiar with this.

Because some products will be packed mainly on certain sides, we think that it will be possible to simplify the leaflet system as well. It will be easier to forecast which leaflets will be needed during the day. We suggest adding a shelf to the trolleys between the bottom and upper shelves. Since the main number of packing tables will not carry the somewhat higher box K10, there will be space enough for this. This shelf will be divided into five compartments and it will be possible to store five different leaflets at the same time. This will reduce the supply, and it is also possible to forecast the need during a day. The supply of these can also be done in connection with the packaging supply.

Suggested filling of trolley

8.4.2 Completing orders

Our suggestion is to have a central completion system. However, it might be necessary to implement some kind of security control in order to avoid theft, since we know that this has been a problem before. This station will need a system of organised shelves. When taking away the storage in the aisles, it will be possible to use some of the shelves that is now used in the area. There will be a lot of orders, and to easily keep track of every single order, we suggest that the shelves will have numbered positions where you place the non-complete orders. We will not make a detailed description of how to design this station here, since we will present how to perform the different procedures for Ellos exclusively.

Our aim is that the non-complete orders will be transported to the central completing station when the next batch is gone. That is, the order will be in the packing area until the next batch is finished. This is because a lot of missing items turn up in the next batch.

We suggest a system with an “Ergo-Björn” vehicle to collect the orders. To reach an optimal solution, this could be made in conjunction with the supply of packaging. There are wagons available at ”Ergo-Björn” with shelves that could be suitable for this. By having a couple of wagons, the wagons could be exchanged when the ”train” has completed one round in the area.

We also think the completing station would be more efficient by changing the way of rotating the staff. Now, the rotation occurs every week. It takes some time to build up routines, and people do not always like to work by the same routines, so by having eight different groups this could mean eight different ways of working. And, out of the eight different groups, there are different persons from the group on different days. This means that the people working in the current central completing area never really build up a routine, since they might only stay there for a couple of hours. If changing this routine into working with the central completing task over a longer time, these people acquire an ”eye” for hunting missing items and can be much more efficient in their work.

8.4.3 Group system

At the beginning of our time here at Ellos, our suggestion was that the groups should have the same position in the area all the time. We thought that the disorder in the packing area has a lot to do with people changing places all the time. However, we realise that the different sides of the packing area are different both in terms of work pressure and environment. This makes us realise that, under the current circumstances, the rotiation system is superior to a system where the groups are in the same place all the time.

If our suggestions can be implemented, then it might also be possible to re-design the station system at the same time. We have observed, and also been aware of when interviewing the staff, that the group system is very positive and most of the staff seems to be very involved in the daily operations. We think that the stations handling the Express Delivery and especially the Completition should not be changed as frequent as the other stations, because these stations require more routines and are less suitable for non-experienced staff. In our future scenario we also see a change of the Express delivery routines so that the group having this station will not feel that their station is to heavy and messy compared to the others.

If it is possible to control the batches and implement the system that two of the sides almost always handles the Ellos brand only, these sides could be very suitable for new personnel and personnel from for-hire companies such as Manpower and Proffice.

8.4.4 Movements

The changes now possible to do on the operational level in terms of routines and movements also makes it possible to reduce the movements within the area. Our suggestion is to invest in one or two “Ergo-Björn” vehicles with a selection of wagons for different purposes. While it is possible to have a couple of wagons in a set, it is possible to perform more than one routine at a time. For the packaging supply there can be a wagon that can load a whole pallet, and for

the non-complete orders there can be a wagon with shelves. The “Ergo-Björn”-system also includes customised products, so it is possible to find the ultimate solution.

The following movements will remain in the area, and they are possible to perform within the same movement:

- supply packaging from the four-storey rack direct to the packing tables
- supply leaflets from the pallets direct to the packing tables
- collect non-complete orders from the aisles to the central completing station

The movement of KK2 Jumbo box will be eliminated due to the fact that these boxes will be packed at the special packing station. We suggest that this should be situated close to the dispatch area.

In total this reduces the movements in the area. The staff does not need to walk around in the area to supply their trolleys. The transportation of non-complete orders and the supply of packaging and leaflets will be performed in one movement. This, in conjunction with taking away the middle inventory, the aisle shelves, will leave the packing area much more spacious.

8.5 Summary of conclusions

We have now given our conclusions and recommendations for the three parts of our study and also showed the connection between them and how a change on one level affects the other levels. Here we highlight the issues that are the main changes we recommend, and they all influence each other. Our suggestions will lead to the following possibilities:

- **Less frequent changes of packaging –** when the brands are dedicated to certain packing sides, the packing staff does not have to change the packaging so often and can instead store more of the most frequently used.

- **Fewer varieties of packaging on the main number of packing trolleys –** when both brands and orders are being controlled, there will be less packaging on each packing trolley.
- **Mini-well & Bubble bag –** these new packaging materials and designs takes up less space on the packing trolleys.
- **Enough with one trolley –** when separating the brands and reducing the number of boxes on the packing trolleys, it is possible to use only one trolley.
- **Space for leaflets on trolley –** when taking away the large boxes from the main number of trolleys, it will be possible to store the leaflets there instead, which means that the packing staff does not need to search in order to find the proper ones.
- **Easier handling of the large boxes -** the special packing station can be equipped in a way that makes the handling of the boxes much more efficient than it is now. It can also be situated close to the dispatch area in order to reduce movements.
- **Ergonomical improvements –** the main number of packing staff will only use smaller packaging. For the staff working at the special packing station there will be a more frequent job rotation, since this task will be harder. This station will also have suitable equipment.
- **Easier supply of packaging and leaflets –** when having more space on the trolleys and fewer varieties it is possible to take away the middle inventory in the aisles and by the packing sides. Instead the supply flow will go direct from the four-storey high rack to the packing tables.
- **Easier to forecast daily use for each packing trolley –** due to not having that many varieties on each packing trolley, it is possible to use a forecast for supplying them.
- **Reduce and utilize the movements within the area and make them smoother** – it is possible to perform more than one movement at a time, for example packaging supply can be done in conjunction with collecting non-complete orders.
- **Spacious area** - no storage in the aisles next to each packaging side

In the model below, we will visualise the whole flow in order to connect all the parts towards the main purpose.

