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Packaging Logistics

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Standardization of packages at Duni AB

**- A process to maintain a limitation of
packages and increase the filling rate.**



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Preface

This Master thesis is the last phase of the education in Master of Science, Machine Engineering, at Lund Institute of Technology. The Mater thesis comprises 20 points and was carried out during the autumn and spring 2006/2007, in collaboration with; the division of Packaging Logistic at Lund Institute of Technology and Duni AB, in Malmö. Our supervisors have been Annika Olsson, Assistant Prof. at the division of Packaging Logistics at Lund Institute of Technology and Jenny Klevås, packaging responsible at Duni AB.

First and foremost, we would like to thank Jenny and Annika for their guidance and support through our Master thesis. Their thoughts and ideas have been invaluable during our work. We would also take the opportunity to thank respondents at Duni in Bramsche and employees at Duni in Malmö for taking time during interviews and supply us with material through the Master thesis.

Finally we would like to thank each other for enjoyable and instructive moments with fine collaboration during the Master thesis.

Lund, 28th of May 2007

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Abstract

Duni AB is a leading provider of premium solutions and products, e.g. napkins, plates, table covers, candles and food solutions. The company has recently made major organizational changes, i.e. going from a decentralized organization to a centralized organization with all product development in Malmö. There is a lot of work to be done to optimize both product and packaging development in order to reduce logistics costs and enhance production efficiency. The filling rate among the napkin packages is at present low and the fact that the company has no process for introducing new packages for napkins, has caused a large number of different box sizes. The problem of finding appropriate packages for napkins is complex, since many factors affect the packaging size and design. The lack of standardization of the boxes causes consequences during transports, handling, production and purchasing. At present Duni have no process for introducing new boxes. For this reason, the purpose of the Master thesis was to develop a process to maintain a limitation of boxes and develop standardized boxes.

During the Master thesis a systems approach has been used and information has been gathered through interviews, database searching, literature studies, simulations in software for pallet utilization and a visit at Duni's plant in Bramsche, Germany.

In the Master thesis a box management tool have been developed. The tool helps to examine if existing boxes can be used for new products and illustrates how adjustment in the number of packages per box affects the choice of an appropriate box. An inventory of Duni's existing packaging solutions (primary and secondary packaging) has been done and simulations have been carried out for each primary package, trying to find the most appropriate packaging solution, concerning filling rate.

Duni have got an enhanced awareness of the packaging potential, as a way to increase sales and reduce cost associated with production and handling. The packaging function at Duni is nowadays involved at an early phase of the product development and there is still much work to be done, trying to reduce the amount of boxes and increase the filling rate of the boxes. By using the box management tool it is possible for Duni to take a further step in the process of making suitable packages for napkins.

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1 Introduction

1.1 Background

On a market where companies have a large focus on cost reductions to be able to meet the competition from global actors, packaging has attained a larger attention as a potential area for cost savings. Costs associated with handling and transports, constitute an evident part of the total costs for products produced today. Packaging solutions with high filling rate reduces the logistical costs and constitute, indirectly, to reduce the negative environmental effects, caused by emissions. Except for protect the product during transports; the purpose of the packaging is to marketing the products and in this way increasing the sales. To be able to meet demands regarding high filling rate, stable and attractive packaging solutions in an efficient way, it is essential to integrate the packaging in an early phase of the product development.

Duni AB is a leading provider of premium solutions and products, e.g. napkins, plates, table covers, candles and food solutions, that creates enjoyable eating and drinking occasions. Duni's headquarters is located in Malmö, Sweden and the company holds production facilities in Germany and Poland. Duni's major markets are Central, Northern and North West of Europe and the global reach spans more than 50 markets across Europe, Middle East, Africa and Asia Pacific.

Duni's products can be categorized as Fast Moving Consumer Goods (FMCG). For FMCG, with low margins, it is extremely important to keep logistics and production costs as low as possible. Duni have recently made major organizational changes, i.e. going from a decentralized organization to a centralized organization with all product development in Malmö. For that reason, there is a lot of work to be done to optimize both product and packaging development in order to reduce logistics costs and enhance production efficiency.

1.2 Problem introduction

Duni have an average, low filling rate on their boxes today; this result in empty space during the transport and also more pallets to handle. In addition, the bad filling rate increases the risks of transport and storage damages, due to double stacking and a gained number of pallets to be handled and stored internally.

Another problem is the large number of different box sizes, which Duni uses for there articles today. The numerous variants results in unnecessary production complexity, due to set-up times in the production and more boxes to be kept in stock. The large number of different box sizes also affects the purchasing price, as each box size is ordered in smaller quantities than if the boxes were standardized.

1.3 Purpose

The first step of the Master thesis is to make an inventory of the current packaging solutions, primarily Stock Keeping Units (SKU), used today and try to decrease the number of SKU packages and increase the filling rate.

The second step is to develop a process (box management tool) to maintain a limitation of SKU boxes. The intention is to set up guidelines to be used during new product development. In addition the purpose is to develop standard Duni boxes to be used for most of Duni's high volume products.

1.4 Focus and delimitation's

During the Master thesis some delimitation's has been done and focus has been at:

- Napkins produced at Duni's facilities in Bramsche, Germany.
- Only activated SKU boxes for napkins have been analyzed.
- Packaging solutions as repack and display pallets have been excluded.
- When using the pallet optimizing program CAPE PACK, packaging solutions with a filling rate below 70 % have been rejected due to the risk for instability in the box.
- All packaging solutions being proposed, is based on EU-pallets (1200*800 mm) with a height of 1250 mm (including the height of the pallet it self 145 mm), weight/ pallet 1000 kg and weight/SKU 15 kg (ergonomic demands).
- Overhang on the pallets is not allowed.

1.5 Target groups

The target groups of the Master thesis are first and for most the company management at Duni AB and the division of packaging logistics at Lund Institute of Technology, LTH. Secondly the Master thesis is intended for students and employees at universities in Sweden.

2 Methods

2.1 Scientific approach

Depending on a person's essential assumption she may have different goals with the research. A scientific research could be illustrated in three different method approaches; analytical, systems and an actors approach. Parallel to these approaches there are two other ways of science; positivism and hermeneutic. Both corresponding with the explaining and understanding knowledge.¹ See figure 2.1.

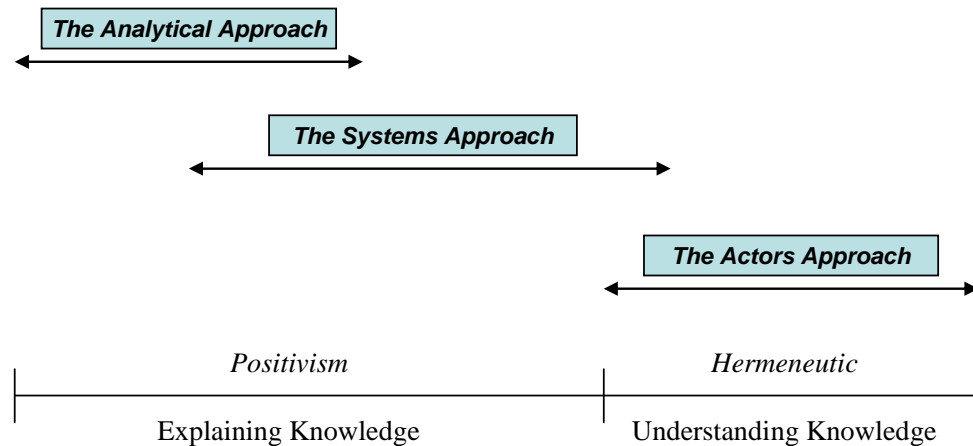


Figure 2.1 The different approaches², modified by the authors.

2.1.1 The analytical approach

Analytical approaches are based on the assumption that an observation in reality, as a whole, could be divided into different parts, which together sum the entirety. One way to solve a problem is therefore to break down the problem into parts and then solve them parallel. This method means that when each separate part is solved, the problem as an entirety is solved.³

By explaining the truth as objective and complete as possible, the examiner struggles to find so-called, cause-effect relations. Non consideration to the subjective view is done and the knowledge regards to be independent of the observer.⁴

One example of an analytical approach could be a football manager who hand-pick the best players, regardless their personality and solidarity to the team. The basic idea is to create the best entirety by using the best players and then the result becomes pure, cause-effect relations.⁵

¹ Arbnor Ingeman, Bjerke Björn, *Företagsekonomisk metodlära*, Lund, Studentlitteratur, 1994, p.62-65

² Ibid.

³ Ibid.

⁴ Björklund Maria, Paulsson Ulf, *Att skriva, presentera och opponera*, Lund, Studentlitteratur, 2002, p.64

⁵ Arbnor Ingeman, Bjerke Björn, *Företagsekonomisk metodlära*, Lund, Studentlitteratur, 1994, p.65-66

2.1.2 The systems approach

The systems approach intends that the entirety, not equals the sum of its parts. The approach involve, focus on the relations who affect the entirety and the surroundings. Synergism effects emphasis between the different parts as plus or minus and relations are as important as the parts itself.⁶

To be able to understand the underlying factors of different behaviours, the examiner tries to observe connections and relations between the different parts of the system. Fundamental is to define the boundaries of the system.⁷ If only the parts are observed separately, the entirety could be unable to find.⁸ The difference between a systems and an analytical approach is that the result can not be applied straight on new problems.⁹

Relating to the football example again; the manager selects players based on their relations to each other and the team as an entirety. The systems approach also considers the surrounding environment, the opponents and the playing field.¹⁰

2.1.3 The actors approach

A vital point in the actors approach is that the reality is a social construction, which affects the human being. In this approach the entirety is obtained on the basis of properties from the different parts of the observation. This means that if the observers are exchanged, the new observers could develop individual depended knowledge and skills by seeing the reality from another view.^{11 12}

According to this approach, a system consists of a socially constructed reality, with the producing operators and its product – the reality. Carried out correctly, the actors approach increases the knowledge of the processes which socially construct the reality.¹³

The actors approach can also be applied to the football metaphor. If a manager chooses football team with the actors approach, the players with most team spirit and skills would be chosen. The choices depend on the individual manager's vision of the players. Probably another manager would generate another team.¹⁴

2.1.4 Hermeneutic and positivism

Traditionally, people who consider that there are not any fundamental difference between nature and social science are called positivists or explanatics. This approach means that methods suited for nature also suits

⁶ Arbnor Ingeman, Bjerke Björn, *Företagsekonomisk metodlära*, Lund, Studentlitteratur, 1994, p.65-66

⁷ Wallén Göran, *Vetenskapsteori och forskningsmetodik*, Lund, Studentlitteratur, 1996, p.26

⁸ Björklund Maria, Paulsson Ulf, *Att skriva, presentera och opponera*, Lund, Studentlitteratur, 2002, p.64

⁹ Arbnor Ingeman, Bjerke Björn, *Företagsekonomisk metodlära*, Lund, Studentlitteratur, 1994, p.65-67

¹⁰ Ibid.

¹¹ Björklund Maria, Paulsson Ulf, *Att skriva, presentera och opponera*, Lund, Studentlitteratur, 2002, p.64

¹² Arbnor Ingeman, Bjerke Björn, *Företagsekonomisk metodlära*, Lund, Studentlitteratur, 1994, p.65-66

¹³ Arbnor Ingeman, Bjerke Björn, *Företagsekonomisk metodlära*, Lund, Studentlitteratur, 1994, p.128

¹⁴ Arbnor Ingeman, Bjerke Björn, *Företagsekonomisk metodlära*, Lund, Studentlitteratur, 1994, p.67-69

social science, however with some adapts.¹⁵ Positivists consider that the reality should contemplate as objective, concrete, divided and not depended by history e.g. everything should be tried empirical. Estimations and judgement shall be replaced by measurements. This means that feelings, valuations, religion and political statements should not contemplate as science.¹⁶

Hermeneutics stress that the method used for nature science is inappropriate to use within social science. The hermeneutic approach also highlight that it is a decisive difference to explain the nature and interpret culture.¹⁷

Analysis and interprets of the reality are entirely a result of human interpretations and always subjective and value dependent. With an understanding in form of linguistic and cultural fellow ship, the interpret makes that measures are based on common opinion of the reality. The knowledge from the hermeneutic approach depends on time, place and the history behind it.¹⁸

2.1.5 Our approach

We have chosen a system approach for our Master thesis. By using this approach, all the impressions we have got from interviews with the responsible people within the different functions at Duni, has helped us to attain the entirety of the packaging role. It is important to understand how the different functions interact and it is not possible, according the systems approach, to only study each function separately. By using the systems approach, we have tried to understand how the different functions collaborate and see how a possible change may affect the entirety. It is not necessarily favourable that an improvement within one function means an improvement of the entirety. The systems approach supports both the understanding and explaining knowledge. Our approach is situated in between hermeneutic and positivism. The main part of the Master thesis has been carried out with a positivistic approach through concrete studies in computer systems, but also through the hermeneutic approach with interpretations from interviews and theories.

2.2 Research approach

A scientific work can take two alternative paths; the verification path, *deduction* and the discovering path, *induction*.¹⁹ Depending on, if an examination starts in the theory or by real observations the approach is called deductive or inductive. See figure 2.2.

The inductive approach implies starting by studying the reality and trying to find patterns that can be summarized into models and theories.²⁰ By not having any preconceived notion and expectations, the purpose with the inductive approach is to give the researchers data that correctly reflects the

¹⁵ Arbnor Ingeman, Bjerke Björn, *Företagsekonomisk metodlära*, Lund, Studentlitteratur, 1994, p.62-63

¹⁶ Wallén Göran, *Vetenskapsteori och forskningsmetodik*, Lund, Studentlitteratur, 1996, p.26-28

¹⁷ Arbnor Ingeman, Bjerke Björn, *Företagsekonomisk metodlära*, Lund, Studentlitteratur, 1994, p.62-63

¹⁸ Wallén Göran, *Vetenskapsteori och forskningsmetodik*, Lund, Studentlitteratur, 1996, p.33-35

¹⁹ Patel Runa, Tebelius Ulla, *Grundbok i forskningsmetodik*, Lund, Studentlitteratur, 1987, p.17

²⁰ Björklund Maria, Paulsson Ulf, *Att skriva, presentera och opponera*, Lund, Studentlitteratur, 2002, p.66

reality in a given context. To be sure that the information is both correct and relevant, the researchers have to evolve the theories.²¹ When using a deductive approach, theories are studied and then tried to be applied and verified by empirical studies in the reality.²² Sympathizers of this strategy claims that the best way of working, is by first getting expectations how the world appears and then collect empiricism to see if the expectations agrees with the reality. The expectations are built on previous empirical findings and theories.²³

If both methods; inductive and deductive, are used to and fro, the approach is called abduction.²⁴

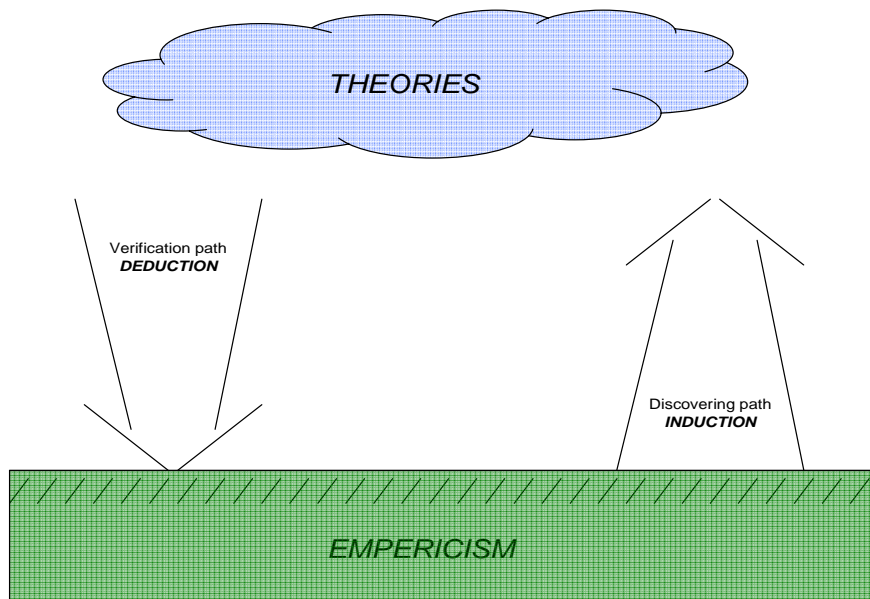


Figure 2.2 Deductive and inductive approaches²⁵, modified by the authors.

2.2.1 Our choice

Our Master thesis has an abductive approach. The studies started in reality to get an overall view of the problem and then continued by focusing on theories (inductive approach). Subsequently, the theories were tried to be applied and verified in the reality by further empirical studies (deductive approach). The approaches were used to and fro and finally, after gathering all the impressions from both empirical and theoretical studies, a tool was designed.

²¹ Jacobsen Dag Ingvar, *Vad, hur och varför?*, Lund, Studentlitteratur, 2002, p.34-35

²² Björklund Maria, Paulsson Ulf, *Att skriva, presentera och opponera*, Lund, Studentlitteratur, 2002, p.66

²³ Jacobsen Dag Ingvar, *Vad, hur och varför?*, Lund, Studentlitteratur, 2002, p.34

²⁴ Björklund Maria, Paulsson Ulf, *Att skriva, presentera och opponera*, Lund, Studentlitteratur, 2002, p.66

²⁵ Patel Runa, Tebelius Ulla, *Grundbok i forskningsmetodik*, Lund, Studentlitteratur, 1987, p. 16-19

2.3 Qualitative and quantitative methods

Within methodology studies there are there two main ways of gathering information; by qualitative or quantitative methods. Quantitative and qualitative indicates in which format the information is gathered: figures (quantitative) or words (qualitative).²⁶

The main purpose of quantitative methods is to make the studied objects measurable, in a way that the results can be presented numerical. The quantification is a question of the level of preciseness during the observation. To obtain precise observations, the observations must be objective measured.²⁷ One common quantitative measurement tool is questionnaires, with predetermined answering alternative. The method assumes that the researcher has knowledge of the examined phenomenon and that the respondents can fit their opinions of the reality, in the predetermined answering alternatives.²⁸ Followers of the qualitative methods oppose to the method of making everything measurable. They think that the quantitative method do not measure anything else than the observers understanding of the occurrence. Despite all, it is the observer who defines the questions and the answering alternatives.²⁹ As a starting point for the qualitative studies, all phenomena consist of a unique combination of qualities or characteristics and that is why it is not possible to measure or weigh it.³⁰ To really understand how people interpret the social reality, they must be observed –what they do and say – and have the satisfactory opportunities of expressing themselves with there own words. For this reason observations and open interviews are ideal for qualitative studies. Qualitative studies are flexible and the collected data can consequently be adapted to the environment that the research object is present in.³¹

2.4 Primary and secondary data

When gathering information to a study, the information can either be primary or secondary. Information that has been collected for the first time, from a single person or a group, is called primary data. The author goes straight to the primary information source and the data collected are tailor made for the specific problem. Primary data can be collected through various methods; interviews, observations or questionnaires.³²

If the information instead is collected from other sources, e.g. literature, the information will be secondary. The author then collects information which is not straight from the source, but based on information collected by others. The problem with this kind of information is that it is often collected in

²⁶ Jacobsen Dag Ingvar, *Vad, hur och varför?*, Lund, Studentlitteratur, 2002, p.38

²⁷ Andersen Heine, *Vetenskapsteori och metodlära*, Lund, Studentlitteratur, 1994, p.69-70

²⁸ Jacobsen Dag Ingvar, *Vad, hur och varför?*, Lund, Studentlitteratur, 2002, p.38-39

²⁹ Jacobsen Dag Ingvar, *Vad, hur och varför?*, Lund, Studentlitteratur, 2002, p.39

³⁰ Andersen Heine, *Vetenskapsteori och metodlära*, Lund, Studentlitteratur, 1994, p.70-71

³¹ Jacobsen Dag Ingvar, *Vad, hur och varför?*, Lund, Studentlitteratur, 2002, p.39

³² Jacobsen Dag Ingvar, *Vad, hur och varför?*, Lund, Studentlitteratur, 2002, p.152

another purpose than the authors. However, it is often favourable to use both primary and secondary data within research.^{33 34}

2.5 Methods of information gathering

There are four main ways of gathering information: literature studies, interviews, questionnaires and observations.

2.5.1 Literature studies

Literature studies are used to review earlier published information, within the areas that are supposed to be examined. The literature can e.g. consist of non-fictions, newspaper articles or specific company information. The benefits with literature studies are that they relatively fast, can provide an overview over the area. Although, it is important to be aware of that information could be slanted or incomplete, when using secondary data.^{35 36}

The literature studies during the Master thesis were mainly carried out through library searching, article searching through data bases and by using the Internet. The literature studies formed a theoretical frame of reference for our problem and constituted as a good base for our theoretical chapter. This information which primarily consisted of non-fictions could be considered as secondary data. The information used for the empirical chapter, on the other hand, were collected from internal sources at Duni and could therefore be considered as primary data.

2.5.2 Interviews

Qualitative methods are usually interviews which are directly connected to the purpose, primary data. Interviews could also be of a quantitative character if the questions are designed within simple quantifiable answers. There are usually three ways an interview can be carried out; structured, semi-structured or unstructured. The most suitable method depends on the character of the problem. If the result shall be quantitative analyzed, a structured interview is to prefer. Although the disadvantages with this interview method are that questions can not be adapted to the specific interviewee and interview situation.³⁷

However, if the result shall be qualitative analyzed, a semi-structured or unstructured interview method has to be used. These methods make it possible to design the interview and adapt questions gradually as the interviews are carried out. When using a semi structured interview, comprehensive questions has been made, which can be expounded during the interview. An interview is usually personal, even though it exist other common interview techniques like; group interviews or focus groups.³⁸

³³ Jacobsen Dag Ingvar, *Vad, hur och varför?*, Lund, Studentlitteratur, 2002, p.153

³⁴ Arbnor Ingeman, Bjerke Björn, *Företagsekonomisk metodlära*, Lund, Studentlitteratur, 1994, p.241

³⁵ Björklund Maria, Paulsson Ulf, *Att skriva, presentera och opponera*, Lund, Studentlitteratur, 2002, p.52-54, 67-70

³⁶ Ejvegård Rolf, *Vetenskaplig metod*, Lund, Studentlitteratur, 2003, p. 59-62

³⁷ Patel Runa, Tebelius Ulla *Grundbok i forskningsmetodik*, Lund, Studentlitteratur, 1987, p.102-103

³⁸ Björklund Maria, Paulsson Ulf, *Att skriva, presentera och opponera*, Lund, Studentlitteratur, 2002, p.52-54

Primary data has firmly been gathered during interviews with employees at Duni's headquarters in Malmö and production unit in Bramsche. The interviews were implemented in two sets. In the first set we used an unstructured interview method with our supervisor and a product developer at Duni. The interviews took shape of, what could be described as a discussion. This gave us good background information about how the company works and which problems exist. In the second set we used more structured interviews with responsible people within each function at the production unit in Bramsche. The interviews were based on, in advanced fixed patterns, a semi structured agenda. The interviews had semi structured character, as both we as interviewers and the interviewees had a certain freedom to digress from the fixed patterns. Some interviews were also complemented with semi structured interviews per phone and structured interviews per e-mail.

2.5.3 Questionnaires

By using questionnaires it is possible to receive a large quantity of primary data, with a relative small effort. Questionnaires consist of a number of standardized, in advanced defined questions and answering alternatives. The answering alternatives can e.g. be graded from 1-5 or based on yes or no questions, but the respondent can also be offered to give more open and graphic answers.

One of the questionnaires disadvantages is that body language and other information channels not are included. With questionnaires, the risks of misunderstandings are more obvious than with interviews, where the respondent has the opportunity to easier ask for clarifications.³⁹

We have not been using questionnaires in our Master thesis, but our interviews by e-mail could more resemble as questionnaires, since no body language and information channels could be included.

2.5.4 Observations

One method of increasing the amount of data is by doing observations. Observations are particularly useful when collecting information within areas touching patterns of behaviour and course of events. Besides, observations are often useful in laboratory situations, e.g. at tests and experiments.⁴⁰ Observations can be carried out in a numerous ways. The observer can take an active part in the observation, so called participation observation, or observe the event from outside. The observed person can be informed of the observation, or the observation can be done on the sly.⁴¹

Observations were used when the existing packaging solutions were inventoried, and a box management tool was developed. The observations took shape as pure experiments in CAPE PACK, to examine the boxes suitability.

³⁹ Björklund Maria, Paulsson Ulf, *Att skriva, presentera och opponera*, Lund, Studentlitteratur, 2002, p.53-55

⁴⁰ Patel Runa, Davidson Bo, *Forskningsmetodikens grunder*, Lund, Studentlitteratur, 1994, p.74

⁴¹ Björklund Maria, Paulsson Ulf, *Att skriva, presentera och opponera*, Lund, Studentlitteratur, 2002, p.53-55

2.6 Source criticism

To attain high quality on a survey it is important to have a critical approach to the studied material. Different sources can be of varying trustworthiness and the quality of the survey could be put at risk, despite various individual interprets has been considered. If a meaningful analyze should be achieved, is it significant that the information, which underlies the analysis, is correct. Unfortunately, this is not always the case. Sometimes, the information can be influenced by actors, who are driven by there own interests. In these cases the information risks to mediate a misleading description to the examiner.

Taken all in all, a critical approach to sources and knowledge about how these can be evaluated, two demands to being avoided are misled. By being source critic, possible insufficiencies can be noticed and the reliability of the source can easier be valued.⁴²

2.6.1 Concepts to consider

Studies credibility can be measured through *Validity*, *Reliability* and *Objectivity*. By reaching a high level of these three factors throughout the Master thesis, a high credibility can be achieved.