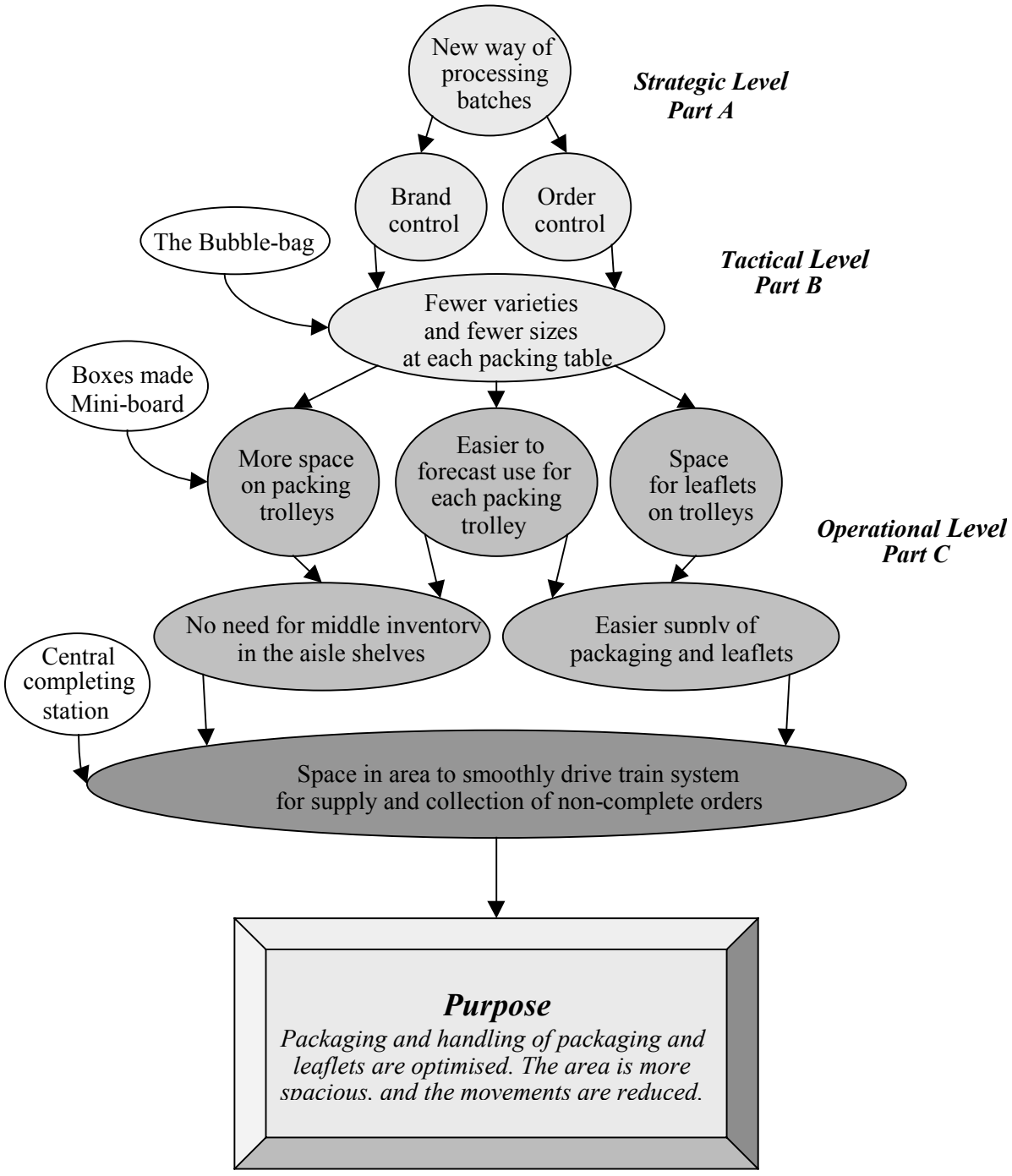


Fig. 8.5 Conclusions and Recommendations. *Own model*

To implement our suggestions involves changes on all levels and we think it is necessary to do it slowly and with a very thorough project plan. This involves changing routines that are deeply rooted into people's daily life, so it must be performed with careful preparations.

Our suggestion is to appoint a project group with representatives from different levels and different areas. It is important that the project leaders are given time and resources in order to achieve a successful implementation. It is also necessary to choose people that will devote themselves to the project in terms of not giving up if there are problems.

Finally, we think the best time of the year to start implementing this is during the summer catalogue season. Most of the issues circulate around the different boxes, and during this time the boxes are the least frequent. This means that it is possible to be well prepared when the winter catalogue starts.

9 Further investigations

During the process of our study, a lot of ideas have passed through our minds. Some of those are to be considered more "wild" compared to others. Since our aim with the study is to give reasonable suggestions that are possible to implement in the near future, we decided to let some of these ideas only be "thought-provoking" There is also a limitation in time, which made us choose to not go any deeper into those.

Further refining of order control

Today, depending on season, 50-75% of all orders are packed in plastic bags. In order to refine the batch planning further, some of the chutes could be dedicated to plastic bags only. This means that the packing staff needs no boxes at all or just a few just in case an order cannot fit into the bag.

Automate handling of boxes after strapping machine

When the larger boxes are concentrated to one certain area, the handling after the strapping machine can be different. The sorting of the different box varieties into the postal crates is both boring and time consuming. From what we have observed, it occupies at least three or four persons full-time. Instead, it might be possible to use a robot to take the parcel from the conveyor belt and put it straight into the postal crates. There will mainly be three boxes coming through the strapping machine, K2, K4 and K7, since K17 is not used that much.

Neutral packaging

The optimal solution would be the possibility of introducing a neutral packaging that could be used for all the brands within the group. It is impossible to measure the value of the fact that the brand name is printed on the package or bag. How would the customer react if they instead received a neutral package? There are currently no marketing surveys made in this area.

This we found out when interviewing Lennart Helgesson from the branch organisation SPF.

We have found some ideas that could be interesting to look into:

- *Strapping machine with wider strap*
  We found an idea that might not technically be possible to peform at present, at least not in the way our first thoughts were. This is using neutral packaging and instead having the brand name on the straps. Currently it is not possible to have a strap that is wider than 12 mm, but having a strapping machine that could handle wider strap would make this possible. It could be as wide as 50 mm. Then it would be possible to have different strapping for the different brands, and the only constrain would be to make sure the right strapping is in the machine. By being so wide it will still protect the value of the brand name. In connection to this, the adhesive address label could be larger than the present and have the brand name printed. This would make the brand name even more obvious.

- *Scan brand name in connection to strapping*
  With today's sophisticated technique, the possibility to scan the brand name on a neutral box would not be too far away, maybe it is already available. Then all brands could be packed in a neutral packaging and in conjunction with going to the strapping machine the brand name would be scanned onto the ready parcel.

- *Joint packaging*
  Having a joint design for all brands containing the text: "We distribute for Ellos, Josefssons Josefine, La Redoute, Catalog and Enjoy". This does not necessarily connect the ties of the different brands to each other. Instead, it gives the customer the thought that the distribution is outsourced.

  There could be a joint design for Ellos and Josefssons Josefine as they have similar target groups. We know that most customers do not buy from only one mail order company, they might buy from three or four different ones. The La Redoute brand has a different target group and must, if they want to

keep their special image, have their own packaging. The Catalog Mail Outlet brand mainly sells surplus from the other brands and must therefore not be connected to the others.

Automatical ”train” system

If the system with an ”Ergo-Björn” type of vehicle could be implemented, a further developing of this could be to automate the train. This can only be done if it is found that the system of supplying and collecting non-complete orders are working satifsying. It requires a larger investment and it also ties Ellos to the supplier over a long time. However, in the long run, this means that no staff is needed to perform the rounds in the area.

New way of selling advertising

The handling of the leaflets includes a lot of moments. Another idea could be to sell advertising space on the invoice. When taking away the dispenser machine for all markets, the invoices will not be double folded anymore. However, it could be possible to keep this type of invoice and sell advertisment space on the other side. This side could also be used for Ellos internal advertising. An example of this would be the invoice you get together with ”Allt om Mat”. They always have an offer on the second side of their invoice.

Handling of promotion items

We suggest another way of handling when the pressure is heavy on the sorting machine. If we manage to implement the packaging flow so that the packing staff only needs to fill up one of the trolleys, it would be possible to fill the other one with these items. This assumes that the item is not too heavy. The order settle will still show the right number of items included in the order. Instead of sending the items on the sorting machine, they will be delivered to each packing trolley. This saves both the label handling, the sorting and the need to place it right onto the conveyor belt. This might cause the control of the items to be less, but we think that would be of minor importance. The supply of these could be done with the same system as for the other supplying tasks in the packing area.

Appendix 1 - Simulation

In this appendix, we have chosen to put the extended parts of the simulation that are interesting when it comes to simulation. As mentioned before, we chose to put the details here and just give a brief description within the thesis. Still, those parts are very important, especially if interested in details of how to perform a simulation task. The parts we mainly deal with here are theory and the steps in building the model, like queue diagrams and attribute descriptions. We also show the tables we used for the input data in the model.

QBM - A Method for Modeling and Simulation

QBM is a scientific method for modelling and simulation, and stands for Quality Based Modelling. Since the problem is often vague in the beginning of the process, the QBM method focuses on using the simulation as a tool for problem solving. This method is iterative, which means that it sometimes might be necessary to build a completely new model after a while. (Lind 1997)

When working with this method, the following stages are used in the process (Lind 1997):

1. **Determine the purpose**
2. **Describe the system**
3. **Identify the problems and their relations**
4. **Identify goals and their structure**
5. **Build the model**
   - 5.1 Choose model characteristics
   - 5.2 Choose level of abstraction
   - 5.3 Choose the modelling technique
   - 5.4 Data collection
   - 5.5 Determine the objects in the model
   - 5.6 Determine the character of needed probability distributions, if applicable
   - 5.7 Test random number generators for accuracy, if applicable
   - 5.8 Model construction

6. **Validate the model**
   - 6.1 Viability
   - 6.2 Stability
   - 6.3 Premise validity
   - 6.4 Reproduction of historical behaviour
   - 6.5 Prediction
   - 6.6 Technical validity
   - 6.7 Subjective validity
   - 6.8 Total validity
7. **Make model experiments**
   - 7.1 Experiment planning
   - 7.2 Main experiment
   - 7.3 Sensitivity analysis
8. **Put the results together and arrange presentation**
9. **Validate the result**
10. **Present conclusions and recommendations**

Through the description of the system and the purpose of the modelling it is possible to identify the problems in the specific situation. These problems should be listed and drawn in a picture to show the relations between them. When doing this, it is possible to see which problem is the cause of the others. Then this list is used to create a list of goals, and the goals must meet the purpose of the modelling. The goal list shall also be drawn in a picture, where the hierarchical structure and the relations between them are shown.

The model characteristics shall only specify things that meet the purpose, and this is true even when it comes to determining the level of abstraction, which we further on will refer to as limitations. There are also limitations depending on the modelling technique, the time and resources available.

Data should be collected when needed, and it is necessary to use different sources. Direct observation, interviews, manuals and work descriptions are examples of suitable sources. The major problem with written information is that it often contains unnecessary data and is organised in a way that does not suit the modelling purpose.

From the real system, the objects and their activities, attributes and relations to other objects that are necessary for the model shall be identified. To do this, it can be useful to draw a preliminary picture of what the model will look like.