2.6.1.1 Validity

Validity represents in which extent, the method measures, what really is intended to be measured. Two ways of increasing the validity in surveys are, by using various perspectives and seeking information from several independent sources.⁴³ High validity can also be attained by having clear and none slanted formulations, when using interviews and questionnaires. In addition, the choice of method can affect the validity. Though one problem is to know how valid a method really is.⁴⁴

2.6.1.2 Reliability

Another way of measure a study's credibility is reliability, which assure that the research gives a reliable and stable outcome. The reliability is high if the same value can be attained at repeated measurements. With high reliability, random mistakes can be avoided and e.g. be examined by control questions.⁴⁵ If a person is interviewed, or the same time measured several times, the result ought to be equal if good reliability shall be achieved. Similar to validity, the reliability can also be affected by the choice of method.⁴⁶

The concepts of reliability and validity can be clarified with help of the three dart targets, see figure 2.6.1.2 below. The left picture, illustrates both low validity and low reliability. The picture in the middle shows high

⁴² Sjöstedt G, Stenström P, *Vilseledning på Internet*, Lund, Studentlitteratur, 2002, p.11

⁴³ Patel Runa, Davidson Bo, *Forskningsmetodikens grunder*, Lund, Studentlitteratur, 1994, p.85

⁴⁴ Wallén Göran, *Vetenskapsteori och forskningsmetodik*, Lund, Studentlitteratur, 1996, p.61-62

⁴⁵ Björklund Maria, Paulsson Ulf, *Att skriva, presentera och opponera*, Lund, Studentlitteratur, 2002, p.64-66

⁴⁶ Wallén Göran, *Vetenskapsteori och forskningsmetodik*, Lund, Studentlitteratur, 1996, p.66

reliability but low validity and on the picture to the right, both the validity and the reliability are high.⁴⁷

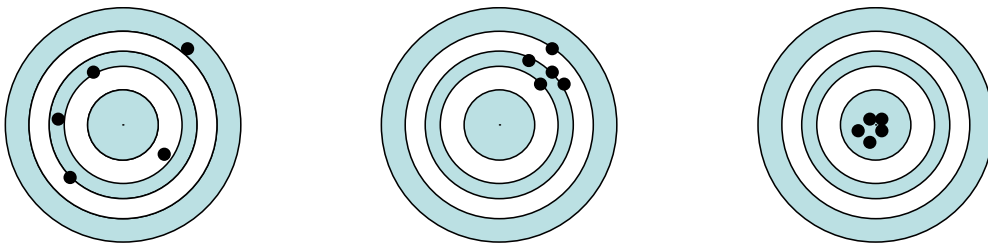


Figure 2.6.1.2 The concepts of reliability and validity⁴⁸, modified by the authors.

2.6.1.3 Objectivity

Objectivity referring to in which extent, valuation and individual people's opinions affects the study, i.e. the researcher must not be affected by outside scientific valuations.⁴⁹ Within research now days, it is accepted that a researcher can not be entirely neutral, in relation to the research project. Regarding, both specifying the problem, how the surveys are carried out or in relation to the information collection, the researcher in different phases during the process must make standpoints that could affect the outcome. How the researcher will handle the complexity of the objectivity problems is related to his epistemology starting point and of course the research's type of problem.⁵⁰

2.6.2 The trustworthiness of the Master thesis

Since the extent of the Master thesis has a broad character, we attained high knowledge within packaging logistics by reading several books and articles within the area. As literature have been gathered through several sources, possible source of errors are reduced. This gives the Master thesis high validity. Another aspect we have considered is, if the sources have had any personal gain by describing a result in a certain way. Regarding information received from Duni, we have not had any reason to be suspicious of the contents in these. By interviewing responsible people within all functions (product development, purchasing, logistics, production, packaging and market) at Duni, instead of just some of them, the validity as well as the objectivity has been maintained. During our studies and analysis of the existing packaging solutions and when we developed the box management tool, the tests have been repeated and controlled to secure the reliability.

⁴⁷ Björklund, Maria, Paulsson, Ulf, *Att skriva, presentera och opponera*, Lund, Studentlitteratur, 2002, p.65

⁴⁸ Ibid.

⁴⁹ Ibid.

⁵⁰ Patel Runa, Tebelius Ulla *Grundbok i forskningsmetodik*, Lund, Studentlitteratur, 1987, p.44-45

2.7 Master thesis work procedure

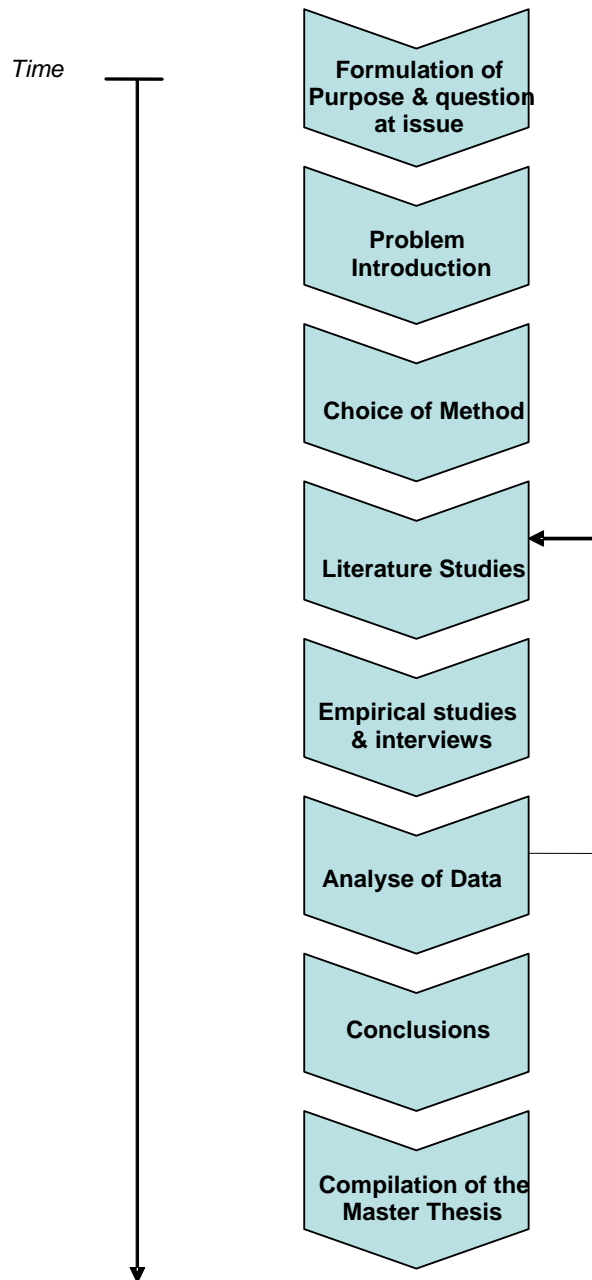


Figure 2.7 The model of procedure for the Master thesis.

3 Theoretical frame of reference

Logistics is an area in continuous development. Except for focusing on the distribution, logistics also covers material supply systems and production systems, from raw material to the end consumer. Companies have realised the logistics potential as a competitive business driver since the market economy constantly demands more efficient, rational and environmental solutions.⁵¹

The logistic chain, from producer to customer, becomes more complex as a result of a gained number of customers specific products are requested. The globalization of the world economy has forced companies to focus and move their activities towards new international markets and customers, which have different demands regarding the product features. The products shall be delivered in a certain way; on a certain time, which requires rapid and flexible logistic and transport solutions.⁵²

Logistics could briefly be described in terms of the knowledge to coordinate and streamlining the control of the material flows, including transports and information; inbound (materials management), outbound (physical distribution management), internal (logistics management). This three terms could be expressed as, the business logistics, also called MA-system (material administration).⁵³ See figure 3

Logistics can be divided into two main parts; structure and controlling. The structure part includes production, distribution, storing, purchasing and supply systems. The controlling part includes planning and performing effective material flows.⁵⁴

Figure 3, the logistic system, is an overview of the process of planning, implementing and controlling the efficient flow and storage of raw materials. The system also includes inventory, finished goods, services, and related information from point of origin to point of consumption for the purpose of conforming to customer requirements.⁵⁵

⁵¹ Lumsden Kenth, *Logistikens grunder*, Lund, Studentlitteratur, 1998, p. 17

⁵² Ibid.

⁵³ Persson Göran, Virum Helge, *Logistik för konkurrenskraft*, Lund, Studentlitteratur, 1998 p. 12-14

⁵⁴ Ibid.

⁵⁵ Ibid.

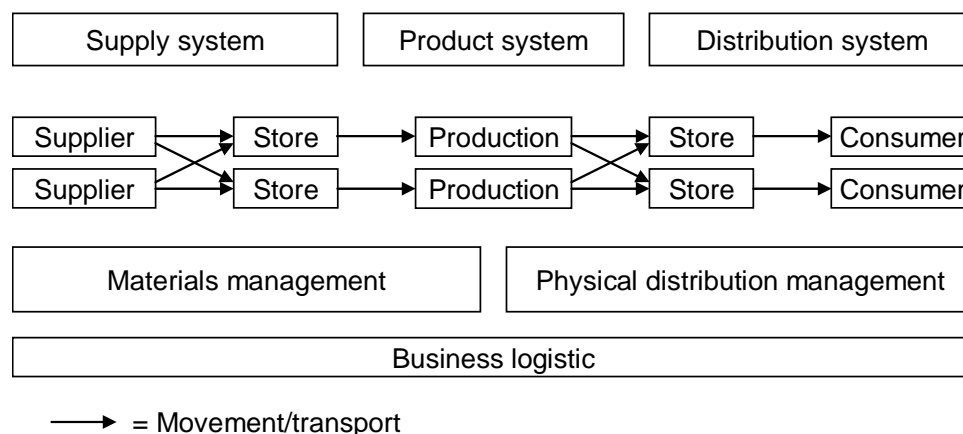


Figure 3 The logistic system⁵⁶, modified by the authors.

During the later decades, the development within logistics has accelerated, from the early 60`s with large focus on optimization and improvement of separate activities (material handling, packaging, storing and transportation), via total cost analyses, lean production and *Just-In-Time* further to today`s Supply Chain Management (SCM) with support of information technology systems and outsourcing by means of third and fourth part logistics.⁵⁷ Outsourcing includes a third part, controlling and performing a value increasing activity in the link between two parts; e.g. assembling, storing, transportation. By handing over responsibility to a third part, it is often easier for the company to focus on their core competence. However, divided opinions exist, if outsourcing is favourable or not.⁵⁸

One of the most essential tasks within production logistics during the decades has been to design strategies to; reduce costs and tied-up capital, reducing lead times, increase flexibility and customer service.⁵⁹

In the 80`s, two strategies for optimizing the material flow through the company were developed by Toyota; *lean production* and *Just- In- Time*. Both strategies advocate the weight of manufacture directly towards customer orders and reducing the waste. *Just-In-Time* focuses on reducing the inventory levels by, striving to supply right amount material at the right time. *Lean production* on the other hand, focuses on reducing unnecessary activities and to eliminate the waste.⁶⁰

In the 90`s, the Supply Chain Management became a natural development within logistics. To increase the control and maximize the efficiency of the logistic system, from raw material to end consumer, the companies are forced to improve relationships with suppliers.⁶¹

⁵⁶ Persson Göran, Virum Helge, *Logistik för konkurrenskraft*, Lund, Studentlitteratur, 1998, p. 23

⁵⁷ Persson Göran, Virum Helge, *Logistik för konkurrenskraft*, Lund, Studentlitteratur, 1998, p. 12-14

⁵⁸ Jonsson Patrik, Mattsson Stig-Arne, *Logistik – Läran om effektiva materialflöden*, Lund, Studentlitteratur, 2005, p.22-23

⁵⁹ Persson Göran, Virum Helge, *Logistik för konkurrenskraft*, Lund, Studentlitteratur, 1998 p. 12-14

⁶⁰ Ibid.

⁶¹ Ibid.

Improved information technology have made it possible for companies to act on global markets and locate their manufacturing and storing units in different parts of the world (outsourcing). At globalization and centralization, the business systems obtain a more vital function as a communicator and to control the inventory, transmit information, planning production and transportation.⁶²

During the later years the understanding of the packaging's role as an important component in the logistic chain has recognized. Packaging logistic is a new area within logistics where the packaging is considered as a part of the logistic chain and thus not as an isolated part with only a protective function.⁶³ The concept of packaging logistics focuses on the synergy's achieved by integrating the systems of packaging and logistics with the potential of increased supply chain efficiency and effectiveness, through the improvement of both packaging and logistics related activities.⁶⁴

Packaging also affects the supply chain effectiveness because it represents an interface between the supply chain and its main customer: the end user, and enables the chain's primary task i.e. serving the end consumer, to be accomplished. Packaging is a vital tool in the marketing mix, too often ignored by companies, even though twice as much annually is spent on above-the-line advertising and promotions. By its marketing capabilities and properties, packaging plays a decisive role in facilitating meeting the consumers' needs and expectations.⁶⁵

Logistics plan, implement and control, while packaging contains, protects, secure, promotes, sells and informs. Saghir (2002) suggests the following definition of packaging logistics: “ *The process of planning, implementing and controlling the co-ordinated Packaging system of preparing goods for, safe, secure, efficient and effective handling, transport, distribution, storage, retailing, consumption and recovery, reuse or disposal and related information combined with maximising consumer value, sales and hence profit* ”.⁶⁶

⁶² Jonsson Patrik, Mattsson Stig-Arne, *Logistik – Läran om effektiva materialflöden*, Lund, Studentlitteratur, 2005, p.22-23

⁶³ Lumsden Kenth, *Logistikens grunder*, Lund, Studentlitteratur, 1998, p. 17

⁶⁴ Saghir Mazen, *The concept of packaging logistics*, 2004, p.4

⁶⁵ Klevås Jenny, Saghir Mazen, *Introducing the concept of design for packaging logistics*, 2004, p.4

⁶⁶ Saghir Mazen, *The concept of packaging logistics*, 2004, p.4

3.1 Packaging on different levels

Packaging may be classified as primary, secondary or tertiary, reflecting the levels of packaging. These definitions should be used together with the consideration of packaging as a system, with hierarchical levels. The system's approach highlights interaction between the different levels of packaging and facilitates an understanding of their interdependence. It can therefore be argued that the performance of the packaging system is affected by the performance of each level and the interaction between these levels.⁶⁷ See figure 3.1 below.

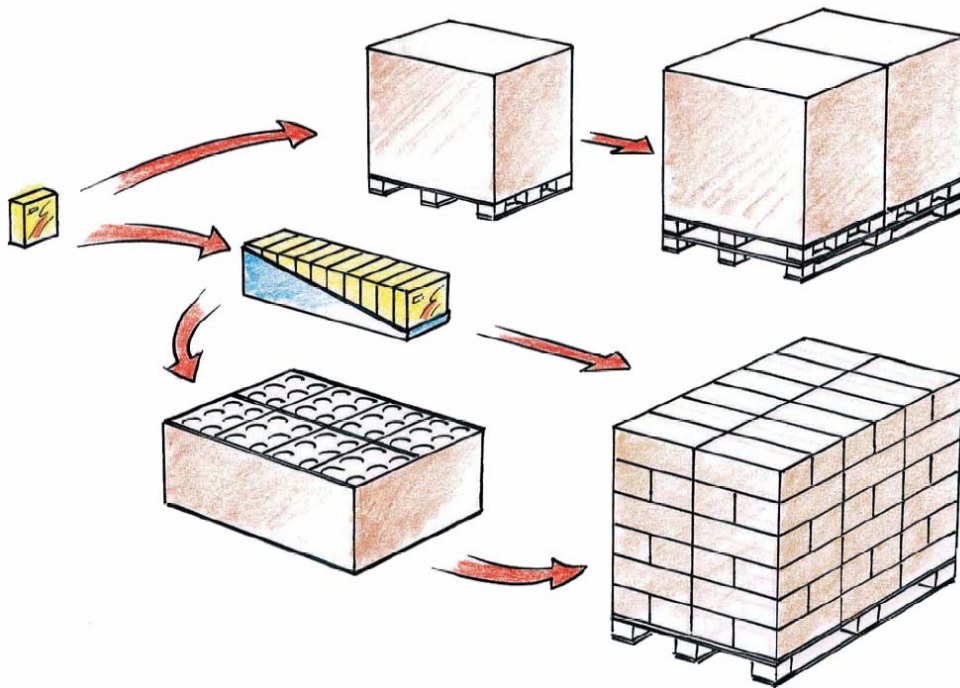


Figure 3.1 The different levels of packaging.⁶⁸

⁶⁷ Klevås Jenny, Saghir Mazen, *Introducing the concept of design for packaging logistics*, 2004, p.3

⁶⁸ <http://www.ecr.se>, 2006-10-30

3.1.1 Primary packaging

Other common names for primary packaging are: Consumer packaging, Consumer Unit, CU, CoP, C-pack, Multiple pack, Multipack

The main functions of the primary packaging are to make the product available and to protect and maintain its qualities.⁶⁹ The consumer packaging should also promote the product by an appealing design and décor. Other things to consider when designing a primary packaging are product information, size of the package and further that it should be easy to open and reseal.

The primary packaging's outer dimensions are an important issue. Together with the secondary packaging the consumer packaging should be well adapted to pallets. If the secondary packages do not fill out the pallet's bottom area, the filling rate will be reduced and the logistic efficiency worsens. A reduced filling rate increases the risks of goods damages, when pallets are stacked on top of each other.⁷⁰

The primary packaging also has to meet a number of other demands as for example:⁷¹

- Be cost efficient.
- Inform the end consumer of its contents.
- Demand a little amount of material.
- Be well adapted to shop shelves.
- Be stackable.

3.1.2 Secondary packaging

Other common names for Secondary packaging are: SKU, Multi-Unit packaging, Outer packaging, S-pack, Trade Unit, Case, ReP.

The secondary packaging is a group packaging containing an appropriate number of primary packaging.⁷² In many cases, the secondary packaging equals an orderable unit. The secondary packaging's most important task is to protect and keep the primary packaging together until they reach the shop shelf. The secondary packaging should be adapted in a way so that it easily can be picked, handled, stored, loaded and unloaded in its way from the producer to the store, where it should be easy to open.

The pallets, from the producer, are usually split up at the distribution centre, where the secondary packaging's are loaded together with goods from other manufactures for further transportation on mixed pallets or roll containers. It is important that the secondary packaging is standardized so that together

⁶⁹ Johansson Kenneth, Lorentzon Karlsson Ann, Olsmats Carl, Tiliander Lisa, *Packaging logistics*, Packforsk, Kista, 1997, p.13

⁷⁰ <http://www.ecr.se>, 2006-10-30

⁷¹ Johansson Kenneth, Lorentzon Karlsson Ann, Olsmats Carl, Tiliander Lisa, *Packaging logistics*, Packforsk, Kista, 1997, p.13

⁷² Ibid.

loading is facilitated and that the secondary packaging endures the stresses this involves. The maximum weight of a secondary packaging is set to 15 kg for secondary packaging that are picked or handled manually, if no other agreements exist between the involved parts.⁷³

3.1.2.1 Corrugated board

The combination of one or two sheets of paper, called outer plies, glued to a corrugated inner medium, called fluting, are the most common types of corrugated board, see figure 3.1.2.1a. Usually the types are called single or double wall corrugated board, see figure 3.1.2.1b and 3.1.2.1c. Depending on the combination of outer/intermediate plies and flutes, several layers give the overall structure a better strength than each distinct layer. For transport operations involving heavier cargoes, severe climatic conditions and mechanical stresses, the triple wallboard is a better option, see figure 3.1.2.1d.^{74 75}

The corrugated board constructions are well known for its ability to, support heavy weight and the bearing capacity increase with the number of plies and the quality of used paper. An increased number of plies also give corrugated board considerable increased rigidity and resistance. The air circulating in the flutes serves as an insulator, which also provides excellent protection against temperature variations.⁷⁶ The corrugated board is, from an environmental point of view favourable as it is made of renewable raw material.⁷⁷

In the figures below, four alternatives of corrugated board are described:

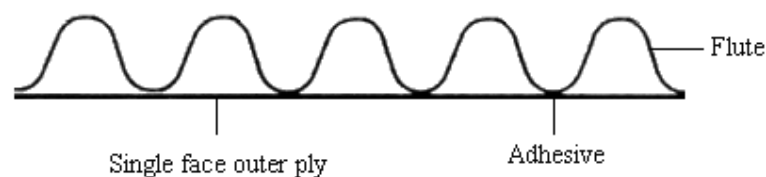


Figure 3.1.2.1a Single face corrugated board consists of one ply of fluted paper, which a paper or cardboard is glued onto.⁷⁸

⁷³ <http://www.ecr.se>, 2006-10-30

⁷⁴ <http://www.fefco.org>

⁷⁵ Johansson Kenneth, Lorentzon Karlsson Ann, Olsmats Carl, Tiliander Lisa, *Packaging logistics*, Packforsk, Kista, 1997, p.10

⁷⁶ <http://www.fefco.org/>

⁷⁷ Dominic, Chris, et al *Förpackningslogistik*, 2000, p. 15-16

⁷⁸ <http://www.tis-gdv.de>

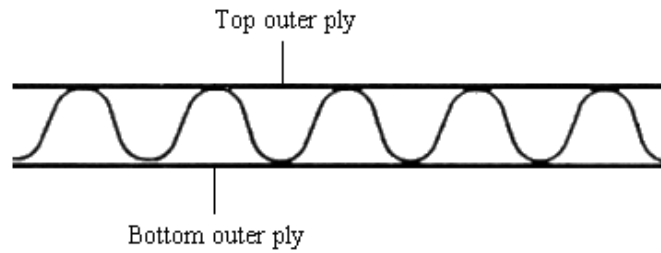


Figure 3.1.2.1b Single wall (double face) corrugated board consists of one ply of fluted paper which is glued between two plies of paper or cardboard.⁷⁹

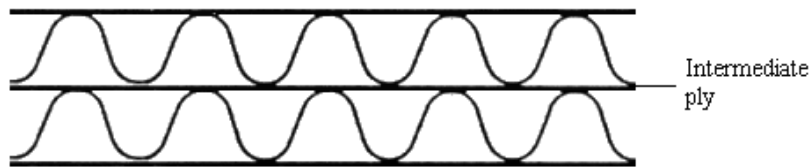


Figure 3.1.2.1c Double wall corrugated board consists of two plies of fluted paper glued together by one ply of unfluted paper or cardboard and the exposed outer surfaces of which each are covered with one ply of paper or cardboard.⁸⁰

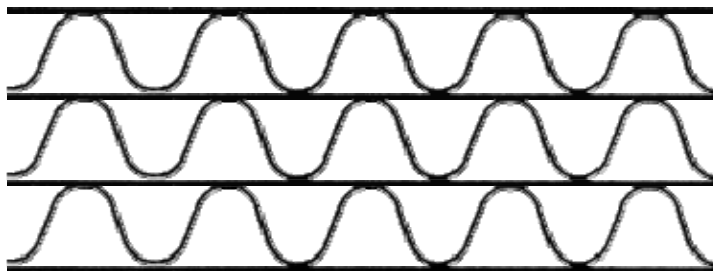


Figure 3.1.2.1d Triple wall corrugated board consists of three plies of fluted paper glued together by two plies of paper or cardboard and the outer surfaces of which are likewise each covered with one ply of paper or cardboard.⁸¹

⁷⁹ <http://www.tis-gdv.de> 2006-11-01

⁸⁰ Ibid.

⁸¹ Ibid.

3.1.2.2 ECT

The most favourable material test to predict a box's stacking strength is the ECT (Edge Crush Test). ECT measures the columnar strength of the board, the amount of force required to crush a piece of board standing on its edge with its flutes vertical.⁸² It is vital that the end and side walls are arranged upright when constructing cartons. In this way, the flute can withstand greater pressure when it is stacked. In contrast, horizontal flutes will have a very poor rigidity and can easily be crushed, see figure 3.1.2.2.⁸³

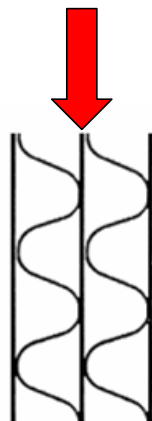


Figure 3.1.2.2 When the corrugated boards are arranged in this way, the flutes will collapse if it is exposed for pressure. The Carton strength is compromised and the entire stack may collapse.⁸⁴

⁸² Twede Diana, Selke Susan E.M., *Cartons, Crates and Corrugated Board* - Handbook of paper and wood packaging technology, Pira International, 2005, p.419

⁸³ <http://www.tis-gdv.de> 2006-11-01

⁸⁴ Ibid.

3.1.3 Tertiary packaging

Other names for the tertiary packaging are: Unit Load, transport packaging, Dispatch Unit.

Tertiary packaging is used when a number of primary or secondary packages are assembled on a pallet or a roll container.⁸⁵ The choice of tertiary packaging is mainly based on, the types of products which should be transported. For some products a shrink film wrapper might be enough, while other might demand the supporting walls of a box to allow stacking on the pallet. When dimensioning a transport packaging it is important to consider the product's sensitivity to different stresses, transport means and routes as well as the country of destination. It is also important that the transport packaging is well adapted to the load carrier to attain high filling rate.⁸⁶

3.1.3.1 Pallets

According to Swedish standard, SS 84 10 00, a pallet consists of two horizontal, rectangular plans which are separated by blocks. The blocks are designed and located in a way that a forklift truck can handle the loading pallet. The loading pallets are first and foremost used to create unit loads, which can consist of one or several types of goods. The pallets are used for intern handling, at storage and within transports over longer distances. There exist both returnable and non-returnable pallets. The most frequently used pallets are the returnable pallets, which has certain standards for construction, material and measurement. The most common returnable pallet is the EU-pallet, which standard measures are 800*1200 mm. The height of a EU-pallet can vary between 144 - 151 mm and the maximum loading height is set to 1250 mm inclusive the height of pallet it self. See figure 3.1.3.1 below. In England, the UK-pallet, with the dimensions of 1000*1200 mm is common.⁸⁷ These standards are necessary both from an ergonomic point of view and to allow double stacking. In Germany it also exist a standard with the maximum loading height of 1650 mm, inclusive the height of pallet it self.⁸⁸ The maximum load capacity allowed for an EU-pallet is 1000 kilo and the averages weight of the pallet it self is 22-23 kilo.⁸⁹

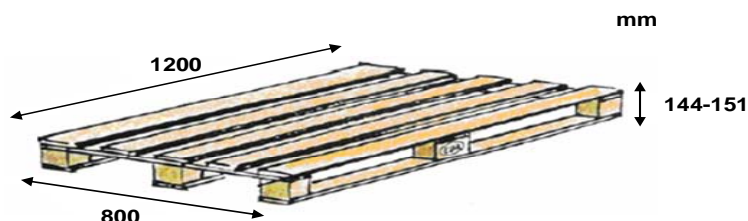


Figure 3.1.3.1 Pallet dimensions⁹⁰, modified by the author

⁸⁵ Article compendium, Packaging logistics, p.7

⁸⁶ Johansson Kenneth, Lorentzon Karlsson Ann, Olsmats Carl, Tiliander Lisa, *Packaging logistics*, Packforsk, Kista, 1997, p.12-14

⁸⁷ TFK, institut för transportforskning, *Materialhantering*, 2002, p. 69

⁸⁸ Larsson Everth, Doctor Technical Logistics, 2006-10-30

⁸⁹ TFK institutet för transportforskning, *Materialhantering*, 2002, p. 70

⁹⁰ <http://www.ecr.se>, 2006-10-30

3.2 The packaging functions

The packaging has three main functions, see table 3.2:

Market function	Graphic design, format Legislative demands and marketing Customer requirements/ consumer convenience for end use as well as distribution
Environmental function	Recovery/Recycling Dematerialization One- way vs. Reusable package Toxicity
Flow function	Facilitate distribution Protect both the product and the environment Provide information about conditions and locations

Table 3.2 Overview of the three different packaging functions.⁹¹

3.2.1 The market function

The market function includes features such as design, ergonomics and layout i.e. activities that add value to the product in relation to the end consumer. The packaging should transmit a message to the customer and attract the customer through an appealing design or layout. The packaging also has to meet customer demands such as child resistant closure and ergonomic design e.g.⁹²

3.2.2 The environmental function

The environmental function includes activities trying to reduce environmental stresses, improving resource economy and facilitate recycling and reuse of packaging material. By selecting the right packaging, the packaging material consumption is optimised considering the product and the distribution. Examples of the environmental function are the reduction of the amount of packaging and the facilitation of the separation of a packaging into its different component materials.⁹³

3.2.3 The flow functions

The flow function includes integral functions of the packaging which contributes to facilitating the handling in the supply chain. Supply of packaging, internal material flow, packing activities, unpacking, disposal and return handling are all part of this function. To smooth the progress of distribution in the supply chain there are three main flow functions; Facilitate goods handling; Protect the product and Identify the product.⁹⁴

⁹¹ Saghir Mazen, *The concept of packaging logistics*, 2004, p.6

⁹² Johansson Kenneth, Lorentzon Karlsson Ann, Olsmats Carl, Tiliander Lisa, *Packaging logistics*, Packforsk, Kista, 1997, p.21-23

⁹³ Ibid.

⁹⁴ Jonsson Patrik, Mattsson Stig-Arne, *Logistik – Läran om effektiva materialflöden*, Lund, Studentlitteratur, 2005, p.102-108

3.2.3.1 Facilitate goods handling

The most associated issue of packaging logistics is to facilitate the goods handling. This can be done in several ways. Some common procedures are presented below:

The use of unit loads

To facilitate efficient handling and storage, product protection and the environment during handling and to identify the product, the product is often covered in a package or loaded onto a load carrier. It is important that the primary package, which is used when promoting the product to the end customer, can be loaded into bigger packages, secondary packages. Together loading makes it easier to store and to handle the products and facilitates the material flow of the products to the end consumer, with higher transport and storage utilization, more efficient handling and less handling damages. The secondary packages are often put on a tertiary package, a standardized EU-pallet. The pallets are then often transported in a container or on a truck. By using standardized unit loads, i.e. same size and shaping for pallets and containers, the handling through the supply chain gets easier. To use the unit loads and the transportation system efficient, a size relation between the different levels of unit load is necessary.

To maximize the loading capacity and reduce the transport damages, there must be a struggle to ensure that the maximum number of product fits each pallet exactly, and that a certain number of pallets fit a container exactly.⁹⁵

Volume efficiency

To achieve a good economy through the distribution, high volume utilization is essential. There are two different types of volume utilization's:

- Internal filling rate – the filling rate of the product in the packaging, figure 3.2.3.1a.
- External filling rate – the filling rate of the packaging on the load carrier, figure 3.2.3.1b.

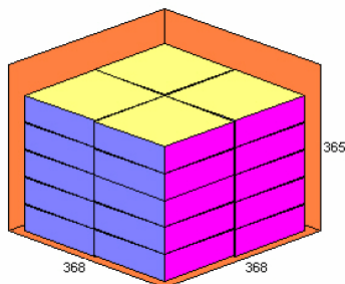


Figure 3.2.3.1a Internal filling rate.⁹⁶

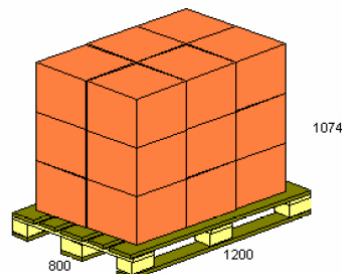


Figure 3.2.3.1b External filling rate.⁹⁷

⁹⁵ Jonsson Patrik, Mattsson Stig-Arne, *Logistik – Läran om effektiva materialflöden*, Lund, Studentlitteratur, 2005, p.102-108

⁹⁶ CAPE PACK software.

⁹⁷ Ibid.

The internal filling rate primarily depends on the way the package is designed. By integrating packaging logistics at an early stage of product development, a high internal filling rate is easier to achieve. However, there are not always good aspects in reducing the package size. In some cases a bigger package brings a better exposure value from a market point of view. The external filling rate is a measurement, describing how well the packages are adapted to modular standards, i.e. fitting to an EU-pallet. To accomplish maximum, internal and external filling rates, an overall view on the three factors product, packaging and distribution environment has to be applied.⁹⁸

Consumption adaptation

When developing a package it is advantageous to design the packages from a consumption point of view. With an increased rate of turnover and a reduced rejection rate, an adaptation of package size results in lower handling costs.⁹⁹

Weight efficiency

By reducing the weight of the packaging, more packages can be transported on each load carrier. As well as volume restrictions, the load carriers have weight restrictions, packages with big volume and weight, reduces the amount of actual products that can be sent.¹⁰⁰

3.2.3.2 Protect the product

The packaging's main purpose is to secure the goods from different kinds of damages.¹⁰¹ Since the products are exposed to mechanical, chemical and thermal stresses during transportation the need for a high-quality package to protect the products is obvious. The purpose of the packaging is that it should protect the product against the distribution environment and the other way around. It is not only by strengthening the packaging the products can get more secure. One way to reduce the product damages is to strengthening the product it self, and by softening the stresses in the supply chain the need of packaging material can be lessened.

Because of the quality concerns in the food industry it is extra important to ensure that the packaging not have been opened or damaged during transport. The product protection does not only depend on the way the packages are designed, but also how the products are transported. To avoid damages during transportation's it is important that the products are fixated close to the load carrier and are well secured.¹⁰²

⁹⁸ Johansson Kenneth, Lorentzon Karlsson Ann, Olsmat Carl, Tiliander Lisa, *Packaging logistics*, Packforsk, Kista, 1997, p.35-38

⁹⁹ Johansson Kenneth, Lorentzon Karlsson Ann, Olsmats Carl, Tiliander Lisa, *Packaging logistics*, Packforsk, Kista, 1997, p.39

¹⁰⁰ Ibid.

¹⁰¹ Lumsden Kenth, *Logistikens grunder*, Lund, Studentlitteratur, 1998, p. 424

¹⁰² Johansson Kenneth, Lorentzon Karlsson Ann, Olsmats Carl, Tiliander Lisa, *Packaging logistics*, Packforsk, Kista, 1997, p.42-43

Goods damages occur for various reasons:¹⁰³

- Insufficient packaging.
- The goods do not endure together loading with other goods.
- Vehicle breakdowns and accidents.
- Carelessness and negligent handling.

Simultaneously as the packages must protect the product, it is essential to eliminate over packing. In some cases there can even be advantageous to allow a few product damages to avoid over packaging, and the costs combined with that.¹⁰⁴ See figure 3.2.3.2.

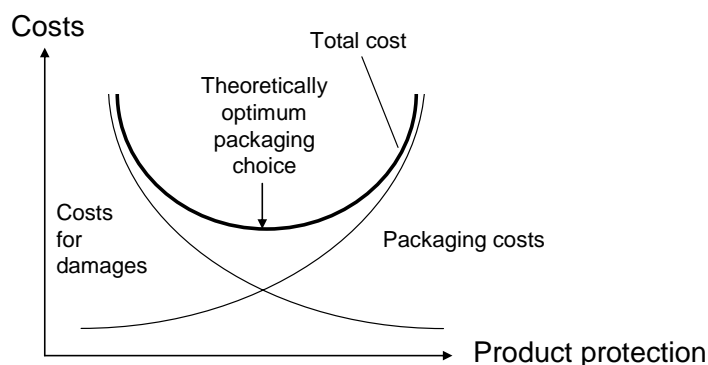


Figure 3.2.3.2 Cost relations when selecting a packaging¹⁰⁵, modified by the authors

3.2.3.3 Identify the product

To identify the products and facilitate handling, the packaging has a significant role as an information carrier. The package must carry information about the product, its weight, size, number of products and storage instructions.¹⁰⁶ The packaging can carry information about how the goods should be stored, handled and transported. The information can consider e.g. if the packaging can not be exposed to high or low temperatures or if the goods can not stand certain mechanical stresses.¹⁰⁷

To make the handling easier, every package carries an EAN-code. EAN is a global bar-code standard that is used for information carrying. The packaging also has a function as promotion display, why factors as colour, size and design are essential.¹⁰⁸

¹⁰³ Lumsden Kenth, *Logistikens grunder*, Lund, Studentlitteratur, 1998, p. 424

¹⁰⁴ Johansson Kenneth, Lorentzon Karlsson Ann, Olsmats Carl, Tiliander Lisa, *Packaging logistics*, Packforsk, Kista, 1997, p.42-43

¹⁰⁵ Johansson Kenneth, Lorentzon Karlsson Ann, Olsmats Carl, Tiliander Lisa, *Packaging logistics*, Packforsk, Kista, 1997, p.44

¹⁰⁶ Johansson Kenneth, Lorentzon Karlsson Ann, Olsmats Carl, Tiliander Lisa, *Packaging logistics*, Packforsk, Kista, 1997, p.45

¹⁰⁷ Lumsden Kenth, *Logistikens grunder*, Studentlitteratur, Lund, 1998, p. 425

¹⁰⁸ Johansson Kenneth, Lorentzon Karlsson Ann, Olsmats Carl, Tiliander Lisa, *Packaging logistics*, Packforsk, Kista, 1997, p.45

According to the organization ECR, the packaging must fulfil certain demands regarding information and labelling:

Primary package

Every primary package must carry an EAN-code and information in plain text, i.e. contents declarations. The EAN-code must be readable through the whole supply chain and the information must be readable through the products lifetime.¹⁰⁹

Secondary package

The secondary package must carry an EAN-article number, an EAN-code and information in plain text. To that, there sometimes is information of number of primary packages, the article number of the supplier and best-before date.¹¹⁰

Tertiary package

It is not necessary to label the tertiary package, as its main function is to keep the secondary packages tighter. However, all tertiary packages should carry an EAN-code to be able to identify and store in different databases.¹¹¹

3.3 The logistic system

The logistic system can be described as an open system which consists of different parts in the supply chain, which is integrated with each other and the surrounding, see figure 3.3a. The different parts communicate through information interchange and material movements.¹¹²

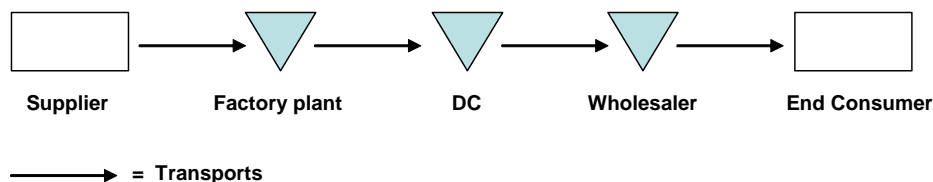


Figure 3.3a The Supply Chain¹¹³, modified by the authors

Logistic systems are attached and relate to each other through three basic cornerstones; *the distribution, the traffic and the transport system*, see figure 3.4b, and the mean driving force in the network is to transport objects from one point to another. The logistic system consists of a network of goods and load carriers. Hence it is often favourable to describe it according to the systems approach. It is pointless to reduce costs in one separate part of the system, if the total cost increase and on the other hand is it possible to increase the parts costs and still decrease the total costs. For example, increase packaging costs will lead to both lesser damages and easier handling; which will reduce the total costs.^{114 115} *Distribution* aims to

¹⁰⁹ <http://www.ecr.se>, 2006-10-30

¹¹⁰ Ibid.

¹¹¹ Ibid.

¹¹² Jonsson Patrik, Mattsson Stig-Arne, *Logistik – Läran om effektiva materialflöden*, Lund, Studentlitteratur, 2005, p.90-98

¹¹³ Lumsden Kenth, *Logistikens grunder*, Lund, Studentlitteratur, 1998, p. 222

¹¹⁴ Institutionen för Teknisk Logistik, *Kurskompendium i Internationell Distributionsteknik*, Lund, Studentlitteratur, 2003, p. 205-207

satisfy the needs of moving a transport object from one point to another in the network and create time and space utility for the transport object. Goods are transported between locations in the network and the demands can be expressed in terms of order sizes, frequency, tones annually or through flexibility.

Traffic is the physical movement, which is necessary to move the transport object. With that traffic can be defined as a movement of the mean of transport in a physical network.

Transport aims to receive desirable changes in the abstract network and hence transport can be defined as a change of address. Transport can be divided into two activities; *loading* which means that the transport object is loaded on a mean of transport and *unloading* that the same object is unloaded at another place and time. In this way loading links the traffic and distribution activities together, while unloading unlinks them. Measurements of the efficiency of the transport process can be in terms of filling rate and delivery service.¹¹⁶

¹¹⁵ Ibid.

¹¹⁶ Ibid

The information system controls and merges the logistic system. Within the information transferring, rapidly technology progresses as well as a structural progress take place, which essentially leads to reducing the lead times, increases flexibility and results in better consumer adaptation.¹¹⁷

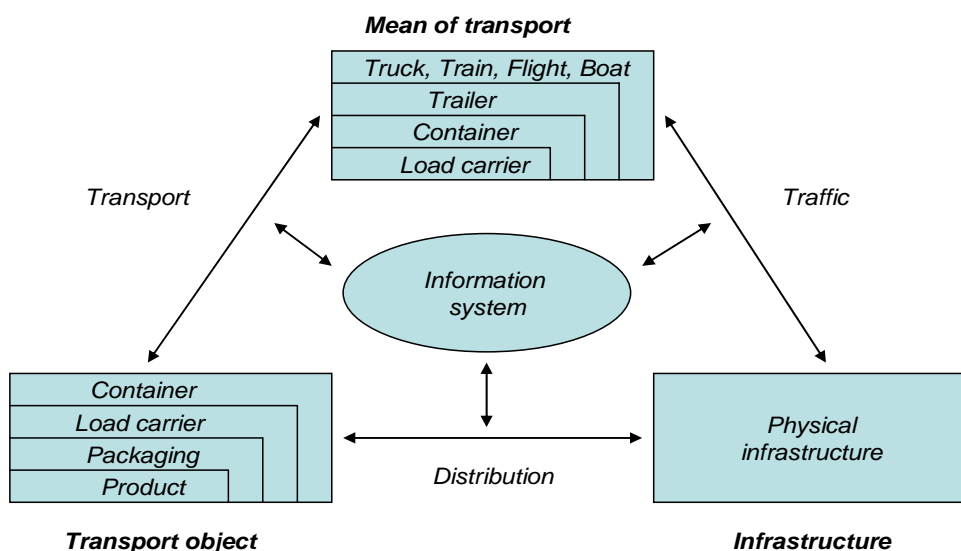


Figure 3.3b An illustration of the interaction between the three fundamental elements in the logistic systems¹¹⁸, modified by the authors

The logistic system in figure 3.3b consists of three fundamental elements; *the mean of transport, the transport object, and the infrastructure*. The physical transport object is transported, between two points, by a physical mean of transport e.g. train or truck and the infrastructure offers physical links, which is a condition for the goods to be transported.¹¹⁹ To perform a transport, a functioning infrastructure in forms of harbours, terminals, railway tracks, roads and air ports are essential. The infrastructure is normally own by the public sector and is complex to transform. Because of this, the infrastructure often constitutes a restriction and condition for the opportunity to perform a high quality transport service.¹²⁰

3.3.1 The distribution system

Distribution endures of alternately relieve of transport and storing activities. In almost all parts of a physical distribution, companies and individuals cooperate during both planning and handling of goods flow.¹²¹ The distribution problematic concerns; how the products shall reach the end consumer, how the consumer will buy, where they want to buy, which type of service they ask for and in which quantities the want to buy. These questions could be measured in terms of batches, flexibility, frequency or

¹¹⁷ Institutionen för Teknisk Logistik, *Kurskompendium i Internationell Distributionsteknik*, Lund, Studentlitteratur, 2003, p. 10

¹¹⁸ Institutionen för Teknisk Logistik, *Kurskompendium i Internationell Distributionsteknik*, Lund, Studentlitteratur, 2003, p. 205-207

¹¹⁹ Ibid.

¹²⁰ Jonsson Patrik, Mattsson Stig-Arne, *Logistik – Läran om effektiva materialflöden*, Lund, Studentlitteratur, 2005, p.90-98

¹²¹ Persson Göran, Virum Helge, *Logistik för konkurrenskraft*, Lund, Studentlitteratur, 1998, p. 75

tonne annually.¹²² The choice of distribution channel depends on the number of participated actors, the products or services, the market, type of suppliers and consumers. There are several reasons why middlemen should both store and distributing the goods. Generally the middlemen have a broader knowledge within the area of distribution and storing, which often contributes to reducing the distribution costs.¹²³ The distribution often represents a significant part of the product price. There are several signals which indicates that the distances in the distribution system will increase; first and foremost the internationalization and globalization of the markets, but simultaneously, the computer technology develops and the streamlining of the information flow.¹²⁴

Figure 3.3.1, the distribution channels, shows three alternative ways to freighting goods; either from the factory direct to the end consumer or via middleman.¹²⁵

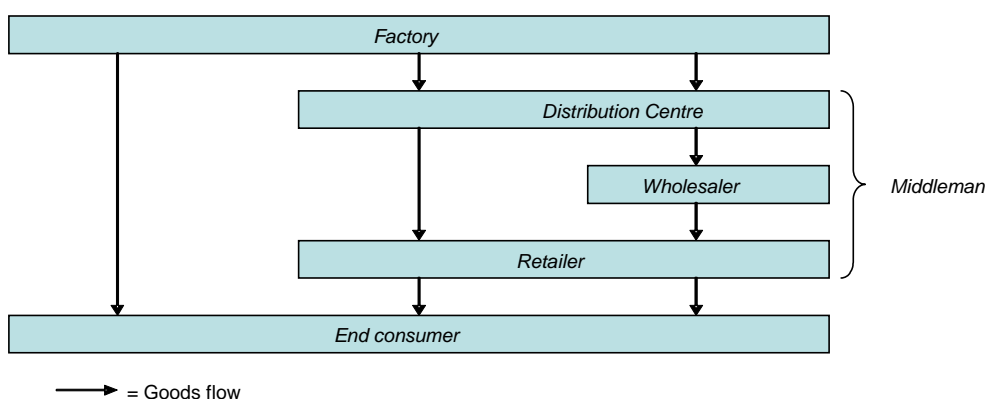


Figure 3.3.1 Three various types of distribution channels¹²⁶, modified by the authors

3.3.2 The transport system

When choosing transport system, it is important to have an overall view i.e. to considerate the whole transport chain from supplier to end consumer. Factors to considerate:¹²⁷

- Character of the goods (packaging, design, size)
- Transport quantity
- Transport distance
- Point of time and punctuality
- Quickness
- Price
- Service
- Flexibility
- Environmental effects

¹²² Persson Göran, Virum Helge, *Logistik för konkurrenskraft*, Lund, Studentlitteratur, 1998, p. 84-85

¹²³ Persson Göran, Virum Helge, *Logistik för konkurrenskraft*, Lund, Studentlitteratur, 1998, p. 84-85

¹²⁴ Persson Göran, Virum Helge, *Logistik för konkurrenskraft*, Lund, Studentlitteratur, 1998, p. 74

¹²⁵ Persson Göran, Virum Helge, *Logistik för konkurrenskraft*, Lund, Studentlitteratur, 1998, p. 84-85

¹²⁶ Ibid.

¹²⁷ Institutionen för Teknisk Logistik, *Kurskompendium i Internationell Distributionsteknik*, Lund, Studentlitteratur, 2003, p. 11-12

3.3.3 The traffic system¹²⁸

The goods traffic can be divided into four main means of transport; sea, rail, road and flight traffic. The different means of transport can also be combined on a transport assignment and is then called combined transports. Through combined transports, goods transports can be optimized by using the differential characteristics (e.g. the speed of flight, big volumes by sea etc.) for each mean of transport.

Because of the large loading capacity of cargo ships, sea transports often have the lowest operating cost per tone km (the quantity of goods in tone multiplied with the number of km) of the four means of transport. On the other hand, sea transports are the slowest mean of transport. As a result of this, sea transports have its major competitive advantages for long transports of low valued goods. The dominated goods type for sea transports is for this reason petroleum products, but also bulky goods as sand, lime and ore is common. One of the strength with sea transports is the flexibility regarding the transport routes as the sea give rise to. Sea transports also have low costs associated to keep an infrastructure for the transports, as the sea ways normally are free.

Railway transports have big advantages towards road transports when large volumes of goods are transported for long distances. Most types of goods can be transported by railway, but because of the relatively long transport time, high value goods generates high tied-up capital, which makes it less suitable. Railway transports are in particular appropriate for long distances, where the mean of transport normally gives a satisfactory speed. Although the transport times are longer than corresponding road transports. The average velocity of a goods train through Europe is 18 km/h, which is slower than an icebreaker.¹²⁹ Railway transports are for this reason especially suitable for transports over long distances with large quantities of bulky, low value goods. Because of the reasons above, a big part of the transports within the wood and ore industries constitutes of railway transports. The railway net is not as expanded as the road net. Because of this, the railway traffic has not the same flexibility as road transports. Deliveries direct to and from customers' respective suppliers, are for this reason hard to perform, why this is done via terminals instead. Though, by combining different means of transport, these competitive disadvantages can be eliminated (or in any case reduced). One example of this is when goods are transported in containers, which easily can be unloaded from the train and then loaded onto a truck for further transportation. However it should be emphasised that this rearrangements often demands a lot of time and resources.

One important competitive advantage with the railway is that it is environmentally friendly. The railway does not contribute to any direct pollution; however indirect pollution occurs when producing electric power.

¹²⁸ Jonsson Patrik, Mattsson Stig-Arne, *Logistik – Läran om effektiva materialflöden*, Lund, Studentlitteratur, 2005, p.90-98

¹²⁹ Larsson Everth, Doctor Technical Logistics, 2006-10-30

Because of its ability to transport large volumes to relatively low energy consumption, the railway is the most efficient mean of transport, with respect to energy consumption.

The most common way of performing both long and short transports of goods is by trucks. Road transports are in principle the only mean of transport which can deliver directly from the supplier's to the customer's facility. With transports by road almost any kind of goods can be transported anywhere and the size, weight and distance is of less importance for its possibilities. It is for example; almost possible to customize a transport route for a single order, presupposed that a passable road is available. This makes road transports more flexible than the other means of transport. Road transports compete with flight traffic when involving small volumes or high value goods. When concerning transports of large volumes with low value, the railway is the main competitor. One negative aspect of transports by road is the large amount of exhausted fumes that truck transports are associated with.

The major advantage with flight transports is high-speed transports over long geographical distances. Flight transports are carried out in the same way as railway and sea transports, only between terminals and not direct from the supplier's to the customer's facility. Flight transports is the mean of transport which causes the highest costs per tone kilometre and is for that reason mainly used for transports of goods with high value, time sensitive express goods, emergency deliveries and post and packages over long distances. Increased claims of rapid and safe transports have led to a substantial growth in demands of flight transports during the later years. In addition, an increased outsourcing trend has led to that high valued goods are purchased from suppliers in other continents and then transported by flight.

Combined transports represent a combination of several different means of transport, e.g. railway and road transports. By using the mean of transport, which is the most efficient for each part of the transport, the total transport can be optimized through a combination. Because of the demands to transport goods all the way from the supplier's to the customer's facility, an combined solution for sea, railway and flight transports is often enforced. When combining transports, it is important that the interface between the transports is efficient. For combined transports to be profitable, it is vital that the external terminal activities at the transition between the means of transport, is less than the cost savings through cheaper railway or sea based long distance transports. To make the loading activities between the different means of transport in a convenient way it is advantageous to use standardized unit loads (e.g. containers, semi-trailers etc.). This makes the terminal activities more efficient thus time related competitive disadvantages do not arise.