Simulation models most often require some random behaviour, and this is implemented in the model through a probability function, which makes it possible to generate random numbers that follows a specific distribution. When the decision is made that random numbers of a certain distribution is needed, it is very important to test that those numbers are good representatives from the distribution.

The construction of the model must allow observation of all the parameters that have been determined earlier. All the simplifications must be listed to make it possible to evaluate these when validating the model. The model must clearly picture the intended behaviour.

Validation means that the model is checked to make sure that it is a sufficiently close picture of the real system and for the modelling purpose. It is important to evaluate what the consequences of the differences between the model and the reality will be, considering all the limitations and simplifications. Viability is the time perspective of the validity of the model and answers the question if the model work well during a reasonable time. Discontinuity in values of the parameters could be an indication that the model is not sufficiently stable, and the sensitivity analysis can also give hints about this. When determining the premise validity, it is checked that the premises that the model is built on are well known and accepted facts. Comparing the behaviour and the output from the model with what has happened in the historical system can be an important validity test as well, and the ambition is that the model should be able to say something about the future. Limitations and simplifications are things that influence the behaviour of the model, and this affect the technical validity. In case the model builder has any doubts about the model, he/she should state this, and this determines the subjective validity. The total validity should be an overall view of the model, how it works as a whole.

The experiments in a quantitative model are directed towards understanding the behaviour of the model by looking at the influence the different objects have on it. There is no standard for experiments of this kind.

In a quantitative model, there are several different combinations of parameter values that can be tested, but in a large model, it is not possible to include all different combinations. Therefore, it is necessary to decide which combinations will create significant result with a minimum number of experiments, according to the purpose of the simulation. If the model has a random behaviour, it shall also be set how many experiments should be done with the decided combinations. Each experiments should have the same set of random numbers, so the start values for the random number generator must be determined and documented.

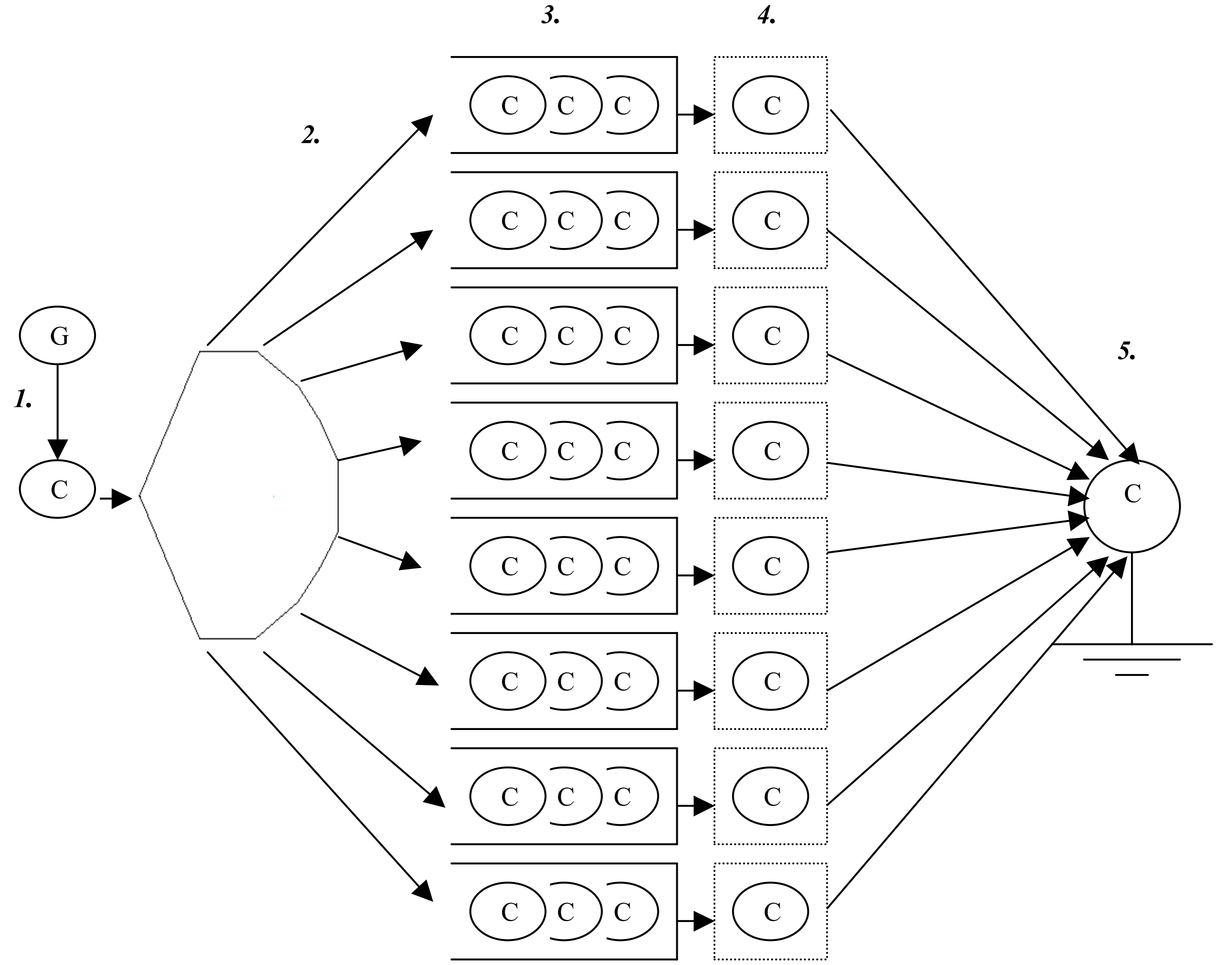
To guarantee that the model can handle the different values, a sensitivity analysis should be done. It is preferable if the values can be both increased and decreased, and the analysis shall be performed with the same sets of random numbers as in the main experiment. The most common is to change one value at a time, to be able to isolate what result will be of each parameter.

Quantitative models can create an enormous amount of output data, especially a computer model, and this result must be put together and presented in a way that is understandable. Examples of this are diagrams and pictures, tables that are easy to read, and mean values of interesting figures. The result must also be validated in order to draw conclusions from it, and this can be done with some statistical methods. An example of this is to use confidence intervals, which gives the reasonable limits that the values vary within. After all this, the result can be used as a basis to draw conclusions from. Here, it is important to be clear about the purpose to avoid moving outside the target area. It is not allowed to draw conclusions about something that is not covered by the purpose of the model.

Describing the steps in the model

We will build our model representing one of the four packaging sides in order to get a clear view of the system and that it will be easy to show for someone without knowledge of simulation tools. To achieve the normal production for one batch, with four packing sides, the model can be run four times. We see no constrains in doing it this way, as the orders are randomly spread.

Simulation Flow Model



1. Each arrival (batch) contains 320 orders that will all enter the system at the same time. No new batch will be let in to the system until the present batch is completed. Here the different orders are given their identity by terms of Packaging ID, required Packaging Time and which of the chutes they can be handled in.

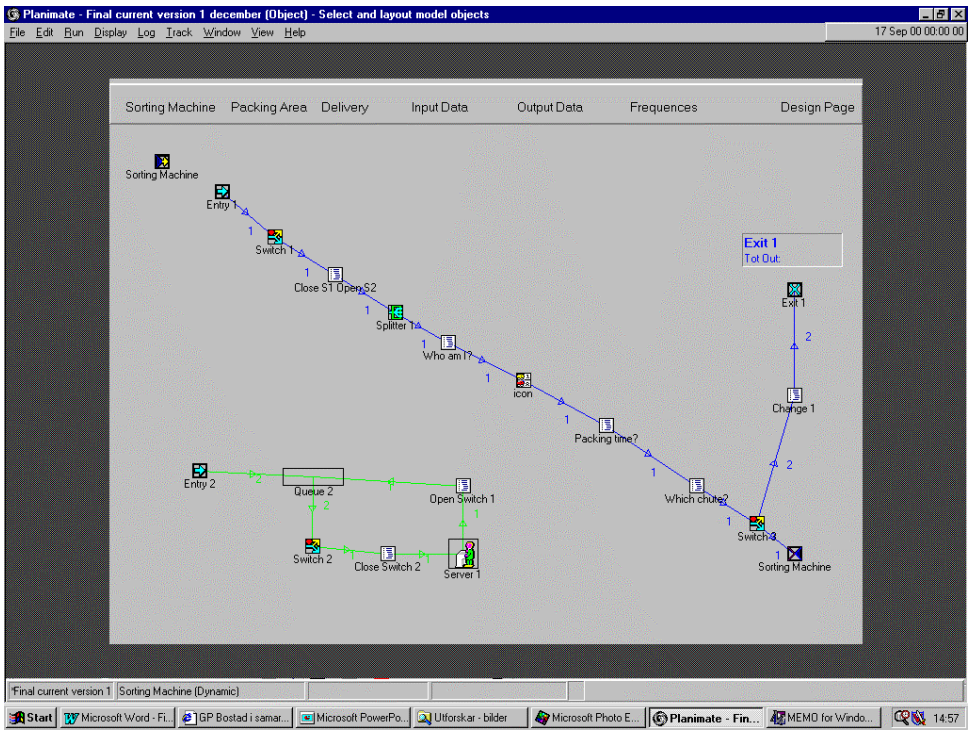
2. The orders will be split into the eight different queues. The order is already given the number of the chutes it can be handled in. (For the current alternative, all ID:s can be handled by all chutes, but in our other alternative we will direct some ID:s to certain chutes.) If an order can not find an available queue it will automatically be directed to a certain exit where they are being counted.