3.4 Module system

In many cases, the package will be loaded together with several other, similar or closely related products in a transport. To attain high volume utilization and create conditions for gained automatization it is important to build up size variations as modules. This involves that the modules (packages) must be adapted to larger packages, e.i. the dimensions of the larger packages must be physical multiples of the smaller ones. Simultaneously as the modules must result in an optimal volume utility of the different load carriers, they also have to be adapted for optimal use in each part of the supply chain. The modules must also be suitable with the production environment, the space in the mean of transport and for demands as e.g. good exposure in the shop shelves.¹³⁰

Standards for the flow of goods and information are handled by organizations such as; ISO (International Standardisation Organisation) and SIS (Swedish Standards Institute). In order to effectively utilize the production equipment, transports and warehouse resources, in-store systems, etc., it is important to adapt all units to a modular system. SIS has developed and designed a basic module, measuring 600 x 400 mm, in collaboration with the grocery industry, which shall be a guiding influence to all types of packages. The 600 x 400 mm module applies both to primary and secondary packages and the standard is suitable irrespectively if the 800 x 1200 mm or 1000 x 1200 mm loading pallet is used. See figure 3.4

When primary and secondary packages are produced, it is important to utilize these ideal modules. The primary package's outer dimensions must fit the secondary package's internal dimensions. With this in mind it is also important to consider the thickness of the packaging material; the package must be able to cope with normal loads during transport, storage and handling. The packaging material must be correctly adapted, neither too thick nor too thin.

The secondary packages must be modularly adapted to achieve the highest possible filling rate in the roll container or on the loading pallet. This is easiest performed by reducing the dimension of the secondary package by 5–10 mm per secondary package. In practice this means that a secondary package according to the 600 x 400 mm basic module should have secondary dimensions of 590 x 390 mm.

The primary package must be modularly adapted to the inner dimensions of the secondary package to achieve the highest possible degree of filling. The calculation must be performed with consideration for the thickness of the secondary package.¹³¹

¹³⁰ Lumsden Kenth, *Logistikens grunder*, Lund, Studentlitteratur, 1998, p. 422

¹³¹ <http://www.ecr.se>, 2006-10-30

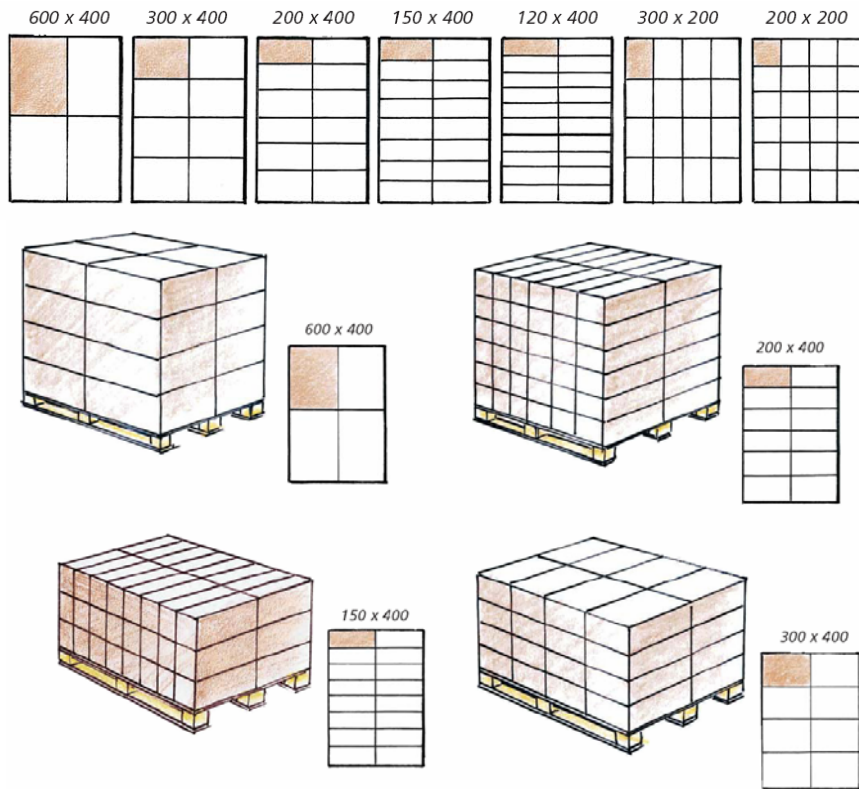


Figure 3.4 The module system.¹³²

¹³² Ibid.

3.5 Cost aspects

To get a proper perspective how the packaging affects the costs, it must be placed in its right context – as an integrated part of the cycle from raw material to disposed of the used packaging. An intelligent designed packaging can in different ways contribute to making the cycle as efficient as possible, from both an economical and environmental point of view. Depending on product and branch, the packaging costs, as part of the total product cost, vary significantly. The packaging contributes directly to the total costs through costs for material or packaging, purchasing administration, storage and internal handling of packaging. Simultaneous, the packaging influences the costs in an indirect way, by making the flow more efficient and consequently reduces the total costs in the goods flow. The package design influences the costs for packaging and the costs for other activities in the cycle such as transport, storing and handling as well as for collection and recycling. By designing a packaging so it is better adapted to a standard pallet, the volume utilization during transport increases which results in reduced transport costs.¹³³

3.5.1 Purchasing

As business is becoming more competitive, purchasing and supply chain management are increasingly recognized as key business drivers by top managers. It often appears that buyers and supply chain managers can contribute significantly to the company's end result. Since most companies today spend more than half of their sales turnover on purchased parts and services, efficient and constructive relationships with suppliers are central issues for the company's short term financial position and long term competitive power.¹³⁴

Apart from immediate savings on purchasing prices, the purchasing function can contribute to the improvement of the company's competitive position in a more indirect way. This indirect contribution can take the shape of standardization of the product assortment, reduction of stocks, product and process innovation, reduction of quality costs (costs related to inspection, rejection, repairs), and cutting down on production lead times. The purchasing function can contribute to cost reduction by striving for a reduction in product variety. This can be achieved through standardization of specific products and reduction of the number of suppliers. This may lead to less dependence on certain suppliers, better use of competitive bidding and a lower number of items to be kept in stock. In practice, these indirect contributions often turns out to be more substantial than the amounts of money which are saved directly (i.e. exclusively by purchasing).¹³⁵

3.5.2 Production

Set-up times are a central issue within production. The set-up time is the time it takes to rearrange product equipment, e.g. a machine, from

¹³³ Johansson Kenneth, Lorentzon Karlsson Ann, Olsmats Carl, Tiliander Lisa, *Packaging logistics*, Packforsk, Kista, 1997, p.26-31

¹³⁴ Arjan J. Van Weele, *Purchasing & Supply chain management –Analysis, Strategy and Practice*, 2005, p.4

¹³⁵ Arjan J. Van Weele, *Purchasing & Supply chain management –Analysis, Strategy and Practice*, 2005, p.18-19

production of one type of product to another kind of product. The set-up time is independent of the number of units made in the batch, the batch size. The set-up time is more precisely defined as the time from the last correct unit in a batch to the first correct unit in the following batch. Set-up times are capacity demanding as the product equipment can not be used for its purpose during the set-up time. Depending on product type and process the set-up times vary substantially, from single minutes to several hours and in exceptional cases, days. By reducing the set-up time the available capacity and flexibility in the production increases.^{136 137}

3.5.3 Pricing of transports

Pricing on transport services could either be done with the individual, tender, contract, demand- or tariff method. The goods eventual overhang, filling rate and height (single or double stacking) of pallet, may affect the pricing. One of the most applied methods to explicitly establish price levels on transport services are the tariff method. The tariff method designates a classification i.e. a price list for cargo calculation to apply, when transport service repeats in certain interval of time and during similar condition e.g. regular traffic for trucks. The tariff method has traditionally been used for markets with few sellers, several purchasers and for transports where the goods weight, transport distance and value of the goods vary. One of the great advantages with the tariff method is that it is possible at an early stage to estimate the price for the transports. In this way unnecessary and time demanding negotiations can be avoided.¹³⁸

3.6 Product development

Product development always involves a compromise of different demands. Conflicts often occur between demands from the sales division and demands from the purchasing and production divisions. For the sales and marketing divisions it is important that the company can offer the products that the customers demand. Preferably, each customer should get the product that is most suitable for the current purpose. The product should to the greatest extent possible, be customer adapted. For the production and purchasing divisions, on the other hand, the manufacturing and purchasing price is a more central issue. The more standardized the product and the detailed components are, the easier it is to build a rational production and purchase components to low costs. In this way a tension between large series of a few standard products and small series of individual customer adapted products occur. The construction division is situated in between and the various interests must be weighed against each other, see figure 3.6 below. In time, the company obtains a certain position; it chooses a location on the scale in the figure. However, difficulties arise when the company needs to move along the scale, either towards a higher degree of customer adaptation or towards standardization. One reason for moving towards a new direction could be that the competitors have success with their products, which forces a strategic change. Another reason could be that new product or production technology have been developed that e.g. allows economical production in

¹³⁶ Olhager J, *Produktionsekonomi*, Lund, Studentlitteratur, 2000, p. 90

¹³⁷ Anlander M. et. al, *Industriell ekonomi*, Lund, Studentlitteratur, 1998, p.55

¹³⁸ Lumsden Kenth, *Logistikens grunder*, Lund, Studentlitteratur, 1998, p. 604-605

bigger series than before. To change direction within the product development area is often associated with a lot of work.¹³⁹

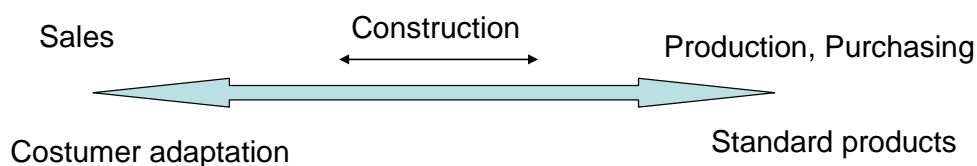


Figure 3.6 Scale over the degree of customer adaptation¹⁴⁰, modified by the authors

In order to get the full picture of the influences on the product development, it is necessary to elaborate the role of packaging logistics in the product development process. The influence of packaging logistic is not confined to the product development process alone, it also applicable to all of the sub-processes forming the industrial innovation process. The process shall fit both the storing, transport- and groceries decoration better. However, many of this standards or modules do not apply; instead they occur in the product development without any contribution from the distribution functions. Product development is a term for, how a product's methods and technique shall develop in a satisfied way and how to find balance between technique (research and innovation) and economy (market analyze).¹⁴¹

3.6.1 When choosing a new package

The development of new products or modifications of existing products changes many conditions that have a direct impact on the distribution. Of particular importance are parameters such as weight, volume, design and size per trade unit or per transported unit. These parameters can be of crucial importance for how storage, handling and transport should be performed. To reduce the distribution costs, some branches have developed standards and module systems for dimensioning the products. The modules dimensions are suitable with the dimensions of the storage interior, transport equipment and grocery interior. In many cases neither of the standards or modules is used, but instead product development exists without any participation from the distribution function, which may result in sub optimization.¹⁴²

To be able to choose suitable packaging for a product, information regarding the product and its characteristics is essential. The facts should include definitions and information how the product can be damaged or destroyed. Some of these facts can be received visually by inspecting the product; others through plain measurements, while other information must be collected from the constructor or producer. The product facts are determined by the specific situation and affect the choice of packaging. Some product facts to consider when choosing packaging is presented below:¹⁴³

¹³⁹ Anlander M. et. al, *Industriell ekonomi*, Lund, Studentlitteratur, 1998, p.44

¹⁴⁰ Ibid.

¹⁴¹ Bjärnemo R, Johnsson M, Jönsson G, *Packaging Logistics in the Development*, Article, p. 11

¹⁴² Persson Göran, Virum Helge, *Logistik för konkurrenskraft*, Lund, Studentlitteratur, 1998, p. 88

¹⁴³ Lumsden Kenth, *Logistikens grunder*, Lund, Studentlitteratur, 1998, p.430

- **Structure**
 - The material, the product is made of and how it can be damaged.
- **Size and shape**
 - To fit standards and modules.
- **Weight and density**
 - Decide stiffness, stability and possible centre loads.
- **Weaknesses in the construction**
 - Which parts can easily be broken, bent, moved, come loose or be scratched.
- **Strengths in the construction**
 - Which parts can stand stresses or pressures.
- **Moisture sensitivity**
 - How the product is affected by moisture and temperature changes.
- **Compatibility**
 - Can the product be affected by the potential packaging material and which products can be packed together.

3.7 CAPE PACK¹⁴⁴

CAPE PACK is a comprehensive system for pallet optimizing. After entering appropriate data it is possible to view a range of on-screen diagrams and reports, to find the optimal package solution. The program is divided into three different groups: Pallet, Arrange/Design and Casefill.

Pallet Group

The CAPE PACK Pallet Group is a simple and practical program for solving pallet loading problems. The Pallet Group calculates the external filling rate and proposes the best packaging pattern to fit secondary packages (SKU's) onto a pallet.

Arrange/Design Group

The CAPE PACK Arrange/Design Group is designed to determine the maximum number of primary packages (CU's) loaded onto a pallet. The dimensions of the primary package (CU's) could either be fixed or varying. It is also possible to decide how the primary package should be bundled. The program arranges a number of primary packages together and calculates the new case (SKU), which is in turn, palletized. If the dimensions of the primary packages are set to be varying, the Arrange/Design Group will calculate a new size for the CU's and evaluate various arrangements of them.

Casefill Group

The CAPE PACK Casefill Group can be used when the case size (SKU) is already known to compare several different case sizes for packing a particular CU. A data base can be used to store (existing) secondary packages (SKU's). When the dimensions of the primary pack (CU) is entered and the packaging settings are done, the program arrange and fit the CU's into the existing SKU's. Casefill helps to find the best SKU package and fits the maximum number of packs per pallet.

¹⁴⁴ CAPE PACK software.

4 Empirical findings

4.1 Company description¹⁴⁵

Duni has since the 50's been a large Swedish producer of paper cups and napkins. Today the company is a leading international provider of premium solutions and products for handling and serving meals. During the decades, the road has been lined with numbers of product innovations, mergers and international expansion.

In 1949 Duni produced its first waxed paper cup and napkin made out of thin, glazed crepe paper. The company was then known as Billingsfors Långed AB, and was bought by the Swedish-based Bonnier Group earlier that year. The brand name Duni was presented in the 50's and became a part of the official company name in 1970. The company is since 1990 called Duni.

Nowadays the company is a leading provider of premium solutions and products that both create enjoyable eating and drinking occasions, e.g. napkins, plates, table covers, candles and food solutions. There are approximately 3,300 employees in 25 countries with a net sale in 2005 of EUR 642 million.

4.1.1 Duni's vision and mission

Vision

“is to be the market leader in premium table top solutions for the food service industry”

Mission

“is to enhance atmosphere and bring convenience on any eating and drinking occasion by providing inspiring and innovative products and concepts”



Figure 4.1.1 Products in Duni's assortment¹⁴⁶

¹⁴⁵<http://www.duni.com> 2006-10-30

¹⁴⁶ Ibid.

4.1.2 The organization at Duni

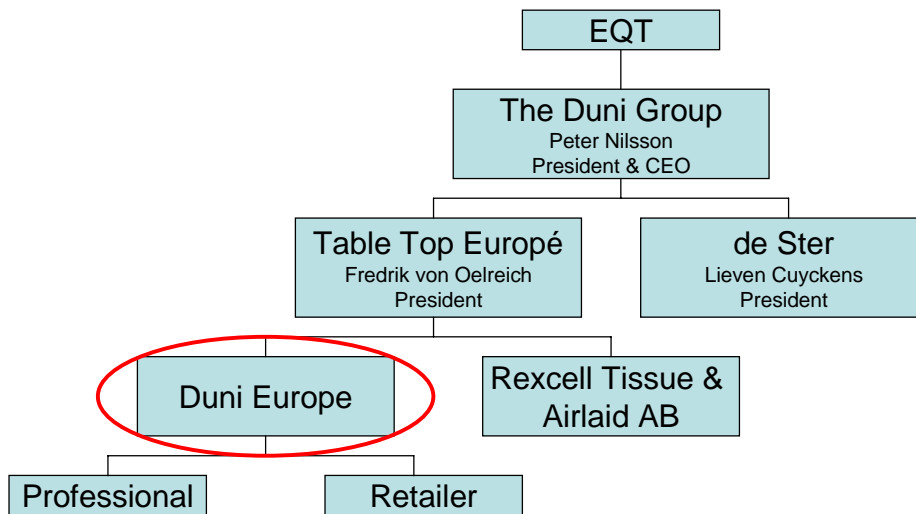


Figure 4.1.2 Duni's organization¹⁴⁷, modified by the authors

EQT

From the beginning the Duni Group was owned by the Bonnier Group, but is since 1997 the Duni Group is owned by the Wallenberg Group, EQT; a leading private equity group in Northern Europe. The Duni Groups global activities are refined and organised into two separate legal and independent businesses; Table Top Europe and deSter.

deSter

deSter represent 25 % of the Duni Groups total sales and is located in Hoogstraten, Belgium. deSter started as a supplier to the airline industry in 1973, the production are both in Belgium and Thailand with a total amount of 900 employees. deSter offers full meal and service solutions for different needs of the airline sector, where design and innovative product development represent the core expertise.

Table Top Europe

Table Top Europe represent approximately 60% share of the Duni Group sales and the headquarters is in Malmö, Sweden. The company has production units in Bramsche, Germany and Poznan, Poland. All in all, the total number of employees within Table Top Europe is approximately 1500. Table Top Europe focus on tissue-based products and the concepts includes an assortment of candles, cutlery, glasses and similar products. Table Top Europe operates its activities in two entities; Duni Europe and Rexcell Tissue & Airlaid AB.

¹⁴⁷ <http://www.duni.com> 2006-10-30

Duni Europe

The customers at Duni Europe are divided into two main categories, professionals and retailers. Representatives of the professional category are for example restaurants, hotels, bars and cafés and the retailers customers are mainly grocery stores, supermarkets, speciality retailers and interior design stores.

The concepts for Duni Europe are:

- *Table tops*; napkins coverings and placemats (which represent 67 % of the sales).
- *Food service*; glasses, cups, cutlery, plates and serving trays.
- *Food solution*; cardboard and plastic food containers.

Rexcell Tissue & Airlaid AB

Rexcell Tissue & Airlaid AB provides tissue and Airlaid material for primarily table top and hygiene applications. The production facilities are located in Skåpafors respective Dals Långed, Sweden and the production capacity is approximately 50 000 tons annually.¹⁴⁸

4.2 General about Bramsche

Duni's production unit in Germany is located in Bramsche, a small town in North West of the country, on the border to Netherlands. The factory was built in 1958 and was at the beginning an old weaving factory with 200 employees.¹⁴⁹ The production unit of napkins started in 1972 and was first and foremost intended for the German market. Over time, the importance of the factory has increased and other factories nearby have been bought or closed and consolidations or collaboration with suppliers have developed.¹⁵⁰ See figure 4.2a.



Figure 4.2a Production plant in Bramsche¹⁵¹

¹⁴⁸ <http://www.duni.com> 2006-10-30

¹⁴⁹ <http://www.duni.com> 2007-02-21

¹⁵⁰ Interview at Duni

¹⁵¹ Ibid.

Since the start of the factory, the production unit in Bramsche has gradually expanded and nowadays the plant consists of four different factory parts. The production unit is built on 53.000 m² with about 20.000 m² of production floor for the approximately 70 machines and with 9.300 m² for the raw material warehouse. Wall to wall with the factory in Bramsche Duni holds a distribution centre with an area of 23 700 m².^{152 153}

In Bramsche, approximately 5 billion napkins are manufactured annually. Napkins are Duni's best selling product and the assortment consists of dunilin, dunicel, airlaid and 1, 2, 3 – 4 ply.¹⁵⁴ Apart from the DC in Bramsche, Duni also holds six other DC's in Europe. The DC's are located in Sweden, Finland, Spain, England, Russia and Czech Republic.¹⁵⁵ See figure 4.2b below.



Figure 4.2b The structure of Duni, modified by the authors.

¹⁵² <http://www.duni.com> 2007-02-21

¹⁵³ Interview at Duni

¹⁵⁴ <http://www.duni.com> 2007-02-21

¹⁵⁵ Ibid.

4.3 Packaging on different levels

Duni uses the following definitions for there different levels of packaging: CU – Primary packaging, SKU – Secondary Packaging and UL – Tertiary packaging. See figure 4.3.



Figure 4.3 Duni's levels of packages¹⁵⁶

Duni offers a wide range of napkins. The material, which the napkins are made of are tissue, Dunicel, Dunilin or Airlaid and comes in 1-, 2-, 3- or 4-ply.

The different napkin sizes are for example:

24x24cm – as a cocktail napkin.

33x33cm – for breakfasts or snacks.

40x40cm – for price attractive lunch offers.

Classic napkins 40x40 – for conference lunches

Dunilin – premium napkin for dinners and banquets, available in 40x40 as well as 48x48 cm.¹⁵⁷

4.3.1 Primary packaging

The CU packaging for napkins primary consist of printed, transparent plastic foil. Although for some napkins Duni uses plastic bags, plastic strips or cardboard inlayer to keep the napkins together.¹⁵⁸ Picture 4.3.1 below, shows a representative CU package.



Picture 4.3.1 CU package 40*40 cm napkins¹⁵⁹

¹⁵⁶ Duni Logistic manual

¹⁵⁷ <http://www.duni.com> 2007-02-20

¹⁵⁸ Interview at Duni

¹⁵⁹ Own picture

The print on the CU's varies, depending on the napkin type and whether the napkin is customer specific or not.¹⁶⁰ Apart from all the different napkin standards (e.g. 24 cm, 33*33 cm 40*40cm.), the napkins also comes in different numbers of pieces per package (e.g. 8, 10, 20, 50 psc/CU). This causes a large number of different CU sizes. Please see appendix I, table of all CU packages.

Depending on the thickness of the raw material and in which machine the napkins are produced in, the dimension of the CU's sometimes varies. This causes extra complexity when packing the napkins, since some napkins must be pressed together to fit inside the SKU box.¹⁶¹

4.3.2 Secondary packaging

All Duni SKU packages for napkins are boxes made of corrugated board. The current number of activated SKU's for napkins produced in Bramsche is 67 boxes.

The reason why there are so many SKU boxes could partly be explained by all the different CU sizes which demands different SKU sizes, customer demands regarding the number of CU/SKU, the box design and stability demands (different ECT values). The boxes can either be white or brown and some of the boxes are printed, while others are blank.¹⁶² If the annual volume is more then 5 000 SKU's, the boxes must be Duni printed, otherwise the boxes must be neutral.¹⁶³ Figure 4.3.2 below, shows a brown Duni printed box.¹⁶⁴

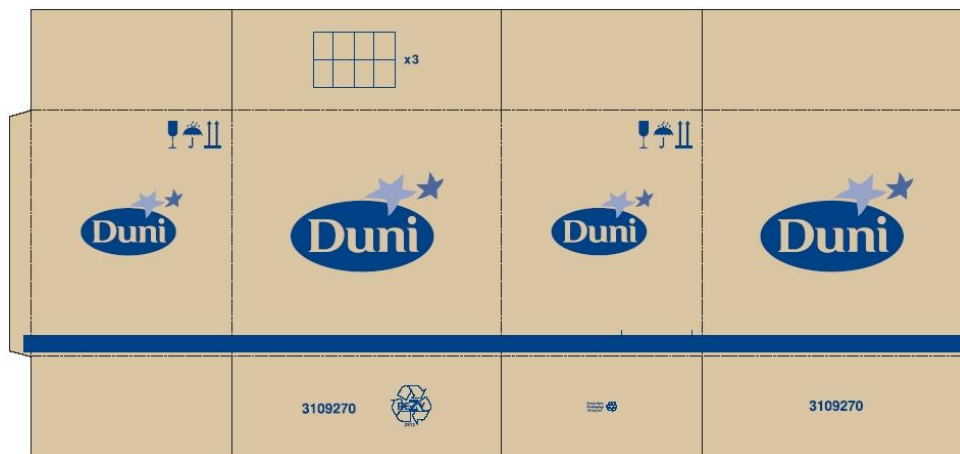


Figure 4.3.2 Duni printed box.¹⁶⁴

Another reason for the large number of different SKU boxes is that Duni has no satisfying process for introducing new SKU boxes today. When new products are developed, new SKU boxes are often developed simultaneously to fit the products, because it is hard to find appropriate

¹⁶⁰ Interview at Duni

¹⁶¹ Ibid.

¹⁶² Ibid.

¹⁶³ Duni Logistic manual

¹⁶⁴ Ibid.

existing packages with the current process. This process is done manually, which demand a lot of time and resources and often occurs in a late phase of the new product development. The new boxes causes a large number of different box sizes and many of the SKU boxes in Bramsche are at present only used for 3 or fewer articles.¹⁶⁵

At the factory in Bramsche some of the SKU's are packed manually, while others are packed automatically by machine. There are no general rules whether the CU's should stand up or laying down inside the SKU, but to attain good exposure of the products in the stores it is sometimes vital that all the CU's are packed in the same direction. The automatic packing also constitutes a limitation of packaging patterns inside the SKU, although the machines can handle some complex packaging patterns, but this demands certain adjustments in the production.¹⁶⁶

Since the napkins generally are thicker on one side of the napkin, problems sometimes occur when packing the napkins. If the thicker side of the napkin is oriented downwards in the SKU, the napkins get rickety when the SKU is exposed to pressure and the napkins risks to get creased when reaching the end consumer. To avoid this problem, the thicker side of the napkin is situated vertical (when standing up). In this way the constructions get more stable and can stand higher stresses. The reason why the napkins are thicker on one side (than the others) is because the napkins are folded and has a perforated pattern, a design detail which distinguishes the product.¹⁶⁷

4.3.2.1 Corrugated board

Duni mainly uses single and double wall corrugated board for their SKU boxes.¹⁶⁸ The corrugated board is primarily purchased from Delkeskamp, who is a local supplier close to the production unit in Bramsche. The boxes are printed at the supplier and then transported to the factory in Bramsche.¹⁶⁹

4.3.2.2 ECT

The ECT value among Duni's SKU boxes vary between 3,7-7.¹⁷⁰ The ECT value is determined by the packaging responsible at Duni in collaboration with the supplier of corrugated board. The strengths of the SKU must manage to transport two UL's in height and the maximum weight of an SKU is set to 15 kg.¹⁷¹

4.3.3 Tertiary packaging

Every unit load leaving the distribution centre in Bramsche is covered with shrink film both on the sides and on top of the pallet.¹⁷² When covering the UL it is important that the shrink film is not wrapped to tightly. If the film is

¹⁶⁵ Interview at Duni

¹⁶⁶ Ibid.