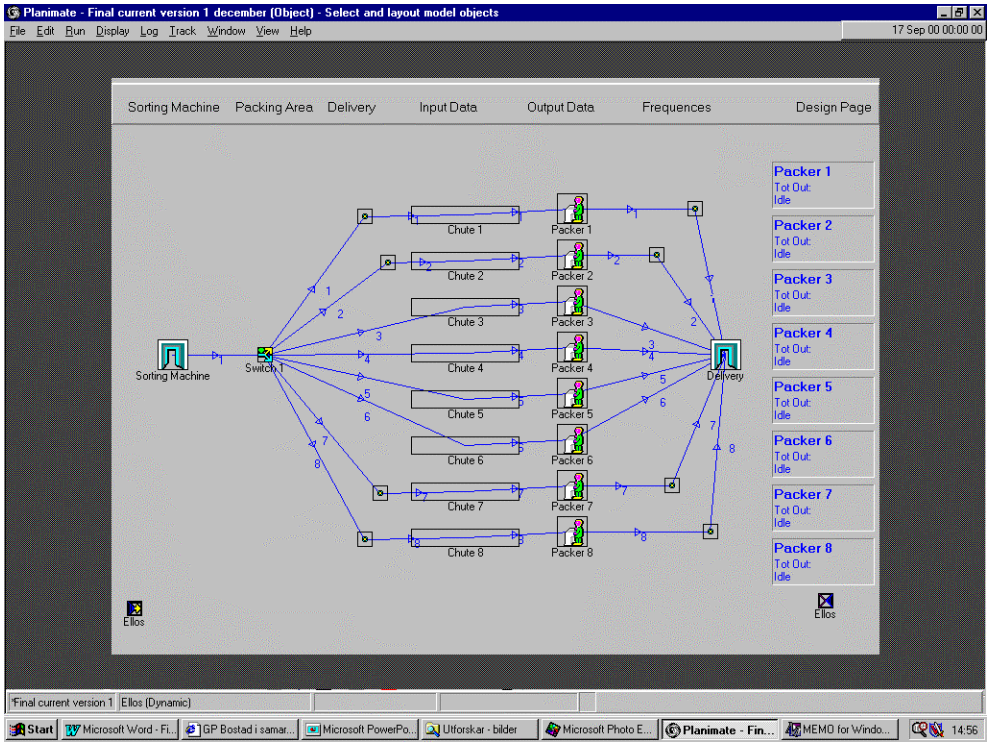
3. Every queue represents eight chutes, which is the normal amount one person is supposed to handle during one batch. Each chute normally contains five orders, which in this case will be 40 orders in each queue. For our suggested alternative, the distribution is different. There is no queue order in our system, because all the packing staff will start packing at the same time, when the batch starts. They have a set time limit by which all orders must be completed. It does not matter which order is packed first, because there is no priority.

4. Each person in the packing staff is represented by a server. These eight persons represent one side of the packing area. The time set for the batch is the limit for the packing staff to complete the work. Each order has an attribute that tells the packing staff how much time is required to complete that certain order. The time depends on the size of the order and the packaging. We have determined a mean time, with a min and max value.

5. When the orders are packed, it means that they are ready for delivery and then they leave the model.

Below are pictures of the panels in our simulation model. First, the sorting machine where the orders are getting their attributes. Second, the packing area where the packing task is performed, and third, the delivery area where all calculations are made.


Planimate - Final current version 1 december (Object) - Select and layout model objects
File Edit Run Display Log Track Window View Help
17 Sep 00 00:00:00
Sorting Machine Packing Area Delivery Input Data Output Data Frequences Design Page
Sorting Machine
Entry 1
Switch 1
Close S1 Open S2
Splitter 1
Who am I?
icon
Packing time?
Which chute?
Switch 3
Exit 1
Tot Out:
Exit 1
Change 1
Sorting Machine
Entry 2
Queue 2
Open Switch 1
Switch 2
Close Switch 2
Server 1
Final current version 1
Sorting Machine (Dynamic)
Start
Microsoft Word - Fi...
GP Bostad i samar...
Microsoft PowerPo...
Utforskar - bilder
Microsoft Photo E...
Planimate - Fin...
MEMO for Windo...
14:57


Planimate - Final current version 1 december (Object) - Select and layout model objects
File Edit Run Display Log Track Window View Help
17 Sep 00 00:00:00
Sorting Machine Packing Area Delivery Input Data Output Data Frequences Design Page
Sorting Machine
Switch 1
Chute 1
Chute 2
Chute 3
Chute 4
Chute 5
Chute 6
Chute 7
Chute 8
Packer 1
Packer 2
Packer 3
Packer 4
Packer 5
Packer 6
Packer 7
Packer 8
Delivery
Packer 1 Tot Out: Idle
Packer 2 Tot Out: Idle
Packer 3 Tot Out: Idle
Packer 4 Tot Out: Idle
Packer 5 Tot Out: Idle
Packer 6 Tot Out: Idle
Packer 7 Tot Out: Idle
Packer 8 Tot Out: Idle
Ellos
Ellos
Final current version 1
Ellos (Dynamic)
Start
Microsoft Word - Fi...
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Microsoft PowerPo...
Utforskar - bilder
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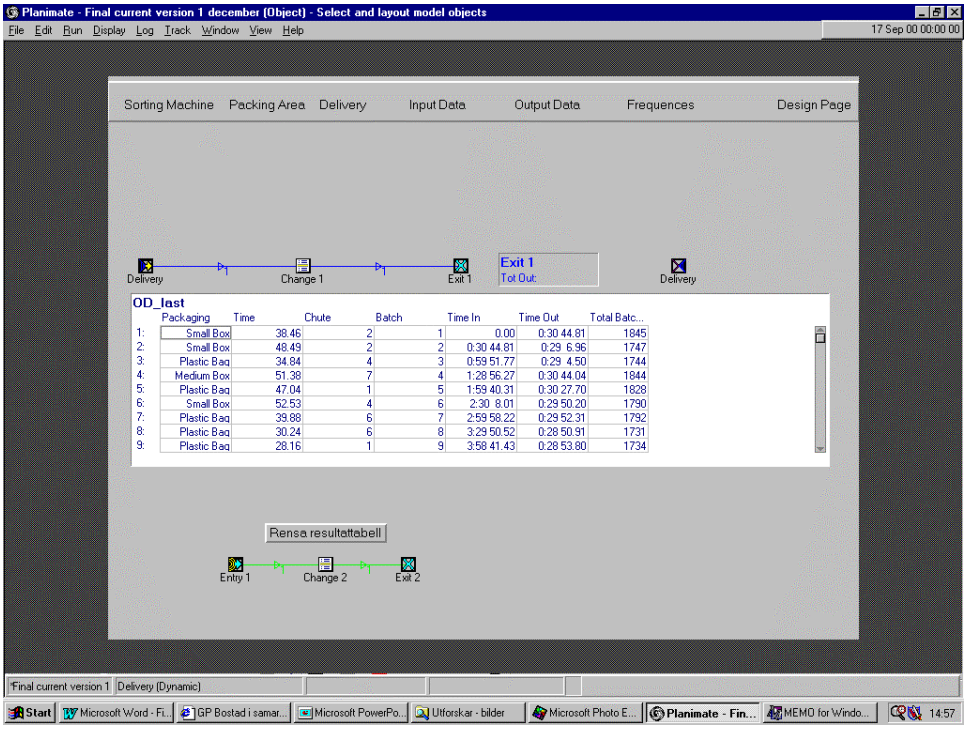
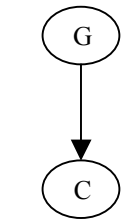
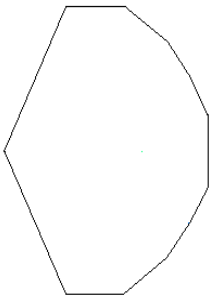
Planimate - Fin...
MEMO for Windo...
14:56


Planimate - Final current version 1 december (Object) - Select and layout model objects
File Edit Run Display Log Track Window View Help
17 Sep 00 00:00:00
Sorting Machine
Packing Area
Delivery
Input Data
Output Data
Frequences
Design Page
Delivery
Change 1
Exit 1
Exit 1
Tot Out:
Delivery
OD_last
Packaging Time Chute Batch Time In Time Out Total Batc...
1: Small Box 38.46 2 1 0.00 0:30 44.81 1845
2: Small Box 48.49 2 2 0:30 44.81 0:29 6.96 1747
3: Plastic Bag 34.84 4 3 0:59 51.77 0:29 4.50 1744
4: Medium Box 51.38 7 4 1:28 56.27 0:30 44.04 1844
5: Plastic Bag 47.04 1 5 1:59 40.31 0:30 27.70 1828
6: Small Box 52.53 4 6 2:30 8.01 0:29 50.20 1790
7: Plastic Bag 39.88 6 7 2:59 58.22 0:29 52.31 1792
8: Plastic Bag 30.24 6 8 3:29 50.52 0:28 50.91 1731
9: Plastic Bag 28.16 1 9 3:58 41.43 0:28 53.80 1734
Rensa resultattabell
Entry 1
Change 2
Exit 2
Final current version 1
Delivery (Dynamic)
Start
Microsoft Word - Fi...
GP Bostad i samar...
Microsoft PowerPo...
Utforskar - bilder
Microsoft Photo E...
Planimate - Fin...
MEMO for Windo...
14:57

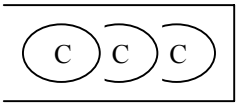
Definitions



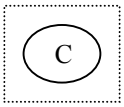
A generator that sends orders into the model. C=order



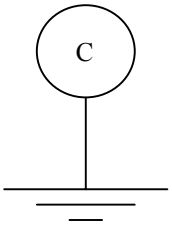
Switch and splitter, that organises the orders to the right queue.



A queue where the orders wait to be served.



A server, here packing staff, who packs the orders.



The order is terminated from the system when finished.

Objects

Plastic Bag Small Box Medium Box Large Box	(C)
Jumbo Box	
Item Generator (Sorting Machine)	(G)
Chute	chuteq
Packing staff	(S)

Attributes and activities

The bags and boxes:

Attributes:	Packaging ID Packing Time Chute Number
Activities:	Who am I? Determine which of the five item types. Packing Time? Determine the time required to pack this item type. Which chute? Determine which chute to send the item to.

The sorting machine:

Attributes:	Batch Start Batch Size Time between batches

Time for New Batch
Number of Batches for each run
Time in for Batch
Time out for Batch
Total Batch Time

Activities: Generate a New Batch
Determine Batch Size
Set Time between batches
Determine number of batches for each run
Set Time in for Batch=Actual time
Set Time out for Batch= Actual time
Total Batch Time= Time out – Time in

Packing staff (Service Person)

Attribute: Packing Time

Activities: Pack items in chute
Packing Time=Taken from a traingular distribution with min, mean and max values.

Input data for the simulation model

Packaging	Chute		Packaging	Chute
Plastic Bag	1		Medium Box	5
Plastic Bag	2		Medium Box	6
Plastic Bag	3		Medium Box	7
Plastic Bag	4		Medium Box	8
Plastic Bag	5		Large Box	1
Plastic Bag	6		Large Box	2
Plastic Bag	7		Large Box	3
Plastic Bag	8		Large Box	4
Small Box	1		Large Box	5
Small Box	2		Large Box	6
Small Box	3		Large Box	7
Small Box	4		Large Box	8
Small Box	5		Jumbo	1
Small Box	6		Jumbo	2
Small Box	7		Jumbo	3
Small Box	8		Jumbo	4
Medium Box	1		Jumbo	5
Medium Box	2		Jumbo	6
Medium Box	3		Jumbo	7
Medium Box	4		Jumbo	8

Chute distribution current alternative.

Chute No	Max No of orders
1	40
2	40
3	40
4	40
5	40
6	40
7	40
8	40

The maximum number of orders for every chute

Packaging	**Chute**
Plastic Bag	1
Plastic Bag	2
Plastic Bag	3
Plastic Bag	4
Plastic Bag	5
Plastic Bag	6
Plastic Bag	7
Plastic Bag	8
Small Box	1
Small Box	2
Small Box	3
Small Box	4
Small Box	5
Small Box	6
Small Box	7
Small Box	8
Medium Box	1
Medium Box	2
Medium Box	3
Medium Box	4
Medium Box	5
Medium Box	6
Medium Box	7
Medium Box	8
Large Box	8
Large Box	7
Jumbo	8
Jumbo	7

Chute distribution – alternative simulation

Chute No	Max No of orders
1	41
2	41
3	41
4	41
5	41
6	41
7	41
8	33

The maximum number of orders

Output data from the simulation model

Current, June

Packaging	Time	Chute	Batch	Time In	Time Out	Total Batch Time
Plastic Bag	33.75	7	1	0.00	0:28 12.94	1692,9367
Plastic Bag	40.21	2	2	00:32	0:27 41.42	1661,4229
Plastic Bag	34.84	4	3	01:04	0:27 39.01	1659,0124
Medium Box	51.38	7	4	01:36	0:29 32.41	1772,414
Plastic Bag	36.09	6	5	02:08	0:28 25.02	1705,0244
Small Box	52.53	4	6	02:40	0:28 27.10	1707,0986
Plastic Bag	39.10	5	7	03:12	0:28 34.81	1714,8108
Medium Box	48.96	4	8	03:44	0:27 34.91	1654,9133
Plastic Bag	28.16	1	9	04:16	0:26 31.29	1591,2878
Plastic Bag	37.98	6	10	04:48	0:27 59.86	1679,8573
Small Box	38.66	5	11	05:20	0:28 19.17	1699,1681
Plastic Bag	30.51	3	12	05:52	0:27 15.77	1635,7657
Plastic Bag	35.34	8	13	06:24	0:27 36.83	1656,8267
Plastic Bag	39.47	5	14	06:56	0:26 53.72	1613,719
Plastic Bag	33.44	2	15	07:28	0:28 15.97	1695,9654
Medium Box	0:01 4.69	1	16	08:00	0:28 27.72	1707,7247
Small Box	47.92	4	17	08:32	0:27 22.30	1642,3002
Small Box	45.38	1	18	09:04	0:27 53.82	1673,823
Plastic Bag	39.42	4	19	09:36	0:27 49.26	1669,2587
Plastic Bag	32.65	1	20	10:08	0:27 40.25	1660,2471
Plastic Bag	35.56	5	21	10:40	0:26 55.96	1615,955
Plastic Bag	38.16	5	22	11:12	0:28 14.07	1694,0718
Plastic Bag	35.78	6	23	11:44	0:27 41.44	1661,4362
Medium Box	40.14	5	24	12:16	0:27 6.94	1626,9389
Large Box	48.17	6	25	12:48	0:28 12.62	1692,6175
Plastic Bag	43.64	7	26	13:20	0:27 13.64	1633,6408
Plastic Bag	37.70	5	27	13:52	0:27 30.37	1650,3739
Small Box	35.01	5	28	14:24	0:28 57.59	1737,5875
Plastic Bag	37.26	8	29	14:56	0:27 31.75	1651,7453
Plastic Bag	32.74	2	30	15:28	0:27 8.13	1628,1333
Medium Box	55.75	5	31	16:00	0:27 46.15	1666,149
Plastic Bag	38.11	3	32	16:32	0:29 5.91	1745,9084
Plastic Bag	38.05	1	33	17:04	0:27 26.48	1646,4846
Plastic Bag	42.28	6	34	17:36	0:27 33.04	1653,042
Plastic Bag	33.94	4	35	18:08	0:27 49.15	1669,146
Plastic Bag	38.06	4	36	18:40	0:28 31.30	1711,2988
Plastic Bag	29.30	3	37	19:12	0:28 19.28	1699,2823
Large Box	41.16	7	38	19:44	0:27 34.25	1654,2472
Plastic Bag	41.37	2	39	20:16	0:27 50.94	1670,9436
						1643,0804
						66845,6593

		Mean for all 40 batches	1671,141483
(m1-m2)+1,96*roten ur((var1/n1)+(var2/n2))	30,56509444	Mean1 (1-20)	1674,67884
(m1-m2)-1,96*roten ur((var1/n1)+(var2/n2))	-16,41566444	Mean2 (21-40)	1667,604125
		Standard Deviation for all batches	37,5816296
		St. Dev1 (1-20)	39,8954954
		St.Dev2 (21-40)	35,79245731
		Variance for all batches	1412,378883
		Variance1 (1-20)	1591,650554
		Variance2 (21-40)	1281,1