¹⁶⁷ Ibid.

¹⁶⁸ Ibid.

¹⁶⁹ Ibid.

¹⁷⁰ Duni's SKU database

¹⁷¹ Duni Logistic manual

¹⁷² Interview at Duni

wrapped too tightly, the edges of the boxes will be crushed and the boxes will lose much of their carrying capacity.¹⁷³ See picture 4.3.3a.



Picture 4.3.3a An EU-pallet being covered with shrink film in Bramsche.¹⁷⁴

For internal transports within Duni in Bramsche an adhesive tape strip around the top layer of SKU boxes is used to keep the boxes together on the UL¹⁷⁵. See picture 4.3.3b below.



Picture 4.3.3b A unit load with an adhesive tape strip in Bramsche.¹⁷⁶

4.3.3.1 Pallets

Duni annually distributes 600 000 pallets from their facilities in Bramsche. The plant handles two different types of pallet standards; EU and UK pallets. Mainly EU pallets are distributed from the DC in Bramsche, but also a few UK pallets.¹⁷⁷

¹⁷³ Duni Logistic manual

¹⁷⁴ Own picture

¹⁷⁵ Interview at Duni

¹⁷⁶ Own picture

¹⁷⁷ Interview at Duni

4.4 Duni packaging functions

4.4.1 The market function¹⁷⁸

Within the professional division, Duni sells whole concepts. Duni is not only interested in selling for example white napkins, but also candles, plates, table covers and coasters. The whole premium segment is a good example of how Duni works to build up their brand. Example of barrier entry's is the hotel business, where Duni sells low margin products as breakfast and bar napkins and coasters to make way for other products such as season products for example Eastern, Christmas and New Years products.

Cash and carries, which represent 55 % of the turnover within professional, have high demands regarding the packaging design. ALDI, for example which is one of the largest Cash and carries, wants all Duni's SKU boxes to be shelf ready. For hotels and other customers in the professional segment, the demands regarding the package design are not that important as for the Cash and carries, since the packages are not exposed to the customers in the same way.

Since the end consumers not often are in contact with the SKU's, Duni do not focus so much on the design of these. Although the shelf ready solutions and the display pallets has a great marketing potential. More efforts are done; trying to make the CU's attractive by nice print and packaging material. By attractive CU's and good quality, Duni wants to maintain their position in the premium segment for napkins. The company is aware of that they charge a high price for their products, but the quality difference compared to the competitors should motivate the higher price. Duni continuously try to improve themselves by developing new unique products and packaging solutions, which contributes for the company to maintain their high position on the market.

4.4.2 The environmental function

The degree of reusability among Duni's packages varies on the different levels of packaging. The CU packages, which consist of plastic foil is not recyclable. The corrugated board used for the SKU's, on the other hand, can be grinded and reused or energy can be extracted by burning the packages. The shrink film used to fixated the packages on the pallets is not recyclable, but the pallets can however be used several times.¹⁷⁹

¹⁷⁸ Interview at Duni

¹⁷⁹ Ibid.

4.4.3 The flow functions

4.4.3.1 Facilitate goods handling

The use of unit loads

Duni uses unit loads, standardized pallets, to facilitate the goods handling in the supply chain. External transports are mainly carried out on EU-pallets (1200*800*145), but for a minority of the transports to the United Kingdom, UK pallets (1200*1000*145) are used. The maximum height of a regular unit load is 1250 mm (including the pallet). The German standard, EU-pallets with an UL height of 1650 mm (including the pallet), is only used internally at the plant in Bramsche. The reason why the German standard is still used internally is since the DC in Bramsche is built to handle this standard. See picture 4.4.3.1a. Duni have investigated whether it is possible to change the structure of the DC, but since the racks, the sprinkler system and the pillars in the building are designed for the German standard, this change would generate far too high costs.¹⁸⁰



Picture 4.4.3.1a Duni's distribution centre in Bramsche, Germany.¹⁸¹

Duni's ambition is to adapt all of the SKU boxes as good as possible to the load carrier (1200*800*1250 (including the pallet)), but because of the fixed dimensions of the napkins this is often hard to achieve with a satisfying filling rate. According to Duni's logistic manual, overhang on either side of the pallet is not acceptable. The only exception to this rule is when the product is bigger than the pallet, for instance, for tablecloth rolls.¹⁸² ¹⁸³ See figure 4.4.3.1a over a satisfying UL and 4.4.3.1b of examples to avoid.

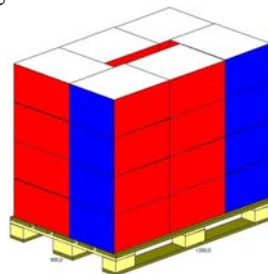


Figure 4.4.3.1a A satisfying UL: Corner over corner; no space between the SKU's and no overhang.¹⁸⁴

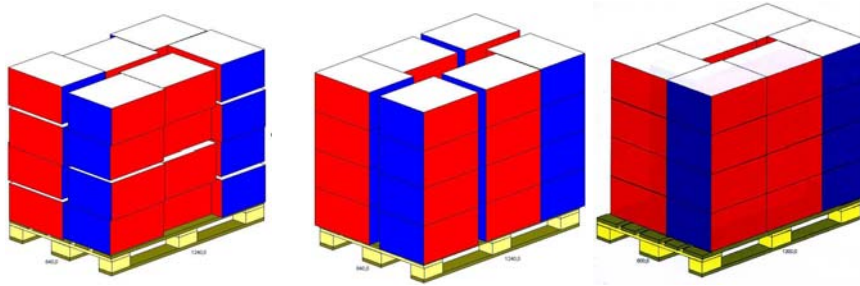
¹⁸⁰ Interview at Duni

¹⁸¹ Own picture

¹⁸² Duni Logistic manual

¹⁸³ Interview at Duni

¹⁸⁴ Duni Logistic manual



Space between the SKU's **Not corner over corner** **Overhang on pallet**
Figure 4.4.3.1b Example of packaging solutions to avoid ¹⁸⁵

Volume efficiency

The internal filling rates of Duni's packages are in general satisfactory, since the SKU boxes are determined by the product and no standard modules are used. The external filling rate, on the other hand is often insufficient. The average external filling rate for boxes with no overhang in Bramsche is XX %, which means XX % empty space in the truck. See picture 4.4.3.1b. This could partly be explained by the fixed dimensions of the napkins, which not are well adapted to the EU-pallets. ¹⁸⁶



Picture 4.4.3.1b A truck loaded with napkins. ¹⁸⁷

Consumption adaptation

Large customers as ALDI, ICA and IKEA have relative big influence of the package design. The customers are able to decide the number of napkins per package (psc/CU), the number of CU/SKU and also the print and design of CU's and SKU's. ¹⁸⁸

Weight efficiency

Duni's napkins are packed in CU's made of plastic foil and then in SKU's made of corrugated board. ¹⁸⁹ Both plastic foil and corrugated board are light material which makes the packaging weight efficient. ¹⁹⁰

¹⁸⁵ Duni Logistic manual

¹⁸⁶ Interview at Duni

¹⁸⁷ Own picture

¹⁸⁸ Interview at Duni

¹⁸⁹ Duni Logistic manual

¹⁹⁰ Interview at Duni

4.4.3.2 Protect the product

Duni's present packages protect the products against the stresses in the supply chain in a satisfying way. If Duni, contrary to expectation receive any claims from the customers, the quality of the box will just be increased.¹⁹¹ When packing the napkins it is vital that there is some air in top of the SKU box. By saving some space inside of the box, the SKU itself carries the stresses instead of the products. This is extra important when the napkins are standing up inside of the SKU, since the napkins risks to get creased otherwise. When the napkins are laying down inside of the SKU, this is not quite as big issue since the napkins will not be damaged.¹⁹²

To avoid product damages it is also important to avoid under hang and overhang on the pallet. If the SKU boxes do not fill out the load pallet, problems may occurs when double stacking the pallets. If the filling rates of the pallets are to low, there is a risk that the pallet damages the SKU boxes. To avoid this problem Duni has a limit regarding the under hang on the pallet. Also pallets with overhang increase the risk of box damages, since the stresses gets irregular when double stacking the pallets. If there is overhang on the pallet, there is also risk that the products on the pallet bump into the surrounding environment and gets damaged. Generally, pallets with high external filling rate gives stable unit loads which results in less product damages.¹⁹³

¹⁹¹ Interview at Duni

¹⁹² Ibid.

¹⁹³ Ibid.

4.4.3.3 Identify the product

Duni follows all the current restrictions regarding labelling and information of the packaging.¹⁹⁴ The labelling of Duni's different levels of packaging is presented below:

CU (Consumer Unit)

Every Duni CU package is labelled with a standard bar code (EAN 13). See figure 4.4.3.3a below.



Figure 4.4.3.3a Standard bar-code.¹⁹⁵

Each bar code symbol must be printed with sufficient clear space around it to enable the scanner to recognize the start and the end point of the bar code. Maximum contrast is achieved, by using black or reflex blue bars on a white background. It is important to note that some colour combinations are not allowed, for example, black bars on a green background.¹⁹⁶

The CU's today are only labelled on one side of the package. Although one of Duni's major customer has requested that the bar-code should be printed on three different sides of the CU packages. The reason why the customer demands this kind of labelling is to facilitate the work for the shop assistants in super markets. Labelling on three side of the packaging will, for this reason, soon be a standard for all Duni CU packages.¹⁹⁷

¹⁹⁴ Duni Logistic manual

¹⁹⁵ Ibid.

¹⁹⁶ Ibid.

¹⁹⁷ Ibid.

SKU (Stock Keeping Unit)

For Duni's standard boxes the bar-code is printed directly on the corrugated board. The blank boxes are on the other hand labelled as the figure 4.4.3.3b shows.¹⁹⁸



Figure 4.4.3.3b Duni standard SKU label.¹⁹⁹

UL (Unit load)

Duni's logistic manual recommends that at least one SKU label is visible at the long and short side of the UL. Apart from this, no other demands regarding the labelling of the UL exists.²⁰⁰

4.5 The logistic system

Duni's logistic system principally consists of a hub system with its central warehouse and factory located in Bramsche. The plant in Bramsche has gradually attained a more important role as a logistic centrum in Europe. Although the location of the plant have been questioned. To examine the optimal geographical location in Europe, Duni carried out a research, which considered the market, the suppliers, the infrastructure and the customer location. The survey revealed that the plant in Bramsche was situated close to the optimal location in Europe, which was within a 90 km radius from Duni's plant in Bramsche. Horst Finke, the logistic manager in Bramsche, also emphasized that IKEA plans to build a new DC not far away from Bramsche.²⁰¹

Duni's choice of distribution channel and the mean of transport generally depend on the market, the infrastructure and on local conditions (e.g. law and culture). For transports within Europe mainly trucks are used. Duni cooperate their transports with both big third part logistic companies and smaller local actors.²⁰²

Duni's information system is in a continuous development and the company has recently implemented SAP as their new enterprise system. At the

¹⁹⁸ Interview at Duni

¹⁹⁹ Duni Logistic manual

²⁰⁰ Ibid.

²⁰¹ Interview at Duni

²⁰² Ibid.

moment the system is not completely integrated with all parts within the Duni Group. Duni believes that the enterprise system will facilitate the coordination of activities and create opportunities for better over view of the company. Due to the globalization, it is important that the fundamental processes and elements are attached to each other, to maintain at a high level of communication with the seven DC's in Europe.²⁰³

4.5.1 The distribution system

The goods flow from the distribution centre in Bramsche either goes direct to the customers or via middleman. Duni mainly uses wholesalers for their distribution of napkins, since a significant part of their customers consist of large chain stores. 80 % of the produced goods at the factory in Bramsche are distributed on whole pallets to the distribution centres around Europe. The remaining 20 % goes directly to the local DC in Bramsche. From the distribution centre in Bramsche, no more than 20 % of the products are distributed to the customers on whole pallets. The remaining 80 % are mixed pallets, which are loaded manually at the DC for further transport to the customers.²⁰⁴

The distribution from the factory in Bramsche to the distribution centres could be described as a hub system, where the truck goes fully loaded with goods to only one customer, the DC. See figure 4.5.1a. The distribution from Duni's distribution centre's to the customers, can on the other hand more be described as milk rounds, where the trucks are loaded with goods to several customers which are distributed to the customers in the same route.²⁰⁵ See figure 4.5.1b

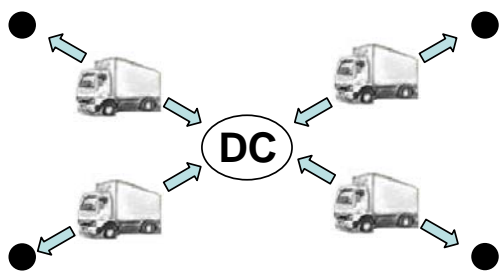


Figure 4.5.1a Hub system.

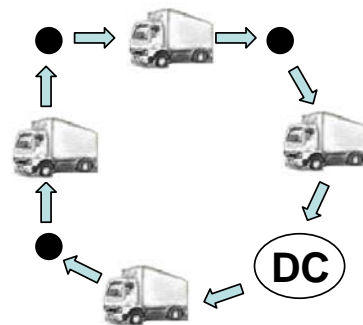


Figure 4.5.1b Milk round.

Duni's distribution distances have increased through the centralization of the organization and the increasingly globalized market. This means that the distribution costs has become a more significant part of the product price. In this way the choice of distribution channel in the future will be a more central issue for Duni, to be able to competing at a high level. Horst Finke thinks that Duni's global enterprise can become more dominant with appropriate distribution channel.²⁰⁶

²⁰³ Ibid.

²⁰⁴ Interview at Duni

²⁰⁵ Ibid.

²⁰⁶ Ibid.

4.5.2 The transport system

Duni's customers can order products on pallets, half pallets or on SKU level. When products are ordered on SKU level, the boxes are picked and stacked manually on mixed pallets at the distribution centre in Bramsche. The different order levels affect the structure of the transport system. When Duni chooses transport system, the whole transport chain, from supplier to end consumer, is considered. Factors as the design and size of the product, packaging functions, the transport distance and quantity, price and environmental effects, service and flexibility affects the choice of transport system.²⁰⁷

4.5.3 The traffic system

Duni have chosen to co-ordinate their external transports by them self, instead of handing over all the responsibility to an individual third part logistic company. The reason why, is that no other third part logistic company have been able to offer a lower price. At present, Duni uses both large third part logistic companies as DHL, DFDS, Schenker and Star Alliance and small local actors to carry out their transports. See picture 4.5.3. The transports are mainly occurs by truck, but also other mean of transports such as boat, train and flight are used. The mean of transport Duni uses for their transports depends on the distance, load, infrastructure and country. Road transports, by truck, are principally the only mean of transport which can deliver directly from the supplier's to the customer's facility, why this is most used. Duni has earlier used train transport at their plant in Bramsche, but because of gained demands regarding shortened lead times this mean of transport has revealed to be to slow. By only using train transports for certain distances, i.e. combined transports, Duni has succeeded to make use of the trains benefits for these routes.²⁰⁸ According to Horst Finke, one negative aspect of the increasing road transports is the large amount of exhausted fumes that truck transports are associated with. Duni are and will keep on working with the environmental questions, by trying to increase the transports filling rate.²⁰⁹



Picture 4.5.3 A truck being loaded at the plant in Bramsche.²¹⁰

²⁰⁷ Ibid.

²⁰⁸ Interview at Duni

²⁰⁹ Ibid.

²¹⁰ Own picture

4.6 Module system

At present, Duni does not have any module system neither for napkins or any other products in the assortment. Though the company has earlier tried to implement a standard module system, but due to the complexity of napkins this has not been possible to carry out. The reason why napkins is a complex product group, is because the napkins have different fixed dimensions, based on history, which are not adapted to EU-pallets, customer demands regarding the number of psc/CU and CU/SKU. Rexcell Tissue & Airlaid AB, which also are included in Table Top Europe (see figure 4.1.2) has a module system. This has been possible to implement, since the companies handles bulk goods, which is easier to adapt to standard module systems.²¹¹ The 40 cm's napkin for example, is well adapted to an EU-pallet if not the packaging material is considered. Since packages are needed when distributing the products, the dimensions of the napkin should rather be 38, 5 cm (instead of 40 cm) to fit packaging and products onto an EU-pallet. Today the 40 cm's napkins are distributed with overhang, which causes problems in the supply chain during storing and transportation. The overhang also increases the risks of product damages.²¹²

4.7 Cost aspects

4.7.1 Purchasing of corrugated board

Duni's main supplier of corrugated board in Bramsche is Delkeskamp, which is a local supplier 30 km from the production unit in Bramsche. Delkeskamp has been Duni's main supplier of corrugated board since the 70's and is each year benchmarked. Duni has examined the possibilities of purchasing corrugated board from a supplier in Poland (IMC) and other large corrugated board suppliers. The supplier in Poland could offer corrugated board to a low purchasing price, but because of the big distance between the two plants, the distributions costs would be increased.

One of the reasons why the factory in Bramsche has chosen the contiguous supplier Delkeskamp is according to Matthias Stuckmann, that the company in this way merely needs a small safety stock (JIT). Another reason is that corrugated board is bulky goods, which makes it expensive to transport over long distances. The corrugated board which is purchased from Delkeskamp, is manufactured from material (recycled magazines), which in turn is purchased from nearby producer in Bramsche. The same supplier of raw material is also used by the producer of corrugated board in Poland. The purchasing price of the corrugated board is a central issue, since it represents a big part of the total costs for the product.

At present, Duni has 5-6 different suppliers of plastic foil for the CU packages and shrink film for the UL. During a 4-5 years period Duni has been working for reducing the number of suppliers. Though there is a trade

²¹¹ Interview at Duni

²¹² Ibid.

off between a few suppliers of large quantities, which includes lower purchasing prices and several suppliers, which gives a better risk diversification.

The rolls with semi-finished material, which the napkins are produced from, are purchased from Rexcell in Skåpafors, Sweden. See picture 4.7.1. The Duni factory in Bramsche uses a SAP system, where 70-85 % of the material requirements are done. Remaining orders are made by email. Is material ordered before 16.00, the corrugated board is available 06.00 the day after.

Generally the blank (white) boxes are more expensive than the brown SKU's. The blank boxes also require labels that have to be attached to the boxes in the factory in Bramsche. By increase the purchased amount of already high volume SKU's, there is less profit to gain than increasing the purchased amount of low volume boxes. When introducing the shelf ready packaging, new product equipment must be procured, to be able to produce the new solution. This includes a large investment for Duni.²¹³



Picture 4.7.1 Rolls of semi-finished material in the production.²¹⁴

4.7.2 Production

All the different CU and SKU sizes causes unnecessary complexity in the production, since product equipment must be rearranged when changing form one package to another. The set-up times in Bramsche varies markedly and can be up to several hours, which affect the productivity negatively.²¹⁵

4.7.3 Pricing of transports

When pricing transports, Duni is charged per pallet according to predetermined tariffs for the intended mean of transport.²¹⁶

²¹³ Interview at Duni

²¹⁴ Own picture

²¹⁵ Interview at Duni

²¹⁶ Ibid.

4.8 Product development ²¹⁷

When developing new products, Duni always struggle to have an overall view, trying to understand the impact of the packaging design in the product development and consider the packaging functionality. The package must e.g. fit the distribution centres, trucks and the grocery decoration. At presents, Duni has no process for introducing new SKU boxes. When a new product is developed, the packaging responsible at Duni must search through a database, with all the existing SKU boxes, trying to find a suitable box for the product. The operation of finding an appropriate box is very time consuming, since all the dimensions of the SKU's must be calculated and compared manually. Because of the difficulties of finding suitable existing boxes for the products, new SKU boxes is often developed simultaneously, which has caused a large number of different box sizes. Another problem is that Duni satisfies all the customer demands regarding the number of psc/CU and CU/SKU today, without questioning them. For example: Sometimes the customer demands a certain number of psc/CU or CU/SKU, which makes it hard to find a suitable SKU for. By changing the demanded quantity (psc/CU or CU/SKU) slightly, it might be possible to find an appropriate box, which provides a win-win situation. Duni does not propose any new solutions regarding the number of psc/CU or CU/SKU today, which has contributed to the gained number of boxes.

Napkin is a product, which has a lot of in official size standards. The different napkin size standards have been formed during the history and the opinions why the napkins have their particular sizes are divagating. Some people think that the sizes arise from plates or cutlery sizes. One of Duni's best-sellers, the 40 cm's napkin, is inappropriate from a logistical point of view, since it does not fit the pallets well. Duni has examined the possibility of changing the dimensions of their 40 cm's napkin. Because of the in official standards established and the production changeovers this would cause, the change has not been accomplished. By changing the dimensions of the 40 cm's napkin, Duni are afraid to loose important customers and the costs combined with changing the production unit to a new standard can at present not be motivated.

Duni has got a gained awareness of the cost reducing potential of packaging. Functional package contributes to efficient transports and increased sales. For this reason Duni has expanded the collaboration between the packaging function and the product development. The packaging techniques are nowadays already involved in an early phase, when ideas arise, in the development of a new product. The collaboration between packaging techniques and product developer at Duni occurs via direct communication. One example of a successful collaboration within the product development is the new shelf ready project. Because of increased customer demand of SKU boxes that could be placed right on the shop shelf, Duni developed a new package solution. The shelf ready solution took shape after a close co-operation between the different functions in Duni. The shelf ready solution

²¹⁷ Ibid.

facilitates the handling for the shop assistance when exposing the products in the shop shelves, since they only has to remove the top layer of corrugated board. See picture 4.8. In this way the packages are ergonomic and give the products good exposure, since the napkins are standing up in the shelves. Another benefit of the shelf ready solution is they fit well to the pallets.



Picture 4.8 Prototypes of a shelf ready SKU boxes.²¹⁸

²¹⁸ Own picture

5. Sequence of work

To get a proper picture of the problem at Duni interviews were carried out with employees within the company, to find out the demands and complications, which are combined with napkins as a product. The interviews were mainly carried out during our visit at the production unit in Bramsche. After the interviews with the responsible persons within; logistics, purchasing, product development, production, marketing and packaging and the guided tour in the facilities with Heiner Schwieter (Maintenance and Construction Manager, in Bramsche), we could establish the fact that packaging for napkins is a complex problem.

After getting a broader understanding of packaging, and all the demands and complications combined with it, an inventory of Duni's existing packages for napkins made. At the inventory Duni's internal databases (the SKU database and GDB) were used, to examine which CU and SKU packages Duni uses for these napkins in Bramsche. The CU packages were then sorted by size (base*height) trying to find SKU's boxes, which could be used for several CU's (with similar base*height) regardless the thickness. All together, there were 64 different CU sizes for napkins made in Bramsche. All the SKU boxes, used for the CU's were then noted and more information about these 67 activated SKU boxes were gathered through further searching in databases at Duni.

To solve the packaging problem at Duni a box management tool, which includes both CAPE PACK and Excel, were developed. The tool helps to identify the filling rate, both on the pallet (external filling rate) and inside (internal filling rate) of the SKU packages, and is an important tool to see if current SKU's can be used when introducing new products during product development. The box management tool can also be used when examining if current SKU's can be exchanged or removed.

To begin with, all the existing SKU boxes were registered in the *Casefill Group* in the CAPE PACK program. Also the module system was included in CAPE PACK, to see if it was applicable for Duni napkins. Please see CAPE PACK manual chapter 1.1 in appendix III.

When all the SKU boxes were registered, the dimensions of all the existing CU packages were entered and simulations were performed. Simulations were done for each CU, both standing up and laying down inside of the box, trying to find the optimal existing SKU box for the CU. In addition, the current market demands (i.e. the number of CU/SKU) were expanded, trying to see if it was possible to attain a better filling rate, by changing the marked demands +/-10 CU/SKU. See CAPE PACK manual chapter 1.2.

When all the simulations were done, the five best SKU boxes (with an internal filling rate above 70 %) were noted, for both the existing and the expanded market demands, both standing up and laying down inside of the box. See Example 1 in appendix II.

To calculate the external filling rate for each unit load, all SKU dimensions were registered in *Pallet Group* in CAPE PACK. See CAPE PACK manual chapter 2.1. The external filling rate for each of the top five SKU boxes were determined, see CAPE PACK manual chapter 2.2, and the total filling rate for each unit load were then calculated, by multiplying the internal and external filling rate in excel.

To get a detailed view of each SKU, the ECT value, number of articles using the box, type of box, type of print, volume annually and space for machine were added. The information regarding the SKU boxes were gathered from the GDB and the SKU databases at Duni.

The Excel sheets acts as basic data for decision-making to examine if existing SKU's can be replaced by boxes with better filling rate. The sheets also facilitate the work of finding SKU boxes, which can be removed from the assortment.

In the section below, a couple of examples which indicates the potential of the box management tool are presented:

Example 1.

The Excel sheet, Example 1, in appendix II shows a 165*165 napkin (with a CU thickness of 55 mm), with six CU/SKU. The napkins are at present packaged in box material nr: 3110062 which give the total filling rate of XX %. If the napkins were packaged in box material nr: 3110105 a total filling rate of XX % would be possible to attain.

Example 2.

The Excel sheet, Example 2, in appendix II shows a 165*165 napkin (with a CU thickness of 50 mm) with 40 CU/SKU. The napkins are at present packaged in box material nr: 3119109 which give the total filling rate of XX %. If it would be possible to change the number of CU/SKU to 32 instead, the napkins could be packaged in box material nr: 3119092 which give a total filling rate of XX %.