Current, August

Packaging	Time	Chute	Batch	Time In	Time Out	Total Batch Time
Small Box	38.46	2	1	0.00	0:30 44.81	1844,8113
Small Box	48.49	2	2	00:32	0:29 6.96	1746,9611
Plastic Bag	34.84	4	3	01:04	0:29 4.50	1744,4998
Medium Box	51.38	7	4	01:36	0:30 44.04	1844,0399
Plastic Bag	47.04	1	5	02:08	0:30 27.70	1827,6993
Small Box	52.53	4	6	02:40	0:29 50.20	1790,2045
Plastic Bag	39.88	6	7	03:12	0:29 52.31	1792,3074
Plastic Bag	30.24	6	8	03:44	0:28 50.91	1730,9105
Plastic Bag	28.16	1	9	04:16	0:28 53.80	1733,8036
Small Box	45.56	6	10	04:48	0:29 9.67	1749,673
Small Box	38.66	5	11	05:20	0:29 36.02	1776,018
Small Box	49.00	2	12	05:52	0:28 49.32	1729,3172
Small Box	41.90	8	13	06:24	0:29 27.05	1767,0466
Plastic Bag	42.62	8	14	06:56	0:29 35.64	1775,638
Plastic Bag	33.44	2	15	07:28	0:29 42.20	1782,2025
Medium Box	0:01 4.69	1	16	08:00	0:29 38.66	1778,6602
Small Box	47.92	4	17	08:32	0:29 33.89	1773,8857
Small Box	50.57	6	18	09:04	0:29 12.06	1752,0568
Small Box	47.45	4	19	09:36	0:30 18.68	1818,6811
Small Box	38.19	1	20	10:08	0:29 18.10	1758,1038
Small Box	46.34	4	21	10:40	0:28 22.68	1702,6761
Plastic Bag	38.00	4	22	11:12	0:29 39.69	1779,6865
Plastic Bag	35.78	6	23	11:44	0:29 43.32	1783,3193
Small Box	39.39	7	24	12:16	0:28 41.74	1721,7437
Large Box	48.17	6	25	12:48	0:30 46.22	1846,2157
Small Box	52.98	7	26	13:20	0:29 9.52	1749,5238
Small Box	45.17	5	27	13:52	0:29 23.72	1763,7156
Small Box	35.01	5	28	14:24	0:30 30.42	1830,4167
Plastic Bag	37.26	8	29	14:56	0:29 28.44	1768,4427
Small Box	45.41	7	30	15:28	0:29 3.52	1743,5201
Medium Box	55.75	5	31	16:00	0:29 28.96	1768,9604
Plastic Bag	38.11	3	32	16:32	0:30 34.58	1834,5761
Plastic Bag	27.93	3	33	17:04	0:28 58.47	1738,4659
Plastic Bag	42.28	6	34	17:36	0:29 30.72	1770,716
Medium Box	0:01 6.73	2	35	18:08	0:29 53.47	1793,4655
Small Box	54.48	2	36	18:40	0:30 0.23	1800,2332
Plastic Bag	42.45	4	37	19:12	0:30 9.83	1809,8314
Large Box	41.16	7	38	19:44	0:29 24.61	1764,6081
Small Box	50.01	2	39	20:16	0:29 45.18	1785,1766
						1786,0361
						69271,8137

Mean for all 40 batches	1776,446245
Mean1 (1-20)	1775,826015
Mean2 (21-40)	1777,066475
Standard Deviation for all batches	35,58151135
St. Dev1 (1-20)	35,44557602
St.Dev2 (21-40)	36,62680807
Variance for all batches	1266,04395
Variance1 (1-20)	1256,38886
Variance2 (21-40)	1341,5
(m1-m2)+1,96*roten ur((var1/n1)+(var2/n2))	21,09800287
(m1-m2)-1,96*roten ur((var1/n1)+(var2/n2))	-23,57892287

Current, November

Packaging	Time	Chute	Batch	Time In	Time Out	Total Batch Time
Small Box	38.46	2	1	0.00	0:29 44.65	1784,65
Small Box	48.49	2	2	00:32	0:29 0.16	1740,16
Plastic Bag	34.84	4	3	01:04	0:29 49.15	1789,15
Large Box	0:01 0.07	7	4	01:36	0:31 28.13	1888,13
Plastic Bag	36.09	6	5	02:08	0:30 50.14	1850,14
Small Box	52.53	4	6	02:40	0:29 56.30	1796,30
Large Box	0:01 3.00	3	7	03:12	0:30 3.41	1803,41
Small Box	46.70	2	8	03:44	0:28 37.36	1717,36
Plastic Bag	28.16	1	9	04:16	0:28 37.74	1717,74
Plastic Bag	37.98	6	10	04:48	0:29 17.85	1757,85
Small Box	38.66	5	11	05:20	0:30 48.37	1848,37
Small Box	35.23	3	12	05:52	0:28 45.03	1725,03
Large Box	58.58	6	13	06:24	0:29 13.71	1753,71
Plastic Bag	42.62	8	14	06:56	0:28 59.01	1739,01
Plastic Bag	33.44	2	15	07:28	0:29 40.93	1780,93
Large Box	0:01 16.51	1	16	08:00	0:30 14.03	1814,03
Small Box	47.92	4	17	08:32	0:30 11.25	1811,25
Plastic Bag	37.17	4	18	09:04	0:29 42.70	1782,70
Small Box	47.45	4	19	09:36	0:29 36.95	1776,95
Plastic Bag	33.29	2	20	10:08	0:28 55.45	1735,45
Plastic Bag	38.57	4	21	10:40	0:28 7.70	1687,70
Plastic Bag	38.00	4	22	11:12	0:29 51.44	1791,44
Plastic Bag	35.78	6	23	11:44	0:30 24.99	1824,99
Large Box	45.55	5	24	12:16	0:29 13.00	1753,00
Large Box	48.17	6	25	12:48	0:30 33.44	1833,44
Small Box	52.98	7	26	13:20	0:28 54.16	1734,16
Small Box	45.17	5	27	13:52	0:29 28.26	1768,26
Small Box	35.01	5	28	14:24	0:30 15.84	1815,84
Plastic Bag	37.26	8	29	14:56	0:30 4.88	1804,88
Plastic Bag	37.87	7	30	15:28	0:28 46.39	1726,39
Medium Box	55.75	5	31	16:00	0:29 8.33	1748,33
Plastic Bag	38.11	3	32	16:32	0:30 33.62	1833,62
Plastic Bag	27.93	3	33	17:04	0:28 58.04	1738,04
Plastic Bag	42.28	6	34	17:36	0:30 9.79	1809,79
Medium Box	0:01 6.73	2	35	18:08	0:29 30.55	1770,55
Small Box	45.66	4	36	18:40	0:30 48.90	1848,90
Plastic Bag	29.30	3	37	19:12	0:30 42.00	1842,00
Large Box	41.16	7	38	19:44	0:29 38.10	1778,10
Plastic Bag	41.37	2	39	20:16	0:29 39.22	1779,22
						1770,4056
						69500,96

Mean for all 40 batches	1781,784095
Mean1 (1-20)	1780,61561
Mean2 (21-40)	1782,95258
Standard Deviation for all batches	44,74014472
St. Dev1 (1-20)	46,79527178
St.Dev2 (21-40)	43,77260342
Variance for all batches	2001,68055
Variance1 (1-20)	2189,797461
Variance2 (21-40)	1916,0
(m1-m2)+1,96*roten ur((var1/n1)+(var2/n2))	25,74593254
(m1-m2)-1,96*roten ur((var1/n1)+(var2/n2))	-30,41987254

Suggestion, June

Packaging	Time	Chute	Batch	Time In	Time Out	Total Batch Time
Plastic Bag	32.47	7	1	0.00	0:29 10.21	1750,2104
Small Box	52.39	2	2	00:32	0:28 30.53	1710,5256
Medium Box	48.13	4	3	01:04	0:28 21.82	1701,8186
Plastic Bag	39.71	7	4	01:36	0:28 2.83	1682,8347
Plastic Bag	36.62	1	5	02:08	0:28 10.66	1690,6565
Plastic Bag	37.53	4	6	02:40	0:29 21.10	1761,0976
Plastic Bag	36.75	4	7	03:12	0:28 21.70	1701,702
Plastic Bag	42.65	5	8	03:44	0:27 54.22	1674,222
Plastic Bag	45.33	1	9	04:16	0:27 16.61	1636,6141
Plastic Bag	41.45	3	10	04:48	0:27 31.23	1651,2258
Plastic Bag	42.62	5	11	05:20	0:28 12.35	1692,348
Plastic Bag	35.07	4	12	05:52	0:27 11.77	1631,7685
Plastic Bag	40.39	7	13	06:24	0:27 28.81	1648,8101
Plastic Bag	42.81	2	14	06:56	0:27 37.65	1657,6506
Plastic Bag	40.43	5	15	07:28	0:27 47.39	1667,3867
Plastic Bag	36.85	1	16	08:00	0:27 51.20	1671,2027
Small Box	51.32	3	17	08:32	0:28 24.78	1704,7831
Small Box	53.71	1	18	09:04	0:28 23.09	1703,0901
Plastic Bag	47.10	3	19	09:36	0:27 37.66	1657,6598
Plastic Bag	40.08	1	20	10:08	0:28 3.48	1683,4787
Medium Box	48.40	2	21	10:40	0:27 21.46	1641,456
Plastic Bag	33.95	4	22	11:12	0:28 27.62	1707,6206
Plastic Bag	39.51	7	23	11:44	0:27 41.05	1661,0485
Plastic Bag	41.19	5	24	12:16	0:27 35.26	1655,2638
Plastic Bag	39.15	5	25	12:48	0:28 0.68	1680,6815
Plastic Bag	42.92	4	26	13:20	0:27 32.16	1652,1581
Plastic Bag	41.44	6	27	13:52	0:27 53.95	1673,9469
Medium Box	55.11	1	28	14:24	0:28 33.31	1713,3055
Plastic Bag	30.49	5	29	14:56	0:28 2.83	1682,8322
Plastic Bag	32.20	4	30	15:28	0:27 29.79	1649,7903
Plastic Bag	44.98	3	31	16:00	0:28 37.65	1717,6495
Plastic Bag	35.52	3	32	16:32	00:29	1739,9992
Plastic Bag	38.58	6	33	17:04	0:27 50.34	1670,3449
Plastic Bag	32.99	5	34	17:36	0:27 26.05	1646,0506
Plastic Bag	37.84	1	35	18:08	0:28 12.93	1692,9299
Plastic Bag	39.86	3	36	18:40	0:28 35.21	1715,2106
Small Box	37.06	3	37	19:12	0:27 50.63	1670,6316
Plastic Bag	39.57	6	38	19:44	0:27 48.74	1668,7424
Medium Box	42.77	6	39	20:16	0:29 5.23	1745,2291
						1683,8922
						65663,9768