Example 3.

The Excel sheet, Example 3, in appendix II shows a 165*165 napkin (with a CU thickness of 25 mm), with five CU/SKU. The sheet shows that five different SKU boxes are used to package CU's with similar dimensions. The filling rate among the boxes varies between XX %. This example shows a case which has a potential of replacing the five different SKU boxes with one universal box.

Example 4.

The Excel sheet, Example 4, in appendix II shows a 207*207 napkin (with a CU thickness of 23 mm). The napkins are at present packaged in the box material nr: 3110252 and 310055 with 12 CU/SKU, which both gives the total filling rate of XX %. The sheet shows that it is possible to fit 14 CU's in the same SKU boxes, which increases the total filling rate to XX %.

Example 5.

The Excel sheet, Example 5, in appendix II shows a 160*160 napkin (with a CU thickness of 90 mm). The example shows how the napkins dimensions sometimes affect the filling rate. Regardless SKU box and expanded market demands, a filling rate above XX % is impossible to attain.

It is important to emphasize, that it is not sure that all the proposed package solution can be carried out. Sometimes the customers have strict requirements regarding the design of the SKU boxes and number of CU/SKU. Though, if the proposed solution means a gained filling rate of e.g. 10 %, the customers might be willing to accept the new packaging solution.

6 Analysis

6.1 Packaging on different levels

6.1.1 Primary packaging

The interviews carried out interpret that Duni has functional and appropriate primary packages for their napkins. Since the packaging is produced of transparent plastic foil, the napkins are exposed for the customers in a satisfying way. The plastic foil protects also the napkins against dirt and to moisture, which is favourable. Although, the inventory of the packages shows that Duni has far too many CU packages at present. The big number CU packages partially depend on the large number of napkin standards and partly because of the variations in the number of napkins per packaging. It might be difficult to change the current napkin standards, but on the other hand it is possible to decrease the number variations of napkins per package. Through decreasing the number of variations regarding pieces per CU, it might be possible to facilitate the work of finding suitable SKU boxes for the CU and doing cost savings in the production, by reducing the set-up times. The variation in raw material, which increases the package complications, is difficult to avoid since the material varies naturally.

6.1.2 Secondary packaging

The large number of CU packages causes an increased number of SKU boxes. With this in mind, Duni maybe should examine if there is a possibility to decrease the number of CU packages and see if it is possible to standardize the print and colour on the boxes, since this also increases the number SKU boxes. This is a sensitive issue for the customers, who often have strict requirements regarding the design of the boxes, but there is a great potential within this area, to decrease the number SKU boxes. If Duni, for example could use labels on unprinted boxes, for their customer specific boxes instead of printing the customers logotype on the boxes, the same box could be used for more than one customer. At present, there are boxes, which Duni only uses for three or fewer articles. Except for all the customer specific boxes, this is the case, since new boxes often are developed for new products, instead of examine if existing boxes can be used. This progress is adverse, since the number of boxes increase in quick rate. By using the developed box management tool, it is possible to reduce the amount of SKU boxes. Although, during the analysis of the SKU boxes, several (23/67) SKU box dimensions in the Group Database at Duni turned out to be incorrect. The incorrect values made it impossible to undoubtedly determine which changes could be done and which SKU boxes could be removed. If the box management tool is used with correct values, it is likely that redundant existing boxes can be removed, which in time automatically leads to a standardization of boxes.

6.1.2.1 Corrugated board

Corrugated board is an appropriate material to use when packing napkins, since the napkins are light and do not expose the SKU for high stresses. Although, corrugated board is a material, which can endure high stresses

with different flute combinations. These qualities make the material suitable during double stacking. Corrugated board also allows logotype and bar-code printing on the box, which is advantageous for Duni's high frequent boxes.

6.1.2.2 ECT

The ECT value is an important factor to secure the stability of the SKU box. If the ECT value is too low, the box might collapse, with an increased risk of product damages as a result. Duni's boxes fulfil the stability demands satisfactory, since the company has few claims regarding damaged boxes. The ECT value is important to consider when examine different boxes in the box management tool.

6.1.3 Tertiary packaging

The shrink film which covers the UL protects the boxes in a pleasing way, since it keeps moisture and dirt away. If the boxes are exposed to moisture, the bearing capacity of the boxes decreases, which probably would increase the number of product damages. The adhesive tape strip, which is used during internal transports, is sufficient to keep boxes fixed on the pallet during internal transports. Shrink film is not needed for internal transports, since the boxes are not exposed to chemical stresses inside of the warehouse. This would only cause extra work and unnecessary waste, by using shrink film internally at the warehouse.

6.1.3.1 Pallets

To reduce the complexity associated with developing standardized packaging solutions, it is important to reduce the number of parameters affecting the solution. The packages can be described as a system with hierarchical levels, whose dimensions are based on a pallet. By reducing the number of pallet standards, this work would be facilitated. On account of this, we suggest Duni to examine if it is possible to set demands on customers, who require deliveries on UK-pallets today, to change their present standard towards to EU-pallets within a five years period for example. Two different pallet standards, causes unnecessary complexity during transports and complicates handling at the production unit in Bramsche.

6.2 Duni packaging functions

6.2.1 The market function

Historically, Duni have not focused much on the design of the SKU boxes, but with increased demands regarding for example shelf ready solutions, the SKU design will attain a more central role. It is rational of Duni by mainly focus on the CU designs today, since this is the package which primarily is exposed for the customers. Since it is the customers on the market, who gives Duni the *raison d'être*, it is important to satisfy the customer requirements. Though, the customers sometimes need guidance to create a win-win situation. By using the box management tool as proposed, we consider this is possible to achieve. See chapter 6.6 for further analysis concerning the market demands

6.2.2 The environmental function

From an environmental view neither the plastic foil, used for the CU packages, or the shrink film, wrapped around the UL, are optimal. Though, these materials are necessary to protect the napkins against chemical stresses. Corrugated board is environmental friendly, since it is produced from recycled news papers and is in addition possible to recycle. Recyclable plastic crates would probably not have been an option, due to the lack of standardization which means a large number of crates to be stored and handled.

By reducing the amount of packaging material and increase the filling rate on the pallet, Duni can affect the environment indirectly. If Duni increases the filling rate, more products can fit onto each pallet and the total amounts of pallets which must be transported and handled are in this way reduced. Duni has come a long way of reducing the packaging material, but the company can still improve the filling rate of the UL's.

6.2.3 The flow functions

6.2.3.1 Facilitate goods handling

The use of unit loads

The German pallet standard, which only is used internally in Bramsche, is difficult to change, since the distribution centre in Bramsche is edified along this standard. Changing the distribution centre in Bramsche would involve large costs, but it would be advantageous moving towards a universal standard (EU standard) since the distribution centre predicts to attain a central role in the future. Besides, a universal standard would facilitate the task of finding optimal filling rate on the pallets, since Duni do not have to adapt the packages to more than one standard. At present, both UK width and German height has to be considered in addition to regular the EU standard.

Despite that the logistic manual at Duni declares that overhang is not allowed, several pallets with overhang have been observed during the Master thesis. Many of the benefits by using unit loads ceases when the pallets are loaded with overhang. However, some of Duni's products must be packed with overhang since they can not be packed in another way, but at too large overhang the company risks to get charged for two pallets instead of one. Within transports space is a vital issue, which means that an e.g. 5 cm's overhang can make it impossible to fit the intended amount of pallets in the mean of transport. In this way the company pays for air, i.e. the pallet spot which not can be used.

When using the box management tool, only solutions without overhang and SKU boxes loaded on EU-pallets are proposed. In this way, problems associated with the above can be avoided for the proposed solutions.

Volume efficiency

At the analysis of the SKU boxes, we have examined the filling rate among the existing packaging solution and calculated the filling rate for alternative solutions. The average external filling rate among the existing packaging solutions is at present XX %, but with the alternative solutions, brought by the box management tool, it would be possible to attain filling rate of XX %, which means a gained filling rate of 10%. However it should be emphasized, that there are aspects which makes it unattainable to implement all of the proposed packaging solutions, since the SKU boxes can be customer specific, must be packed in a certain number or has a too low ECT value. Responsible within each function should be present when making decisions regarding new packaging solutions, based on information gathered from the box management tool.

Consumption adaptation

Today's packaging solutions are well adapted to customer demands, since almost all the customer demands regarding the number of psc/CU and CU/SKU are fulfilled. Although, the customers' large influences concerning the packaging design, often causes negative consequences during packaging, handling and production. This is the case since all different specific customer demands involves new boxes, which means a lack of standardization.

Weight efficiency

The packaging material Duni uses for their products today, are well suited for its purpose. Both corrugated board and plastic foil are light materials which not affect the total weight appreciably and not demand a lot of space. Napkins are by nature light, why they do not demand any strong packages. Although, some of the SKU boxes are big, which makes them ungainly to handle from an ergonomically point of view.

6.2.3.2 Protect the product

Duni's packages protect the products in a satisfying way. The CU packaging made of plastic foil, protects the napkins against moisture and dirt. The SKU packaging made of corrugated board protect the napkins against pressure during stacking and other stresses during handling. The shrink film surrounding the UL, protect the SKU boxes against moisture and keep the SKU's fixated during transports and handling. The product protection of Duni's packages is situated close to the theoretical optimum concerning the amount of packaging material used. See figure 3.2.3.2.

To protect the products against stresses during stacking, it is important that there is air in top of SKU package. In this way the box carries the load itself instead of the napkins, which reduces the risk that the napkins get creased. During the Master thesis no certain book value regarding the minimum amount of air inside of each SKU box has been observed. To avoid insufficient packages, it might be advantageous to state such a book value in the logistic manual. As discussed earlier, in section *the use of unit load*, several pallets with overhang have been observed at Duni. Pallets with overhang increase the risks of product damages during transport and

handling, which further illustrates why this is an important issue. Also under hang affects the packaging in a negative way, since this increase the risks for product damages during double stacking. Too big under hang even makes the pallets impossible to double stack.

6.2.3.3 Identify the product

Duni's labelling of packages is satisfying, since it fulfil all the restrictions regarding labelling. Besides, Duni has also exceeded the restrictions by fulfilling the customer demands regarding labelling on three sides of each CU package. Although, Duni would benefit from taking this further by preparing the introduction of RFID, which soon probably will be the new standard. Apart from making the work easier for the shop assistants, RFID also contributes to facilitate planning, handling and inventory. The costs for introducing RFID are at present to high to justify, but RFID has a big market potential which can be favourable, since it probably will be requested by the customers in the future.

6.3 The logistic system

The examinations which have been carried out to find the optimal location of the distribution centre have showed that the plant in Bramsche is situated close to this optimum. For this reason, an expansion of the plant in Bramsche seems reasonable, since it is situated close to customers, suppliers and modern infrastructure. Increased globalization and centralization verifies the importance of a well functioned enterprise system, which is integrated in all parts of the organization. When Duni's SAP system is entirely integrated in the organization, Duni's planning of production, distribution and material supply will be facilitated.

6.3.1 The distribution system

Duni has come a long way in the logistic thinking concerning distribution channels, centralization of the organization and hub system. The majority of transports are at present delivered on whole pallets to Duni's distribution centres and wholesalers. This way of distributing can closely be resembled as a hub system, while the transports from the wholesalers and distribution centre's mostly are distributed on mixed pallets by so called milk rounds. The large numbers of mixed pallets indicate the importance of a module system, which facilitates mixed loading with other goods at distribution centre's and wholesalers. The increased distribution distances which a globalization and centralization often means, emphasizes the importance of high filling rate and efficient transports. High filling rate is essential, since transport costs represents a big part of the cost associated with a product, particularly for napkins which can be classified as low value goods.

6.3.2 The transport system

The factors, Duni considers when deciding transport system is well thought out as they includes all the conditions which can affect the choice of transports.

6.3.3 The traffic system

Duni has chosen to co-ordinate their transports themselves, since no other supplier can offer a lower price. Outsourcing the logistical activities to a third part is often favourable, since the company can focus on their core competence. A third part logistic company have regularly long experience within the area of logistics, which facilitates to co-ordinate different transports missions and offer overall solutions which level out the imbalances in goods flows and combine different means of transports. Although, by outsourcing all the responsibility to a third part, there is risk to end up in dependence to the supplier.

Duni mainly uses trucks for their transports, which is favourable from a logistical point of view since it is the only mean of transport which can deliver door-to-door. Although, truck transports are inappropriate from an environmental point of view since it contributes to the greenhouse effect. Global factors as increased oil prices and political decisions regarding emission demands, which are topical today, can in the future get large consequences on the prices for truck transports, why the means of transports continuously must be evaluated.

6.4 Module system

Duni have at present no module system neither for napkins or any other products in their assortment. Although, the module system has a great potential since it is suitable for both EU and UK standards, mixed and half pallets and creates pallets with high filling rate and good stability. Because of the napkins fix dimensions (which are not adapted to EU-pallets), the module system is not suitable for this product category. This was shown during the analysis of the module system with the box management tool. On the other hand, Duni would benefit from trying to apply the module system on their remaining assortment (with some exceptions for e.g. plates and table covers, as in likeness to napkins have fixed dimensions).

6.5 Cost aspects

6.5.1 Purchasing

Duni uses a nearby supplier of corrugated board today. In this way the company does not have to keep a large number of SKU boxes in stock. A close supplier also enables quick deliveries at urgent shortage. Although, Duni have a long history of producing napkins and the napkins generally do not have any best before date, which would facilitate the work of predicting the demands at different seasons. This indicates that it might be possible for Duni to use a distant supplier of corrugated board and avoid emergency orders. Although, the transport costs for deliveries from distant suppliers, has turned out to be too expensive to motivate a change of supplier. With a nearby supplier, it might be easier to facilitate the co-operation when developing new SKU boxes.

For boxes which are at present already purchased in large quantities, there is not much of a potential to reduce the purchasing price. Although, a

standardization of SKU boxes would reduce the amount of boxes, which are purchased in small quantities and in this way reduce the total purchasing price for boxes. By using the box management tool, standardization is possible to attain.

6.5.2 Production

It is possible that a standardization of the SKU's will affect the set-up times in the production, since it might be possible to use one SKU for more than one article. Though, a standardization of CU's probably will have a bigger impact on the set-up times than a standardization of the SKU's.

6.5.3 Pricing of transports

Since Duni's carriers charge per pallet spot, it is important that the filling rates of the pallets are as high as possible and that the pallets have no overhang. If the overhang on the pallet is too big there is a risk that the carriers charge for two pallets instead of one, since the pallet makes it impossible to fit intended amount of pallets, which earlier was mentioned in section *the use of unit loads*.

Generally it is essential with a high filling rate within transports. In the long run, the box management tool generates a higher filling rate which provides more efficient transports with reduced amount of emissions as a result. The reduced amount of transports also gets economical consequences, since more products can fit each pallet which means that lesser amount of pallets has to be transported.

6.6 Product development

Duni do not have any actual process for introducing new packages. Duni's present methods of working seem slightly complicated, since the packaging responsible, manually must examine which packages are suitable for the napkins. Duni also satisfies most of the customer demands, without questioning them. By using the box management tool, it is possible to examine if there is existing boxes which can fit more or less the same amount of pcs/CU or CU/SKU, Duni might be able to offer these boxes instead and a win-win situation arises. This is obviously, provided that the amounts of pcs/CU or CU/SKU are not critical for the customer and that the customer can accept another packaging solution. At a situation like this, Duni can use an existing box and with that avoids costs associated with developing a new box, die cutting tool and man-hours, and increase the purchased amount of the existing box. In addition, Duni avoids keeping an additional box in stock. In return, Duni can offer the customer a more favourable price for the napkins. Sometimes, the customer demands a certain number of psc/CU or CU/SKU without any particular reason for it. Certainly, there are cases where the number of pcs/CU or CU/SKU is critical e.g. in grocery stores where the packages must fit the shop shelves. But for e.g. hotels on the other hand, where the customer rarely are in contact with the packages, the number is not always that important.

The large number of different napkin standards makes it difficult for the product development to design superior packaging solutions. Although, it

would be convenient to thoroughly examine if the different napkin standards are that sensitive for the customer. Maybe it would be advantageous for Duni to establish where the different standards have their origin. Divergent answers concerning these questions have been received during interviews in the Master thesis, which indicates that this is slightly unclear. By adjusting the dimensions of the present napkins, there is a great potential to reducing the costs, particularly costs associated with transports and handling. If it turns out that the napkin standards are that sensitive as it is to be feared, it is important for Duni to consider their actions, regarding changing standards or not. If the standards are a sensitive issue for the customers, Duni risks to lose important customers by an alteration.

It is obvious that it can be difficult to change already established standards, in a late phase. See figure 6.6. Duni are situated to the left side in the figure and needs to move towards the right side to be able to reduce the number of SKU boxes. This can be sensitive from the market function, since the customers are used to get their requirements satisfied, but necessary for the production function, to keep the production costs down.

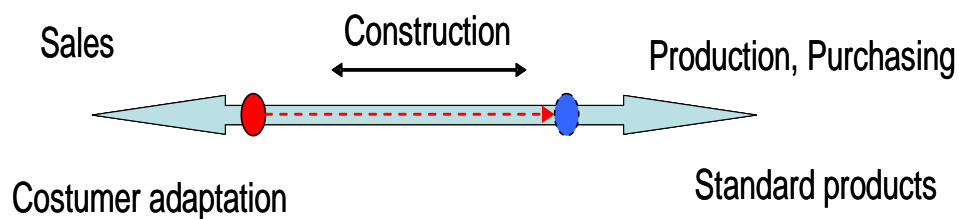


Figure 6.6 Scale over Duni's degree of customer adaptation²¹⁹, modified by the authors

Duni is a large actor within the napkin industry, who reasonably would be able to lead the market and set new standards, affect the customer demands and in this way obtain new customers. One example of this is the 40 cm's napkin. Several employees at Duni are aware that the company probably must change this napkin to 38,5 cm in order to attain high filling rate and avoid overhang, but this will first occur when the customer requires it. By examine the possibilities of being the first producer to deliver this dimension, Duni has a great potential of conquer new customers and convincing existing customers of the 38,5 cm's advantages. Though, except for the risks of losing existing customers, changing to a new standard is combined with high adjustment costs in the factory. Therefore, this is something which must be carried out in the long run, e.g. in liaison with when old machines must be replaced with new ones.

²¹⁹ Aniander M. et. Al, *Industriell ekonomi*, 1998, p. 44

The packaging function is involved at an early phase of the product development at Duni today. This makes it easier to adapt the packages to all demands from the different functions in the organization. The shelf-ready solution, which was a result from a cross functional collaboration driven by the packaging function, is favorable from a market point of view, since it exposes the products well and facilitates the work for the shop assistants. Although, from a logistical point of view, the shelf-ready solution has not been able to get optimized completely because of the dimensions on e.g. the 40 cm's napkin, which still must be loaded with a certain overhang.

7 Conclusions

Duni's choices of packaging materials are well suitable for its purpose. The packaging materials used for the CU's and SKU's complement each other and protect the products from all the stresses, both thermal and chemical, the products are exposed to in the supply chain. The labelling of Duni's packages are satisfying, since it fulfil all present restrictions regarding labelling. Duni has also exceeded the restrictions by fulfilling the customer demands regarding labelling on three sides, instead of one, of each CU package. Though, it is noticeable that there exist so many different variations of CU's and SKU's. During the inventory of packages at Duni, several CU packages which contain similar numbers of pcs/CU have been observed. These variations affect the numbers of SKU boxes, since they render it more difficult to attain standardization. Except for all the different CU sizes, the big number of SKU boxes can partly be explained by all the different CU sizes which demands different SKU sizes, customer demands regarding the number of CU/SKU, the box design and stability demands (different ECT values).

Trying to decrease the number of SKU boxes and in this way create a standardized SKU boxes, a box management tool have been developed. The box management tool includes both CAPE PACK, which is software for pallet utilization, and Excel. The tool helps to identify the filling rate, both on the pallet (external filling rate) and inside of the SKU (internal filling rate), and is an important tool to see if current SKU's can be used when introducing new products during product development. The box management tool can also be used when examining if current SKU's can be exchanged or removed. By using the box management tool, it is possible to visualize how a possible adjustment of the current market demands affects the choice of SKU package and their filling rate.

Since the packaging problem is very complex and the information regarding the box dimensions in Duni's database many times were incorrect, no proposals regarding which boxes should be removed or which boxes should be exchanges have been possible to propose. To make this achievable, the box management tool must be updated with correct information about the SKU dimensions. Because there are many factors affecting the choice of packaging solution (SKU), it is appropriate for responsible people, within each function concerned, to be present when making decisions regarding packaging solutions. With correct values, there is a good potential, by using the box management tool, to decrease the number of SKU boxes and examine if a possible change of the number of CU's per SKU can be motivated.

The box management tool can be used during new product development, to see if existing SKU boxes can be used for new products. In this way the box management tool helps to maintain a limitation of the SKU boxes. By using the box management tool during new product development, it is possible to decrease the costs associated with developing new die cutting tools, since existing SKU boxes are used instead of developing new ones. Gradually, the

box management tool will decrease the purchasing price, as the numbers of SKU's are reduced and the remaining, standardized boxes, can be bought in larger quantities. It is possible that a standardization of the SKU's also affect the set-up times in the production, since it might be possible to use one SKU for more than one article. Although, a standardization of CU's probably have a bigger impact on the set-up times.

The module system has a great potential since it is suitable for both EU and UK standards, mixed and half pallets and creates pallets with high filling rate and good stability. Because of the fixed dimensions of the napkins, which are not adapted to EU-pallets, the module system showed not to be suitable for this product category. This was shown during the analysis of the top five solutions in the box management tool, where the module system only was represented as a possible solution a few times. Although, the module system might be appropriate for Duni's remaining assortment (with some exceptions for e.g. plates and table covers, as in likeness to napkins have fixed dimensions).

The average external filling rate among Duni's existing unit loads is at present XX %, but with our alternative solutions, it would be possible to attain filling rate of XX % which gain the filling rate on a pallet with 10 %. If Duni increases the filling rate, more products can fit onto each pallet and the total amounts of pallets which must be transported and handled are in this way reduced. For Duni, who mainly uses trucks for transports, a high filling rate is essential from an environmental point of view. Increased oil prices and stricter demands regarding emissions, illustrates this further. A high filling rate also have large economical consequences, since the cost associated with transports represents a big part of the total price of the napkins. Except for the filling rate, Duni has come a long way in the logistic thinking concerning distribution channels, centralization of the organization and hub system.

Examinations have shown that the plant in Bramsche, is strategic located in the centre of Europe. The plant is situated close to the customers, suppliers and modern infrastructure. Since the distribution centre in Bramsche are predicted to obtain a central role in the future, it might be advantageous for Duni striving to move towards a universal unit load standard (EU standard), instead of the three different unit load standards used today. The box management tool is adapted to the EU standard, but can also be adjusted to the other standards. The CAPE PACK manual together with the box management tool, are supposed to be used as guidelines during new product development and are important tools to keep a limitation SKU boxes and pallet variants.

Duni have realized the importance of packaging, since the packaging function nowadays is involved at an early phase of the product development and more resources intended for the packaging. By using the box management tool, it is possible for Duni to take a further step in their progress of making suitable packaging for napkins.

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8.1.1 Internal literature

The logistic manual.

8.2 Electronically sources

<http://www.ecr.se>

<http://www.fefco.org/>

<http://www.tis-gdv.de>

8.3 Personal communication

Everth Larsson, Doctor Technical Logistics.

Frank Beinke -Packaging responsible, Bramsche.

Heiner Schwietert -Maintenance & Construction Manager, Bramsche.

Horst Finke -Logistic Manager, Bramsche.

Jenny Klevås -Packaging responsible, Malmö.

Mannfred Meuser -Sales Director Central / Professional, Bramsche.

Matthias Stuckmann -Procurement Manager, Bramsche.

Reinhold Röchembacher -Product Developer, Bramsche.

Thomas Lööb -Product Developer, Malmö.

Appendix II. Examples

Example 1.

Artikel group	CU Height	Packaging alt.	Topp 5 SKU boxes						
			1	2	3	4	5		
A-33cm mply (165*165) e.g Art No 136935	55	Laying down	Market demands fulfilled:						
			Box material nr:	3110105	3120248	3110134	3110062	3210044	
			Box information:	xxx	xxx	xxx	xxx	xxx	
			Type of box:	xxx	xxx	xxx	xxx	xxx	
			Type of print:	xxx	xxx	xxx	xxx	xxx	
			ECT	xxx	xxx	xxx	xxx	xxx	
			Max weight (gram)	xxx	xxx	xxx	xxx	xxx	
			Articles/box	xxx	xxx	xxx	xxx	xxx	
			Volume/Annually	xxx	xxx	xxx	xxx	xxx	
			Machine						
			CU/SKU:	xxx	xxx	xxx	xxx	xxx	
			SKU/UL	xxx	xxx	xxx	xxx	xxx	
			CU/UL	xxx	xxx	xxx	xxx	xxx	
			Filling rate (>70%)	intern (inside box):	xxx	xxx	xxx	xxx	xxx
				extern (pallet):	xxx	xxx	xxx	xxx	xxx
			Total:	xxx	xxx	xxx	xxx	xxx	
			Best Choice:						
			Commentary:						
			Standing up	Box material nr:	3110105	3120248	3110134	3110062	3210044
				Box information:	xxx	xxx	xxx	xxx	xxx
		Type of box:		xxx	xxx	xxx	xxx	xxx	
		Type of print:		xxx	xxx	xxx	xxx	xxx	
		ECT		xxx	xxx	xxx	xxx	xxx	
		Max weight (gram)		xxx	xxx	xxx	xxx	xxx	
		Articles/box		xxx	xxx	xxx	xxx	xxx	
		Volume/Annually		xxx	xxx	xxx	xxx	xxx	
		Machine							
		CU/SKU		xxx	xxx	xxx	xxx	xxx	
		SKU/UL		xxx	xxx	xxx	xxx	xxx	
		CU/UL		xxx	xxx	xxx	xxx	xxx	
		Filling rate (>70%)		intern (inside box):	xxx	xxx	xxx	xxx	xxx
				extern (pallet):	xxx	xxx	xxx	xxx	xxx
		Total:		xxx	xxx	xxx	xxx	xxx	
		Best Choice:							
		Commentary:							
		Laying down		Market demands --10:					
				Box material nr:	3110105	3120248	3110087	3110134	3110062
				Box information:	xxx	xxx	xxx	xxx	xxx
			Type of box:	xxx	xxx	xxx	xxx	xxx	
			Type of print:	xxx	xxx	xxx	xxx	xxx	
			ECT	xxx	xxx	xxx	xxx	xxx	
			Max weight (gram)	xxx	xxx	xxx	xxx	xxx	
			Articles/box	xxx	xxx	xxx	xxx	xxx	
			Volume/Annually	xxx	xxx	xxx	xxx	xxx	
			Machine						
			CU/SKU	xxx	xxx	xxx	xxx	xxx	
			SKU/UL	xxx	xxx	xxx	xxx	xxx	
			CU/UL	xxx	xxx	xxx	xxx	xxx	
			Filling rate (>70%)	intern (inside box):	xxx	xxx	xxx	xxx	xxx
				extern (pallet):	xxx	xxx	xxx	xxx	xxx
			Total:	xxx	xxx	xxx	xxx	xxx	
			Best Choice:						
			Commentary:						
			Standing up	Box material nr:	3110015	3110143	3110105	3110134	3110062
				Box information:	xxx	xxx	xxx	xxx	xxx
		Type of box:		xxx	xxx	xxx	xxx	xxx	
		Type of print:		xxx	xxx	xxx	xxx	xxx	
		ECT		xxx	xxx	xxx	xxx	xxx	
		Max weight (gram)		xxx	xxx	xxx	xxx	xxx	
		Articles/box		xxx	xxx	xxx	xxx	xxx	
		Volume/Annually		xxx	xxx	xxx	xxx	xxx	
		Machine							
		CU/SKU		xxx	xxx	xxx	xxx	xxx	
		SKU/UL		xxx	xxx	xxx	xxx	xxx	
		CU/UL		xxx	xxx	xxx	xxx	xxx	
		Filling rate (>70%)		intern (inside box):	xxx	xxx	xxx	xxx	xxx
				extern (pallet):	xxx	xxx	xxx	xxx	xxx
		Total:		xxx	xxx	xxx	xxx	xxx	
		Best Choice:							
		Commentary:							

Example 2.

Artikel group	CU Height	Packaging alt.	Topp 5 SKU boxes						
			1	2	3	4	5		
A-33cm mply (165*165) e.g Art No 340106	50	Laying down	Market demands fulfilled:						
			Box material nr:	3110056	3119027				
			Box information:	xxx	xxx	xxx	xxx	xxx	
			Type of box:	xxx	xxx	xxx	xxx	xxx	
			Type of print:	xxx	xxx	xxx	xxx	xxx	
			ECT	xxx	xxx	xxx	xxx	xxx	
			Max weight (gram)	xxx	xxx	xxx	xxx	xxx	
			Articles/box	xxx	xxx	xxx	xxx	xxx	
			Volume/Annually	xxx	xxx	xxx	xxx	xxx	
			Machine	xxx	xxx	xxx	xxx	xxx	
			CU/SKU:	xxx	xxx	xxx	xxx	xxx	
			SKU/UL	xxx	xxx	xxx	xxx	xxx	
			CU/UL	xxx	xxx	xxx	xxx	xxx	
			Filling rate (>70%)	intern (inside box):	xxx	xxx	xxx	xxx	
				extern (pallet):	xxx	xxx	xxx	xxx	
				Total:	xxx	xxx	xxx	xxx	
			Best Choice:						
			Commentary:						
			Standing up	Box material nr:	3110001	3110010	3119109	3110145	3110027
				Box information:	xxx	xxx	xxx	xxx	xxx
		Type of box:		xxx	xxx	xxx	xxx	xxx	
		Type of print:		xxx	xxx	xxx	xxx	xxx	
		ECT		xxx	xxx	xxx	xxx	xxx	
		Max weight (gram)		xxx	xxx	xxx	xxx	xxx	
		Articles/box		xxx	xxx	xxx	xxx	xxx	
		Volume/Annually		xxx	xxx	xxx	xxx	xxx	
		Machine		xxx	xxx	xxx	xxx	xxx	
		CU/SKU:		xxx	xxx	xxx	xxx	xxx	
		SKU/UL		xxx	xxx	xxx	xxx	xxx	
		CU/UL		xxx	xxx	xxx	xxx	xxx	
		Filling rate (>70%)		intern (inside box):	xxx	xxx	xxx	xxx	
				extern (pallet):	xxx	xxx	xxx	xxx	
				Total:	xxx	xxx	xxx	xxx	
		Best Choice:							
		Commentary:							
		Laying down		Market demands +-10:					
				Box material nr:	3119109	3110056	3119077	3110027	3110037
				Box information:	xxx	xxx	xxx	xxx	xxx
			Type of box:	xxx	xxx	xxx	xxx	xxx	
			Type of print:	xxx	xxx	xxx	xxx	xxx	
			ECT	xxx	xxx	xxx	xxx	xxx	
			Max weight (gram)	xxx	xxx	xxx	xxx	xxx	
			Articles/box	xxx	xxx	xxx	xxx	xxx	
			Volume/Annually	xxx	xxx	xxx	xxx	xxx	
			Machine	xxx	xxx	xxx	xxx	xxx	
			CU/SKU:	xxx	xxx	xxx	xxx	xxx	
			SKU/UL	xxx	xxx	xxx	xxx	xxx	
			CU/UL	xxx	xxx	xxx	xxx	xxx	
			Filling rate (>70%)	intern(inside box):	xxx	xxx	xxx	xxx	
				extern (pallet):	xxx	xxx	xxx	xxx	
				Total:	xxx	xxx	xxx	xxx	
			Best Choice:						
			Commentary:						
			Standing up	Box material nr:	3110010	3110001	3110121	3110138	3119092
				Box information:	xxx	xxx	xxx	xxx	xxx
		Type of box:		xxx	xxx	xxx	xxx	xxx	
		Type of print:		xxx	xxx	xxx	xxx	xxx	
		ECT		xxx	xxx	xxx	xxx	xxx	
		Max weight (gram)		xxx	xxx	xxx	xxx	xxx	
		Articles/box		xxx	xxx	xxx	xxx	xxx	
		Volume/Annually		xxx	xxx	xxx	xxx	xxx	
		Machine		xxx	xxx	xxx	xxx	xxx	
		CU/SKU:		xxx	xxx	xxx	xxx	xxx	
		SKU/UL		xxx	xxx	xxx	xxx	xxx	
		CU/UL		xxx	xxx	xxx	xxx	xxx	
		Filling rate (>70%)		intern (inside box):	xxx	xxx	xxx	xxx	
				extern (pallet):	xxx	xxx	xxx	xxx	
				Total:	xxx	xxx	xxx	xxx	
		Best Choice:							

Example 3.

Artikel group	CU Height	Packaging alt.	Topp 5 SKU boxes					
			1	2	3	4	5	
A-33cm mply (165*165) e.g Art No 148646	25	Laying down	Market demands fulfilled:					
			Box material nr:	3110105	3120248	3110134		
			Box information:	xxx	xxx	xxx		
			Type of box:	xxx	xxx	xxx		
			Type of print:	xxx	xxx	xxx		
			ECT	xxx	xxx	xxx		
			Max weight (gram)	xxx	xxx	xxx		
			Articles/box	xxx	xxx	xxx		
			Volume/Annually	xxx	xxx	xxx		
			Machine	xxx	xxx	xxx		
			CU/SKU:	xxx	xxx	xxx		
			SKU/UL	xxx	xxx	xxx		
			CU/UL	xxx	xxx	xxx		
			Filling rate (>70%)	intern (inside box):	xxx	xxx	xxx	
				extern (pallet):	xxx	xxx	xxx	
				Totall:	xxx	xxx	xxx	
			Best Choice:	xxx	xxx	xxx		
			Commentary:					
			Box material nr:	3110090	3110071	3110034	3110031	3110115
			Box information:	xxx	xxx	xxx	xxx	xxx
			Type of box:	xxx	xxx	xxx	xxx	xxx
			Type of print:	xxx	xxx	xxx	xxx	xxx
			ECT	xxx	xxx	xxx	xxx	xxx
			Max weight (gram)	xxx	xxx	xxx	xxx	xxx
			Articles/box	xxx	xxx	xxx	xxx	xxx
			Volume/Annually	xxx	xxx	xxx	xxx	xxx
			Machine	xxx	xxx	xxx	xxx	xxx
			CU/SKU:	xxx	xxx	xxx	xxx	xxx
			SKU/UL	xxx	xxx	xxx	xxx	xxx
			CU/UL	xxx	xxx	xxx	xxx	xxx
			Filling rate (>70%)	intern (inside box):	xxx	xxx	xxx	xxx
				extern (pallet):	xxx	xxx	xxx	xxx
				Totall:	xxx	xxx	xxx	xxx
			Best Choice:	xxx	xxx	xxx	xxx	xxx
			Commentary:					
			Market demands +-10:					
			Box material nr:	3110105	3120248	3110134		
			Box information:	xxx	xxx	xxx		
			Type of box:	xxx	xxx	xxx		
			Type of print:	xxx	xxx	xxx		
			ECT	xxx	xxx	xxx		
			Max weight (gram)	xxx	xxx	xxx		
			Articles/box	xxx	xxx	xxx		
			Volume/Annually	xxx	xxx	xxx		
			Machine	xxx	xxx	xxx		
			CU/SKU:	xxx	xxx	xxx		
			SKU/UL	xxx	xxx	xxx		
			CU/UL	xxx	xxx	xxx		
			Filling rate (>70%)	intern (inside box):	xxx	xxx	xxx	
				extern (pallet):	xxx	xxx	xxx	
			Totall:	xxx	xxx	xxx		
		Best Choice:	xxx	xxx	xxx			
		Commentary:						
		Box material nr:	3110143	3110034	3110015	3110134	3110062	
		Box information:	xxx	xxx	xxx	xxx	xxx	
		Type of box:	xxx	xxx	xxx	xxx	xxx	
		Type of print:	xxx	xxx	xxx	xxx	xxx	
		ECT	xxx	xxx	xxx	xxx	xxx	
		Max weight (gram)	xxx	xxx	xxx	xxx	xxx	
		Articles/box	xxx	xxx	xxx	xxx	xxx	
		Volume/Annually	xxx	xxx	xxx	xxx	xxx	
		Machine	xxx	xxx	xxx	xxx	xxx	
		CU/SKU:	xxx	xxx	xxx	xxx	xxx	
		SKU/UL	xxx	xxx	xxx	xxx	xxx	
		CU/UL	xxx	xxx	xxx	xxx	xxx	
		Filling rate (>70%)	intern (inside box):	xxx	xxx	xxx	xxx	
			extern (pallet):	xxx	xxx	xxx	xxx	
			Totall:	xxx	xxx	xxx	xxx	
		Best Choice:	xxx	xxx	xxx	xxx	xxx	

Example 4.

Artikel group	CU Height	Packaging alt.	Topp 5 SKU boxes					
			1	2	3	4	5	
A: 33cm mply (207*207) e.g Art No 150715, 142729, 148076	23	Laying down	Market demands fulfilled:					
			Box material nr:					
			Box information:					
			Type of box:					
			Type of print:					
			ECT					
			Max weight (gram)					
			Articles/box					
			Volume/Annually					
			Machine					
			CU/SKU:					
			SKU/UL					
			CU/UL					
			Filling rate (>70%)	intern (inside box):				
				extern (pallet):				
				Totalt:				
			Best Choice:					
			Commentary:					
			Standing up	Box material nr:	3110252	3110055		
				Box information:	xxx	xxx		
				Type of box:	xxx	xxx		
				Type of print:	xxx	xxx		
				ECT	xxx	xxx		
				Max weight (gram)	xxx	xxx		
				Articles/box	xxx	xxx		
				Volume/Annually	xxx	xxx		
				Machine				
				CU/SKU	xxx	xxx		
				SKU/UL	xxx	xxx		
				CU/UL	xxx	xxx		
		Filling rate (>70%)		intern (inside box):	xxx	xxx		
				extern (pallet):	xxx	xxx		
				Totalt:	xxx	xxx		
		Best Choice:						
		Commentary:						
		Laying down		Market demands +-10:				
				Box material nr:	3110503	3119021		
				Box information:	xxx	xxx		
				Type of box:	xxx	xxx		
				Type of print:	xxx	xxx		
				ECT	xxx	xxx		
				Max weight (gram)	xxx	xxx		
				Articles/box	xxx	xxx		
				Volume/Annually	xxx	xxx		
				Machine				
				CU/SKU	xxx	xxx		
				SKU/UL	xxx	xxx		
				CU/UL	xxx	xxx		
			Filling rate (>70%)	intern (inside box):	xxx	xxx		
				extern (pallet):	xxx	xxx		
				Totalt:	xxx	xxx		
			Best Choice:					
			Commentary:					
			Standing up	Box material nr:	3110503	3110252	3110055	
				Box information:	xxx	xxx	xxx	
				Type of box:	xxx	xxx	xxx	
				Type of print:	xxx	xxx	xxx	
				ECT	xxx	xxx	xxx	
				Max weight (gram)	xxx	xxx	xxx	
				Articles/box	xxx	xxx	xxx	
				Volume/Annually	xxx	xxx	xxx	
				Machine				
				CU/SKU	xxx	xxx	xxx	
				SKU/UL	xxx	xxx	xxx	
				CU/UL	xxx	xxx	xxx	
		Filling rate (>70%)		intern (inside box):	xxx	xxx	xxx	
				extern (pallet):	xxx	xxx	xxx	
				Totalt:	xxx	xxx	xxx	
		Best Choice:						

Example 5.

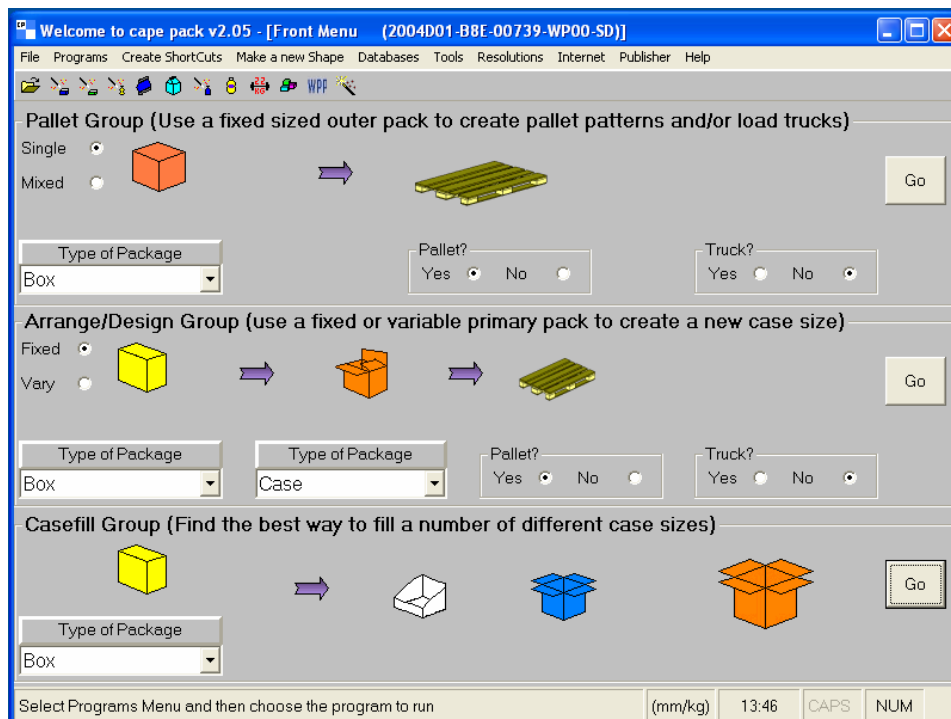
Artikel group	CU Height	Packaging alt.	Topp 5 SKU boxes					
			1	2	3	4	5	
A-33cm mply (160*160) e.g Art No 150969	90	Laying down	Market demands fulfilled:					
			Box material nr:					
			Box information:					
			Type of box:					
			Type of print:					
			ECT					
			Max weight (gram)					
			Articles/box					
			Volume/Annually					
			Machine					
			CU/SKU					
			SKU/UL					
			CU/UL					
			Filling rate (>70%)	intern (inside box):				
				extern (pallet):				
				Total:				
			Best Choice:					
			Commentary:					
			Standing up	Box material nr	3119038	3110001	3110010	3119109
				Box information:	xxx	xxx	xxx	xxx
		Type of box:		xxx	xxx	xxx	xxx	
		Type of print:		xxx	xxx	xxx	xxx	
		ECT		xxx	xxx	xxx	xxx	
		Max weight (gram)		xxx	xxx	xxx	xxx	
		Articles/box		xxx	xxx	xxx	xxx	
		Volume/Annually		xxx	xxx	xxx	xxx	
		Machine						
		CU/SKU		xxx	xxx	xxx	xxx	
		SKU/UL		xxx	xxx	xxx	xxx	
		CU/UL		xxx	xxx	xxx	xxx	
		Filling rate (>70%)		intern (inside box):	xxx	xxx	xxx	
				extern (pallet):	xxx	xxx	xxx	
				Total:	xxx	xxx	xxx	
		Best Choice:						
		Commentary:						
		Laying down		Market demands +-10:				
				Box material nr	3119086	3119027	3119209	3119019
				Box information:	xxx	xxx	xxx	xxx
			Type of box:	xxx	xxx	xxx	xxx	
			Type of print:	xxx	xxx	xxx	xxx	
			ECT	xxx	xxx	xxx	xxx	
			Max weight (gram)	xxx	xxx	xxx	xxx	
			Articles/box	xxx	xxx	xxx	xxx	
			Volume/Annually	xxx	xxx	xxx	xxx	
			Machine					
			CU/SKU	xxx	xxx	xxx	xxx	
			SKU/UL	xxx	xxx	xxx	xxx	
			CU/UL	xxx	xxx	xxx	xxx	
			Filling rate (>70%)	intern(inside box):	xxx	xxx	xxx	
				extern (pallet):	xxx	xxx	xxx	
				Total:	xxx	xxx	xxx	
			Best Choice:					
			Commentary:					
			Standing up	Box material nr	3119038	3110010	3119013	3110113
				Box information:	xxx	xxx	xxx	xxx
		Type of box:		xxx	xxx	xxx	xxx	
		Type of print:		xxx	xxx	xxx	xxx	
		ECT		xxx	xxx	xxx	xxx	
		Max weight (gram)		xxx	xxx	xxx	xxx	
		Articles/box		xxx	xxx	xxx	xxx	
		Volume/Annually		xxx	xxx	xxx	xxx	
		Machine						
		CU/SKU		xxx	xxx	xxx	xxx	
		SKU/UL		xxx	xxx	xxx	xxx	
		CU/UL		xxx	xxx	xxx	xxx	
		Filling rate (>70%)		intern (inside box):	xxx	xxx	xxx	
				extern (pallet):	xxx	xxx	xxx	
				Total:	xxx	xxx	xxx	
		Best Choice:						
		Commentary:						

Appendix III. CAPE PACK manual

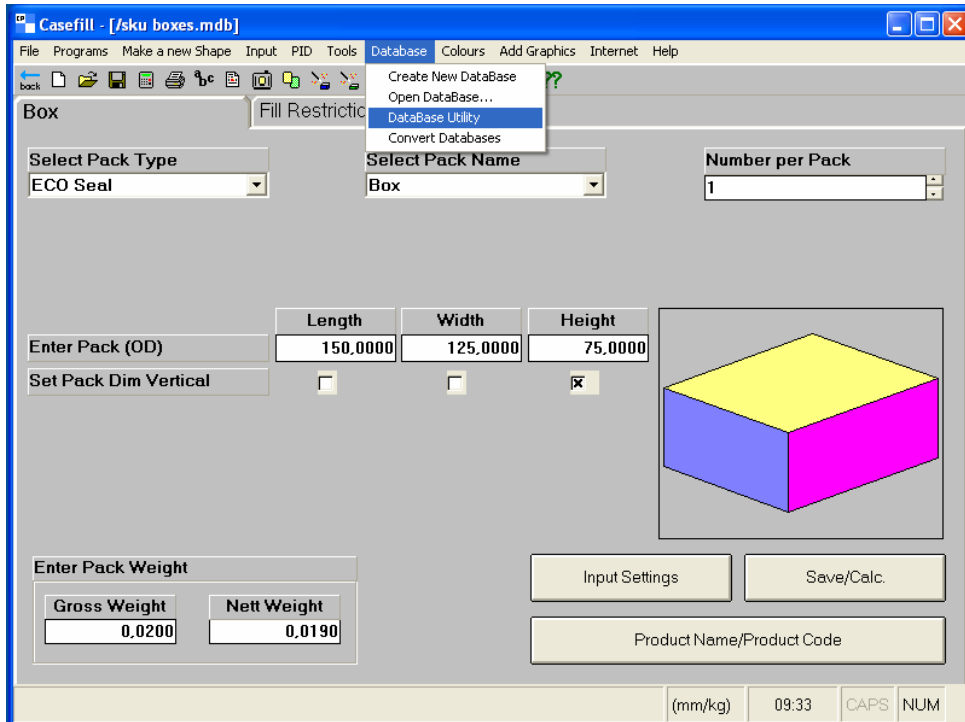
Casefill Group (Find the best way to fill a number of different case sizes)

Within **Casefill Group** it is possible to add SKU boxes, including name (box material number) and dimensions (inbound and outbound). By specifying the dimensions of the CU, the best suitable SKU boxes (with the best internal filling rate) will be shown.

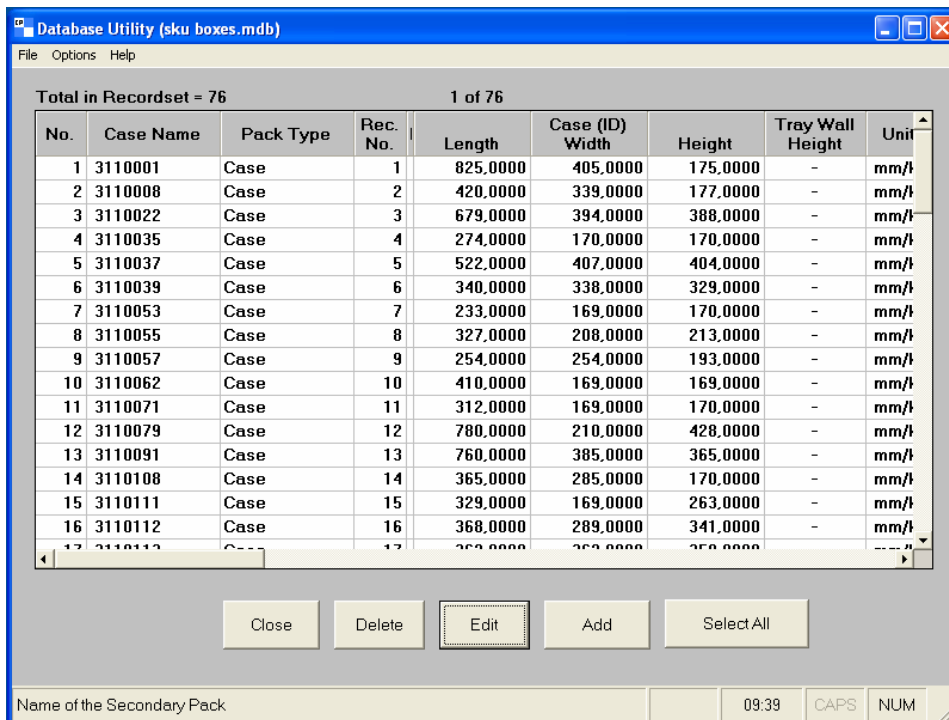
Add, delete or edit boxes in the program
In the start menu, choose **Go** in **Casefill Group**.



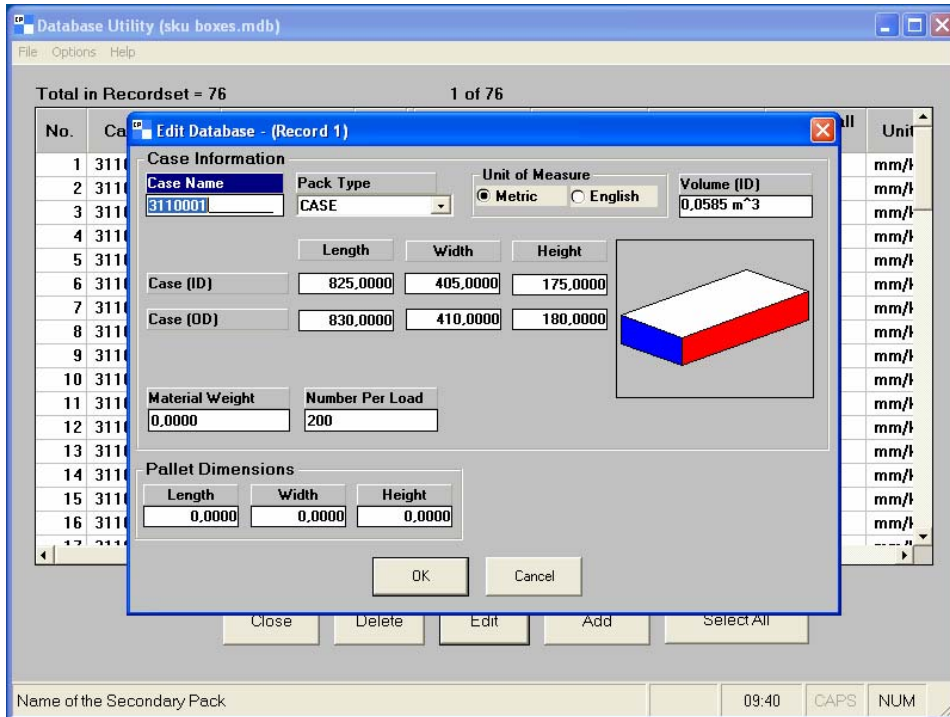
Choose **DataBase Utility** in the **DataBase** menu and create a file for all the SKU's (In our case this file is named *SKU boxes*).