Mean for all 40 batches	1683,696725
Mean1 (1-20)	1683,95428
Mean2 (21-40)	1683,43917
Standard Deviation for all batches	31,93192644
St. Dev1 (1-20)	33,86023298
St.Dev2 (21-40)	30,76209523
Variance for all batches	1019,647926
Variance1 (1-20)	1146,515378
Variance2 (21-40)	946,3
(m1-m2)+1,96*roten ur((var1/n1)+(var2/n2))	20,56477899
(m1-m2)-1,96*roten ur((var1/n1)+(var2/n2))	-19,53455899

Suggestion, August

Packaging	Time	Chute	Batch	Time In	Time Out	Total Batch Time
Plastic Bag	32.67	7	1	0.00	0:30 33.15	1833,1499
Small Box	52.39	2	2	00:32	0:29 49.19	1789,1946
Plastic Bag	44.03	3	3	01:04	0:29 44.26	1784,2573
Small Box	51.91	3	4	01:36	0:29 50.45	1790,4542
Small Box	49.43	4	5	02:08	0:29 52.20	1792,1966
Medium Box	47.22	4	6	02:40	0:30 33.24	1833,2379
Plastic Bag	45.94	6	7	03:12	0:29 46.19	1786,1888
Medium Box	55.81	7	8	03:44	0:29 27.07	1767,0672
Plastic Bag	39.89	1	9	04:16	0:29 28.26	1768,2586
Small Box	45.72	5	10	04:48	0:28 33.75	1713,7498
Plastic Bag	38.12	3	11	05:20	0:30 17.42	1817,4196
Small Box	51.86	2	12	05:52	0:28 51.13	1731,1255
Plastic Bag	35.14	7	13	06:24	0:28 51.99	1731,9922
Small Box	47.05	5	14	06:56	0:29 2.82	1742,8179
Plastic Bag	31.59	5	15	07:28	0:29 6.58	1746,5798
Small Box	44.66	5	16	08:00	0:29 25.75	1765,7481
Medium Box	0:01 0.78	3	17	08:32	0:30 7.48	1807,4752
Small Box	44.52	6	18	09:04	0:29 20.53	1760,5319
Plastic Bag	38.05	7	19	09:36	0:29 25.38	1765,3848
Small Box	48.32	1	20	10:08	0:29 49.57	1789,5734
Small Box	39.47	7	21	10:40	0:29 7.88	1747,8791
Plastic Bag	45.96	4	22	11:12	0:29 47.28	1787,2796
Small Box	41.87	6	23	11:44	0:29 39.20	1779,199
Small Box	49.77	5	24	12:16	0:29 10.11	1750,1139
Small Box	49.67	5	25	12:48	0:29 37.72	1777,7163
Plastic Bag	42.92	4	26	13:20	0:29 15.60	1755,599
Small Box	45.16	6	27	13:52	0:30 3.76	1803,7585
Plastic Bag	36.67	1	28	14:24	0:29 49.03	1789,0337
Small Box	51.03	5	29	14:56	0:29 19.56	1759,5563
Plastic Bag	37.67	6	30	15:28	0:28 35.47	1715,4657
Plastic Bag	36.54	5	31	16:00	0:29 48.90	1788,8986
Plastic Bag	41.71	3	32	16:32	0:30 40.73	1840,7261
Plastic Bag	40.27	6	33	17:04	0:29 20.60	1760,5995
Plastic Bag	32.01	5	34	17:36	0:28 41.44	1721,4427
Plastic Bag	37.84	1	35	18:08	0:29 42.91	1782,91
Plastic Bag	37.62	2	36	18:40	0:30 1.35	1801,3475
Plastic Bag	45.54	8	37	19:12	0:29 20.75	1760,7537
Small Box	47.27	6	38	19:44	0:29 22.90	1762,8985
Small Box	53.14	6	39	20:16	0:31 21.80	1881,8003
						1801,8776
						69283,3813

Mean for all 40 batches	1777,131473
Mean1 (1-20)	1775,820165
Mean2 (21-40)	1778,44278
Standard Deviation for all batches	35,08513609
St. Dev1 (1-20)	32,9579962
St.Dev2 (21-40)	37,90609057
Variance for all batches	1230,966774
Variance1 (1-20)	1086,229514
Variance2 (21-40)	1436,9
(m1-m2)+1,96*roten ur((var1/n1)+(var2/n2))	19,39186391
(m1-m2)-1,96*roten ur((var1/n1)+(var2/n2))	-24,63709391

Suggestion, November

Packaging	Time	Chute	Batch	Time In	Time Out	Total Batch Time
Medium Box	55.91	7	1	0.00	0:29 43.05	1783,0486
Plastic Bag	38.32	2	2	00:32	0:29 35.72	1775,7216
Plastic Bag	44.03	3	3	01:04	0:29 5.18	1745,1829
Small Box	58.36	8	4	01:36	0:29 58.95	1798,9547
Plastic Bag	40.91	8	5	02:08	0:29 57.31	1797,3093
Plastic Bag	40.68	4	6	02:40	0:30 14.67	1814,6694
Plastic Bag	42.41	8	7	03:12	0:30 16.33	1816,3284
Plastic Bag	42.54	2	8	03:44	0:29 10.59	1750,5855
Plastic Bag	32.60	1	9	04:16	0:28 52.21	1732,206
Small Box	38.67	5	10	04:48	0:28 12.92	1692,9181
Plastic Bag	30.69	8	11	05:20	0:30 32.26	1832,259
Small Box	41.99	8	12	05:52	0:29 1.70	1741,6998
Small Box	41.90	8	13	06:24	0:29 11.47	1751,4739
Plastic Bag	36.10	5	14	06:56	0:28 42.88	1722,8846
Plastic Bag	34.58	8	15	07:28	0:30 8.39	1808,3887
Plastic Bag	39.55	8	16	08:00	0:30 39.37	1839,3652
Small Box	50.20	3	17	08:32	0:29 50.12	1790,1189
Plastic Bag	40.84	1	18	09:04	0:28 58.36	1738,3618
Plastic Bag	38.83	7	19	09:36	0:29 23.73	1763,7273
Small Box	56.09	8	20	10:08	0:29 57.96	1797,9579
Plastic Bag	35.70	7	21	10:40	0:28 31.61	1711,6061
Small Box	46.87	4	22	11:12	0:29 35.41	1775,4142
Plastic Bag	32.52	8	23	11:44	0:28 35.15	1715,1481
Small Box	48.32	7	24	12:16	0:28 51.41	1731,4083
Plastic Bag	47.38	8	25	12:48	0:29 37.61	1777,6115
Plastic Bag	44.84	6	26	13:20	0:28 41.45	1721,4523
Small Box	43.21	6	27	13:52	0:29 36.20	1776,2014
Small Box	51.29	4	28	14:24	0:29 48.07	1788,0693
Small Box	49.45	5	29	14:56	0:29 14.59	1754,5862
Plastic Bag	34.57	8	30	15:28	0:28 51.38	1731,3788
Small Box	33.65	8	31	16:00	0:31 14.78	1874,7761
Plastic Bag	34.54	8	32	16:32	0:30 38.38	1838,3847
Medium Box	45.48	3	33	17:04	0:29 16.68	1756,6834
Small Box	38.27	8	34	17:36	0:29 30.71	1770,7145
Plastic Bag	35.54	2	35	18:08	0:28 58.46	1738,4641
Jumbo	0:01 45.92	8	36	18:40	0:33 10.40	1990,397
Plastic Bag	45.54	8	37	9:13 10.40	0:33 9.67	1989,6723
Medium Box	0:01 3.14	6	38	9:46 20.07	0:29 20.08	1760,0782
Plastic Bag	41.64	8	39	0:18 20.07	0:29 29.67	1769,6711
						1769,0756
						69464,8792

Mean for all 40 batches	1780,84887
Mean1 (1-20)	1774,65808
Mean2 (21-40)	1787,03966
Standard Deviation for all batches	62,33471496
St. Dev1 (1-20)	39,47673244
St.Dev2 (21-40)	79,60302162
Variance for all batches	3885,616689
Variance1 (1-20)	1558,412404
Variance2 (21-40)	6336,6
(m1-m2)+1,96*roten ur((var1/n1)+(var2/n2))	26,56045215
(m1-m2)-1,96*roten ur((var1/n1)+(var2/n2))	-51,32361215

June	Current Alt. 1	Suggested Alt. 2	Difference
Mean	1671,1415	1683,6967	-12,5552
Variance	1412,3789	1019,6479	121,60134

(m1-m2)-1,96*roten ur((var1/n1)+(var2/n2))	9,05830753
(m1-m2)+1,96*roten ur((var1/n1)+(var2/n2))	-34,168708

August	Current Alt. 1	Suggested Alt. 2	Difference
Mean	1776,4462	1777,1315	-0,6853
Variance	1266,044	1230,9668	124,85054

(m1-m2)-1,96*roten ur((var1/n1)+(var2/n2))	21,2150615
(m1-m2)+1,96*roten ur((var1/n1)+(var2/n2))	-22,585662

November	Current Alt. 1	Suggested Alt. 2	Difference
Mean	1781,784	1780,8489	0,9351
Variance	2001,6806	3885,6167	294,364865

(m1-m2)-1,96*roten ur((var1/n1)+(var2/n2))	34,5629466
(m1-m2)+1,96*roten ur((var1/n1)+(var2/n2))	-32,692747

Appendix 2 - Interviews

Underlag till intervju 15 November 2000. Base for interview November 15, 2000. PO Gustafsson, Marketing Manager, Josefssons Josefine

- Allmänt om Josefsson – Josefine. Framtid och marknadsandelar.
- Allmänt för hela gruppen. Profilering, särskilt Larry.
- Internets betydelse i framtiden.
- Emballaget – marknadsaspekt på neutralt emballage.
- Förslag bandmaskin.
- Give-Aways och Promotion varor – framgång? Hantering?

- General information about Josefsson-Josefine. Future and market shares.
- General information and future regarding the whole group. Way of implementing profile, especially for La Redoute.
- The importance of internet
- Marketing aspects on packaging – neutral packaging
- Our suggestion with wider straps in the strapping machine
- Give-Aways and Promotion items – success? Handling?

Underlag för intervju 16 november 2000. Base for interview November 16, 2000. Lennart Helgesson, Svenska postorderföreningen

- Postordermarknadens historia och framtid, allmänt om/specifikt för branschen
- Postorderföretagens marknadsandel kontra detaljhandeln
- Postorderföretagens marknadsandelar sinsemellan
- Internets betydelse för de traditionella postorderföretagen, samt konkurrens det inneburit
- Emballage – hur viktigt är detta?
- Marknadsföring
- Kan man identifiera någon speciell målgrupp som handlar på postorder?

- History and future of mail order market, common and specific caractheristics

- Marketing shares compared to the retail industry
- Marketing shares between the Swedish mail order companies
- The importance of internet for traditional mail order companies, threats from new enterprieses
- The importance of packaging
- Marketing in general for the mail order industry
- Is it possible to identify a special target group for the mail order industry?

Base for interview November 17, 2000. Eric Faintreny, CEO, Redcats Nordic

- The present and future of the group.
- Different target groups. Profile for La Redoute?
- The importance of the internet now and in the future. Advantages for established mail order companies.
- Packaging – the possibility of a neutral design.
- Give-Aways and Promotion items – success? Handling?
- The French market. Similarities and differences.
- Strapping machine.

Underlag för intervjuer med gruppprepresentanter okt-nov
Base for interviews with group representatives, October - November

- Hur länge har du jobbat på Ellos?
- **Stationerna** – bra/dåligt? Arbetsbelastning?
- **Grupperna** – bra/dåligt? Arbetsfördelning? Önskas förändring?
- Allmänna **miljön**? Arbetsmiljön & stämningen?
- **Förändringar** – bra och dåliga?
- **Emballage** – hur ofta fylls vagnen på? Någon onödig lådmodell? Förpackningsrek.?
- **Packbordet** – designen?
- **Batchtiden** – hinner man med?
- **Kompletteringen** – bra/dåligt? Önskas förändring? Är det mycket felorder? Är det ofta så att den kan kompletteras under nästa batch?
- **Truck** – vad ingår i uppgifterna när man fyller på emballage?
- **Idéer** – får man gehör för sina idéer från företaget?

- **Bipack** – förslag på förbättringar?

- **How long have you been working at Ellos**?
- **Station system** – positive or negative? How is the work pressure?
- **Group system** – positive or negative? Does everyone take part in all tasks? Any wishes for changes?
- **Environment in general**? Work environment, feeling?
- **Changes the past years** – positive or negative?
- **Packing table** – design?
- **Batch time** – enough time? Optimal time?
- **Completion** – positive or negative? Changes suggested? Is it common with non-complete orders? Will they often be completed during the next batch?
- **Forklift** – what is included in the tasks when supplying packaging?
- **Own ideas** – will the company listen?
- **Leaflets** – suggestions for improvements.

Appendix 3 – Experiment Information

To everyone in the packing area!

We are getting towards the end of our thesis work. After New Year we will come back and present all our ideas for you.

One idea that we would like to test is a new packaging design – we have got samples of a new type of bag – air bubble bag! Our aim is that this could replace K1 and to some extent even K1S when these orders include fragile items.

We have received 200 prototypes of this bag, without logo. There is one prototype on the information board so you can all have a look. Design and quality are not definite so please come with suggestions and views!

During the next couple of days we will choose suitable orders and mark this with post-it on the invoices. We will also inform all persons involved and supply them with the right number of bags.

Every bag will include a small information sheet (se below). In order to make a follow up and be able to evaluate, we will phone the customers to hear their opinion.

Please let us know your views – you know where to find us!!! Ext 0511

Till Er Alla i Packen! 22 november 2000

Nu börjar vi närma oss slutet av arbetet med vår uppsats! Så småningom kommer vi att presentera våra idéer för Er, men det blir nog inte förrän efter nyår.

En idé vi nu vill testa är en ny förpackningstyp - vi har tagit fram ett prov på en helt ny påse – **bubbelpåsen** !!! Vår tanke är att denna skall kunna ersätta K1 och i viss mån även K1S i de fall dessa order innehåller ömtåliga saker.

Vi har fått 200 stycken provpåsar utan logotype. Det finns en provpåse upphängd på anslagstavlan så att ni alla har möjlighet att titta på den. Utseendet och kvaliten är inte definitiv så kom gärna med åsikter och förslag!

Under de närmaste dagarna kommer vi att välja ut lämpliga order och markera dessa med post-it lappar på ordersedlarna. Vi kommer också att se till att de packare som berörs kommer att få rätt antal påsar.

I varje påse kommer vi att stoppa ned en liten informationslapp (se nedan). För att följa upp och utvärdera så kommer vi att ringa upp ett antal kunder och ta reda på vad de tycker!

Vi vill gärna höra era åsikter – ni vet var vi finns!!!! Ankn 0511

Hälsningar

Information to the customer!

Dear customer!

We are performing a survey with a new type of plastic bag and would like to make an evaluation of this. In a couple of day's time we will call you and ask a few questions.

Thanks for your co-operation!
The Project Group
Eva Hansson & Merit Olsson

Så här ser informationen till kund ut!

ellos

Bäste kund!

Vi genomför just nu en test med en ny påse och vill gärna följa upp resultatet. Inom de närmaste dagarna kommer vi att ringa upp Dig och ställa några frågor.

Tack på förhand!

Projektgruppen genom
Eva Hansson & Merit Olsson

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Gunnar Petersson, Sales
Jan Svenäng, Sales
Karin Gunnarsson, Sales

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Stefan Karlsson, MA-manager

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Jan-Erik Eriksson, Sales
Carola Szücs, Sales

Total Logistik, Viared. November 15, 2000
Bengt Motin, Logistic Support
Bengt Dahlberg, Logistic Support

Others

Gorvak AB
Michael Andersson

Högskolan i Halmstad
Mårten Dragstedt, U3
Linda Uppman, U3

Packex
Bob Dustal

Scanpack 2000 2000-10-11
Svenska Mässan, Göteborg

Sealed Air
Sten Fransson