In the **DataBase Utility** window enter **Add** to add a new SKU box. If an already existing box should be changed or deleted, mark the box and press **Edit** or **Delete**.



The picture below shows an example how the **Edit** or **Add Database** window looks like. The inbound dimensions are entered in **Case (ID)** and the outbound in **Case (OD)**. In **Case Name** it is possible to enter the box material number. When all information is added, press **OK** in the **Edit** or **Add Database** window, followed by **Close** in the **Database Utility** window.



Find the best package for the CU's among the available SKU's.

In the **Casefill** window, enter the outbound dimensions of the CU package. Decide whether the CU's should be standing up or laying down inside of the SKU, by ticking in squares in the **Set Pack Dim Vertical**.

Casefill - [Data Input]

File Programs Make a new Shape Input PID Tools Database Colours Add Graphics Internet Help

back

Box Fill Restrictions

Select Pack Type: ECO Seal

Select Pack Name: Box

Number per Pack: 1

Enter Pack (OD): Length 165, Width 165, Height 25

Set Pack Dim Vertical:

Enter Pack Weight: Gross Weight 0.0200, Nett Weight 0.0190

Input Settings Save/Calc.

Product Name/Product Code

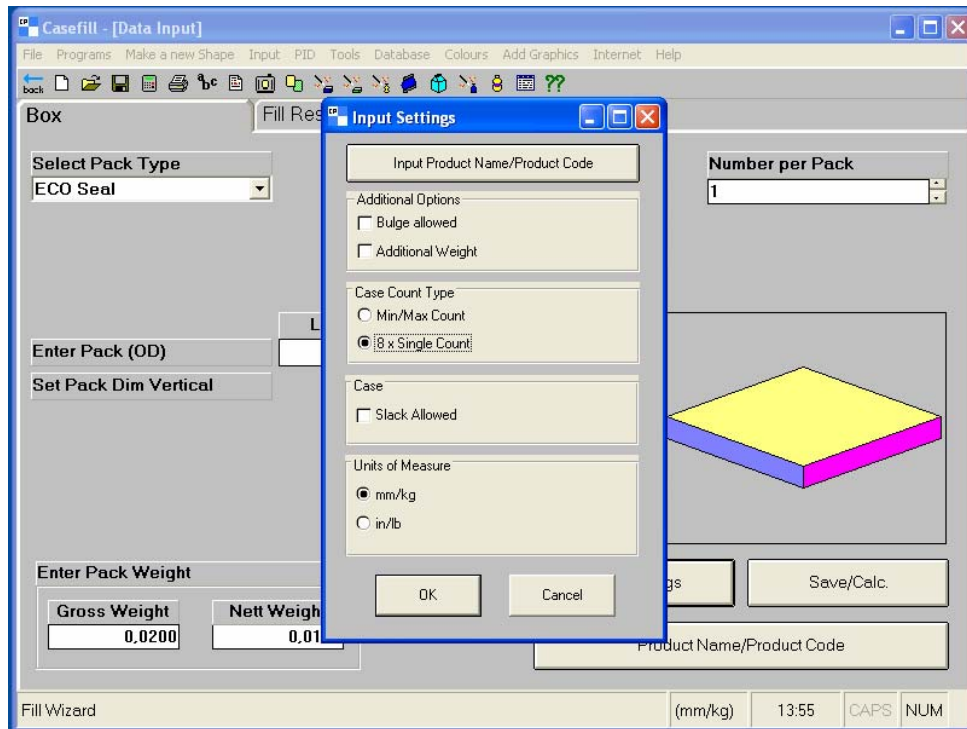
Enter Height of Outside Dimension: (mm/kg) 13:48 CAPS NUM

Packaging restrictions

To add packaging restrictions press the **Input Settings** button. In **Case Count Type** it is possible to choose fixed numbers of CU's/SKU by choosing **8 x Single Count** or to let the number of CU's/SKU hover between two values, by choosing **Min/Max Count**.

Fixed value/values of CU's/SKU

Choose **8 x Single Count** in the **Input Settings** window.



In **Primary Packs per Case** it is possible to enter one up to eight fixed values for the number of CU/SKU. In **Min. Fill Efficiency** the minimum accepted internal filling rate can be entered.

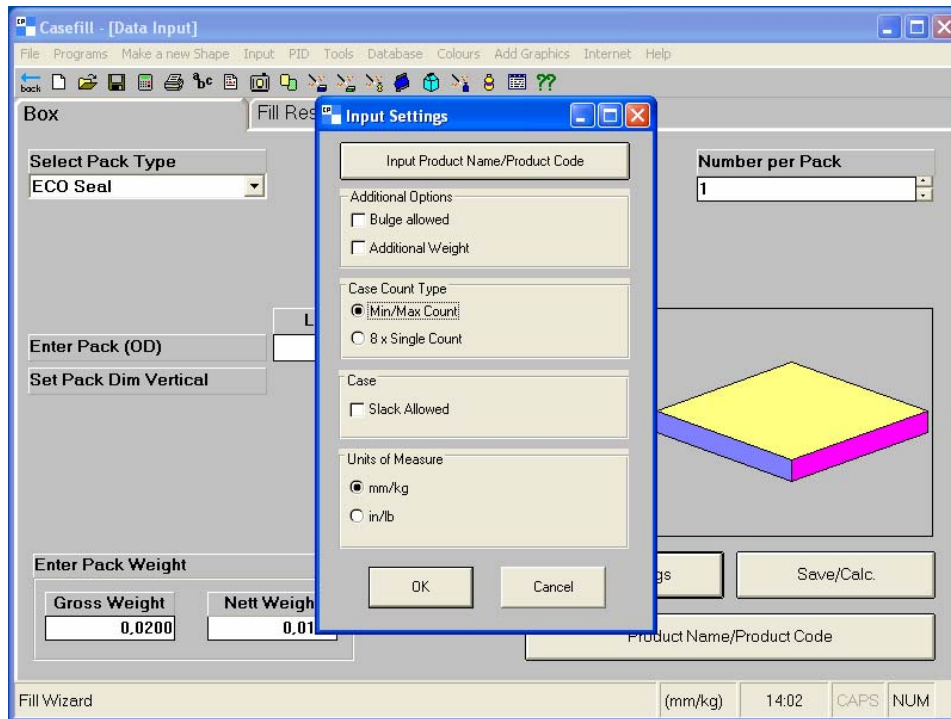
The screenshot shows the 'Casefill - [Data Input]' software window. The interface is divided into several sections:

- Enter Case Restrictions:**
 - Maximum Case Weight:** 50,0000
 - Select Pattern Types To Use:** Simple, Medium, Complex
 - Enter Primary Pack Per Case Count Target:** A row of input boxes with values: 56, 0, 0, 0, 0, 0, 0, 0.
 - Min. Fill Efficiency:** 70%
- No Database selected:** A dropdown menu set to 'All Records'.
- Calculating Using All Records:** A status message.
- Enter Palletising Details:**
 - Select Pallet Size:** All, Select
 - Allow Multi-Dimensional Solutions:**
 - Allow Maximizer Solutions:**
 - Pallet Footprint:** Length: 1200,0000; Width: 1000,0000

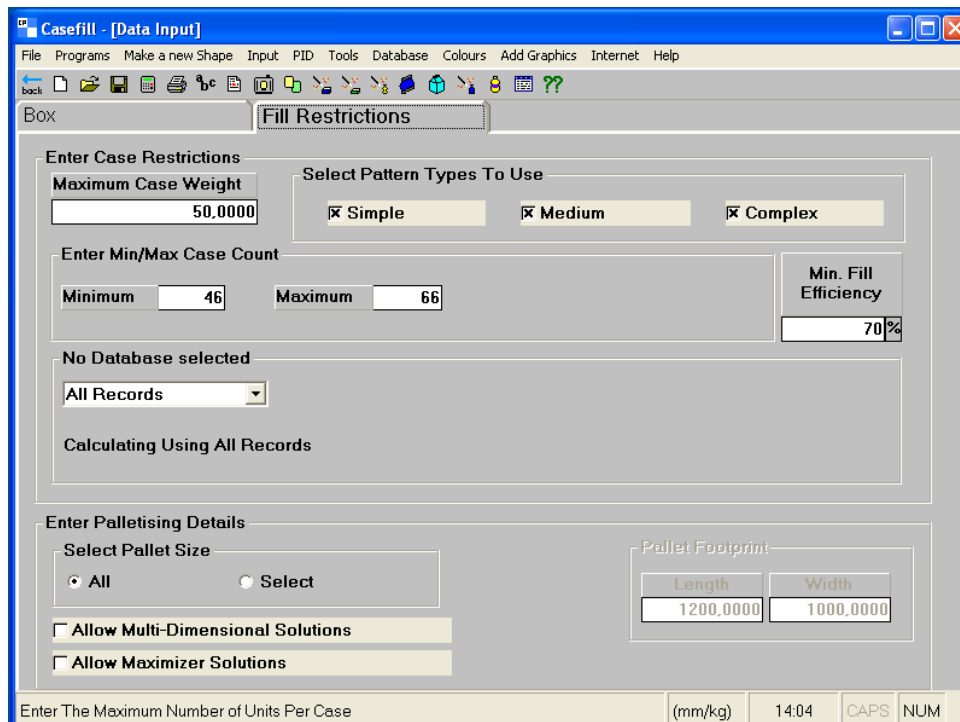
At the bottom of the window, there is a status bar with the text: 'Will Only Display Specified Primary Packs With The Number Per Case Entered' followed by '(mm/kg) 13:58 CAPS NUM'.

Min/Max count of CU/SKU

Choose **Min/Max Count** in the **Input Settings** window.

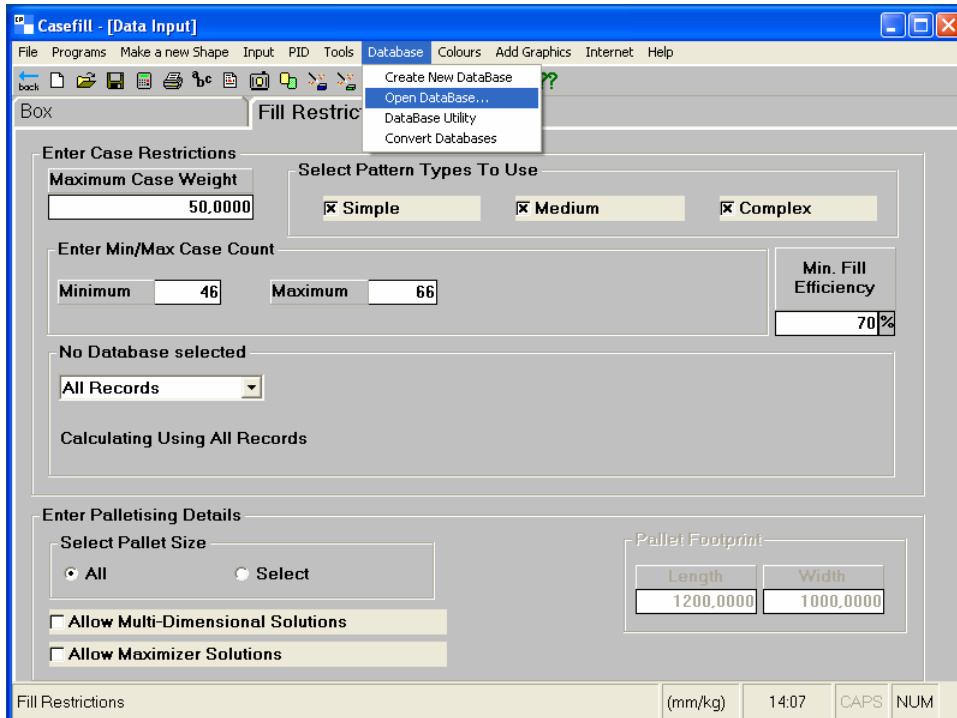


Enter the minimum and maximum numbers of CU/SKU in the **Enter Min/Max Case Count** menu.

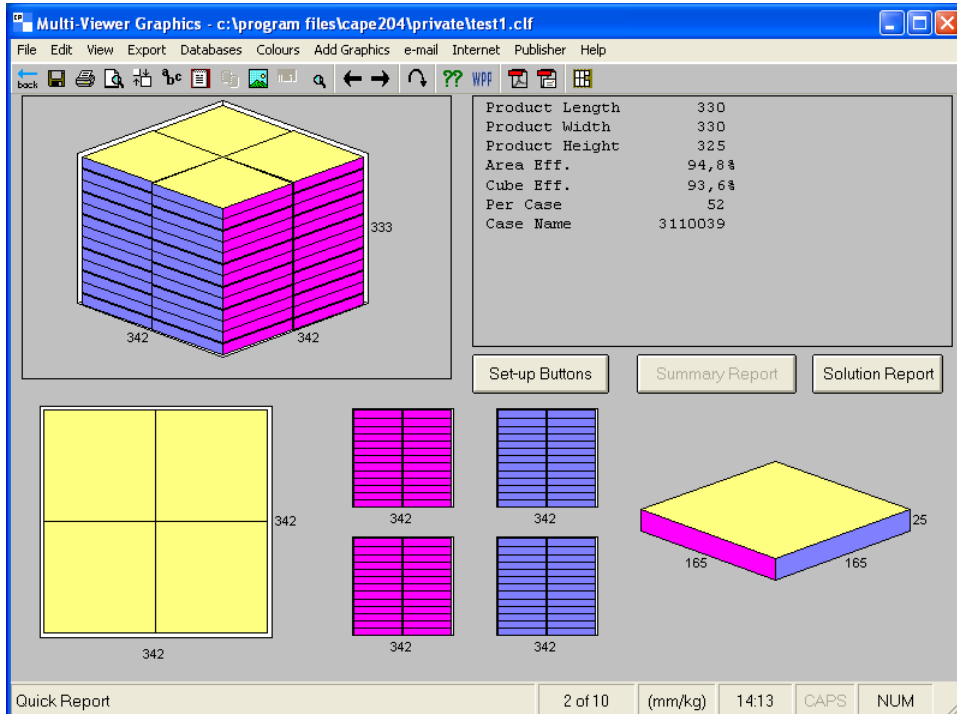


When all the filling restrictions are made choose **Open DataBase...** in the **Database** menu and choose the file where all the SKU's are saved (*SKU*

boxes in our case). By doing this, all the previous added SKU's will be included, when searching for the appropriate boxes for the specific CU's.



Return to the flap **Box** and press **Save/Calc** to find the most suitable boxes.



By pressing the **Solution Report** button, all possible solutions are shown.

The screenshot displays two windows from a software application. The top window, titled 'Multi-Viewer Graphics - c:\program files\cape204\private\test1.clf', shows a 3D visualization of a rectangular case filled with smaller units. The case is colored yellow on top and pink on the sides. A dimension of 349 is indicated on the right side of the case. To the right of the 3D view, the following specifications are listed:

- Product Length: 330
- Product Width: 330
- Product Height: 325
- Area Eff.: 75,6%
- Cube Eff.: 71,9%
- Per Case: 52
- Case Name: 3110138

The bottom window, titled 'Casefill Solution Report - Normal', displays a table with 12 columns: Sol. No., Rec. No., Case Name, Case Length, Case Width, Case Height, Pat Type, # Per Case, Cube Eff., Total Count, and Load Weight. The table lists 10 different solution configurations, with the 5th solution (Case Name 3110138) highlighted in bold.

Sol. No.	Rec. No.	Case Name	Case Length	Case Width	Case Height	Pat Type	# Per Case	Cube Eff.	Total Count	Load Weight
1	1	3110001	825,0000	405,0000	175,0000	S	63	73,3	12600	25,0
2	6	3110039	340,0000	338,0000	329,0000	C	52	93,6	10400	20,0
3	17	3110113	362,0000	362,0000	358,0000	C	56	81,2	11200	22,0
4	18	3110121	426,0000	338,0000	342,0000	C	52	71,9	10400	20,0
5	23	3110138	426,0000	338,0000	342,0000	C	52	71,9	10400	20,0
6	24	3110167	380,0000	380,0000	305,0000	C	48	74,2	9600	19,0
7	37	3119092	404,0000	354,0000	348,0000	C	52	71,1	10400	20,0
8	48	3110172	388,0000	388,0000	350,0000	C	56	72,3	11200	22,0
9	52	3119013	362,0000	362,0000	358,0000	C	56	81,2	11200	22,0
10	65	3110010	825,0000	405,0000	175,0000	S	63	73,3	12600	25,0

To find more than one solution for a specific SKU, mark the desired box and choose **Expand** from the **Options** menu in the **Casefill Solution Report** window. This is an important function to use when the program propose solutions, with complex packaging patterns as the picture below.

The screenshot displays the 'Multi-Viewer Graphics' application window. The main area shows a 3D perspective view of a yellow case with dimensions 410 (width), 830 (length), and 180 (height). To the right, a text box lists product specifications:

- Product Length: 825
- Product Width: 405
- Product Height: 165
- Area Eff.: 100,0%
- Cube Eff.: 94,3%
- Per Case: 81
- Case Name: 3110001

Below the 3D view are several 2D diagrams: a top-down view of the case, a side view showing the height of 165 and a depth of 25, and two smaller diagrams showing the internal layout of the case with dimensions 830 and 410. At the bottom of the window, there are buttons for 'Set-up Buttons', 'Summary Report', and 'Solution Report'. The status bar shows '1 of 50', '(mm/kg)', '14:45', 'CAPS', and 'NUM'.

Below the main window is the 'Casefill Solution Report - Normal' window, which contains a table of solutions. The 'Expand' option is highlighted in the 'Options' menu.

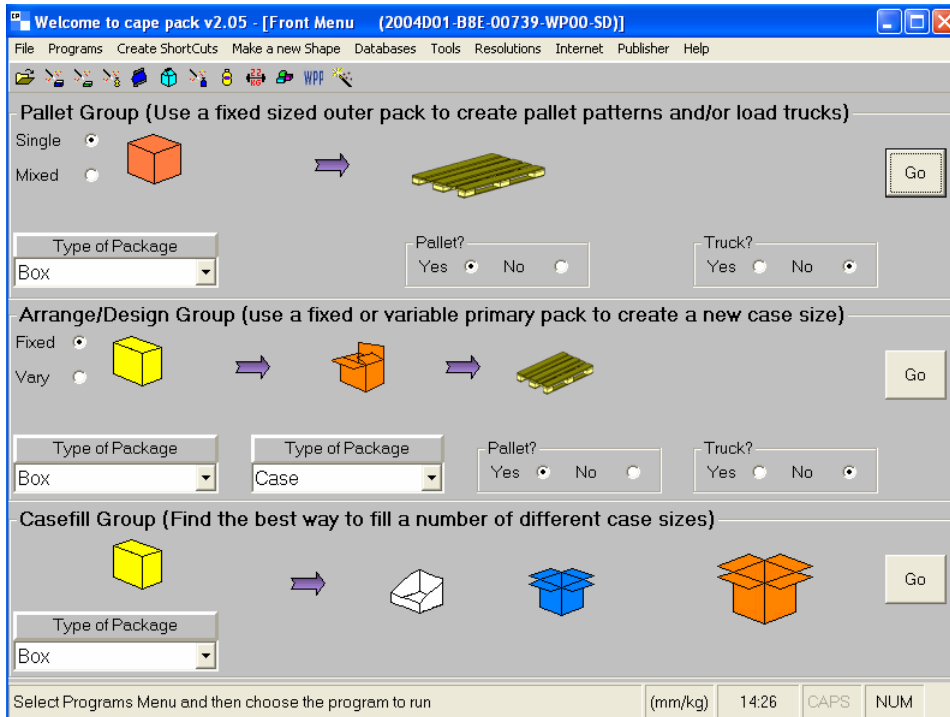
Sol. No.	Pat	Case Length	Case Width	Case Height	Pat Type	# Per Case	Cube Eff.	Total Count	Loa	Weight
1	1	825,0000	405,0000	175,0000	I	81	94,3	16200	32	
2	2	420,0000	339,0000	177,0000	I	33	89,1	6600	13	
3	4	274,0000	170,0000	170,0000	C	10	86,0	2000	4	
4	5	522,0000	407,0000	404,0000	I	100	79,3	20000	40	
5	7	233,0000	169,0000	170,0000	C	9	91,5	1800	3	
6	9	254,0000	254,0000	193,0000	I	13	71,1	2600	5	
7	10	410,0000	169,0000	169,0000	C	16	93,0	3200	6	
8	11	312,0000	169,0000	170,0000	C	12	91,1	2400	4	
9	14	365,0000	285,0000	170,0000	I	23	88,5	4600	9	
10	16	368,0000	289,0000	341,0000	I	46	86,3	9200	18	

Pallet Group (Use a fixed sized outer pack to create pallet patterns and/or load trucks)

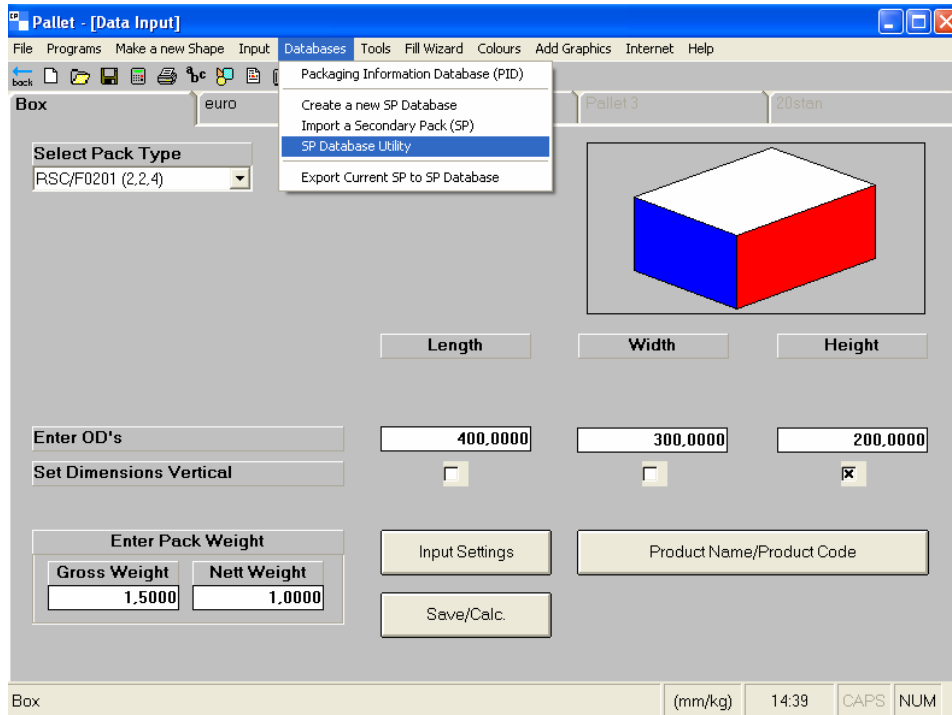
Within **Pallet Group** it is possible to add SKU boxes, including name (box material number) and dimensions (outbound) and calculate the external filling rate.

Add, delete or edit boxes in the program

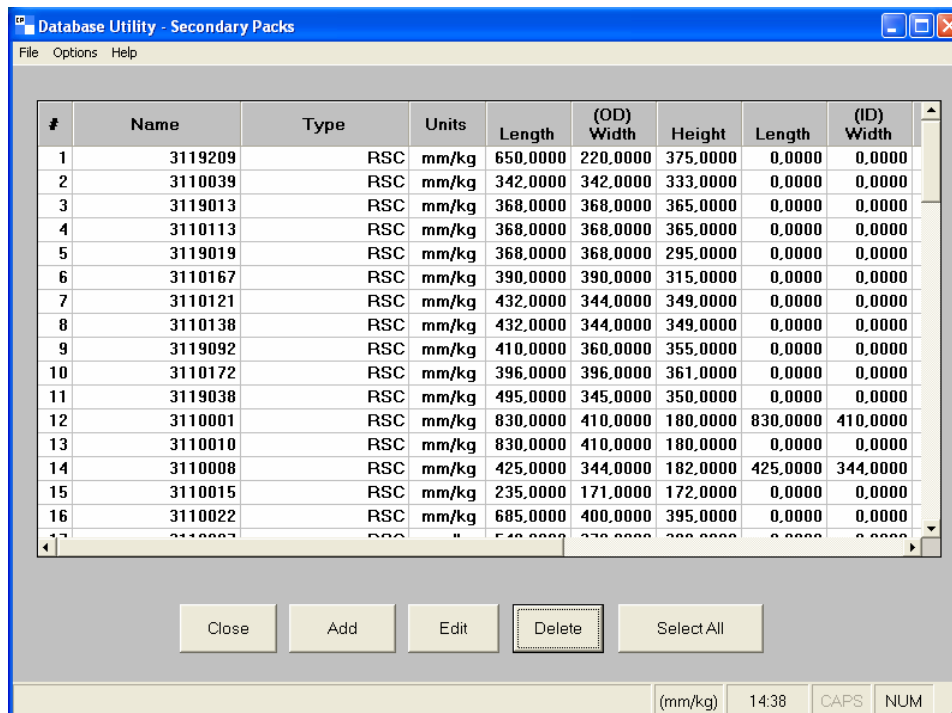
In the start menu, choose **Go** in **Pallet Group**.



To add, delete or edit SKU boxes in **Pallet Group** choose **SP Database Utility** from the **Database** menu. (Adding SKU's can also be done by entering the box dimensions (outbound) in **Enter OD's** and then choosing **Export Current SP to SP Database** in the **Database** menu).

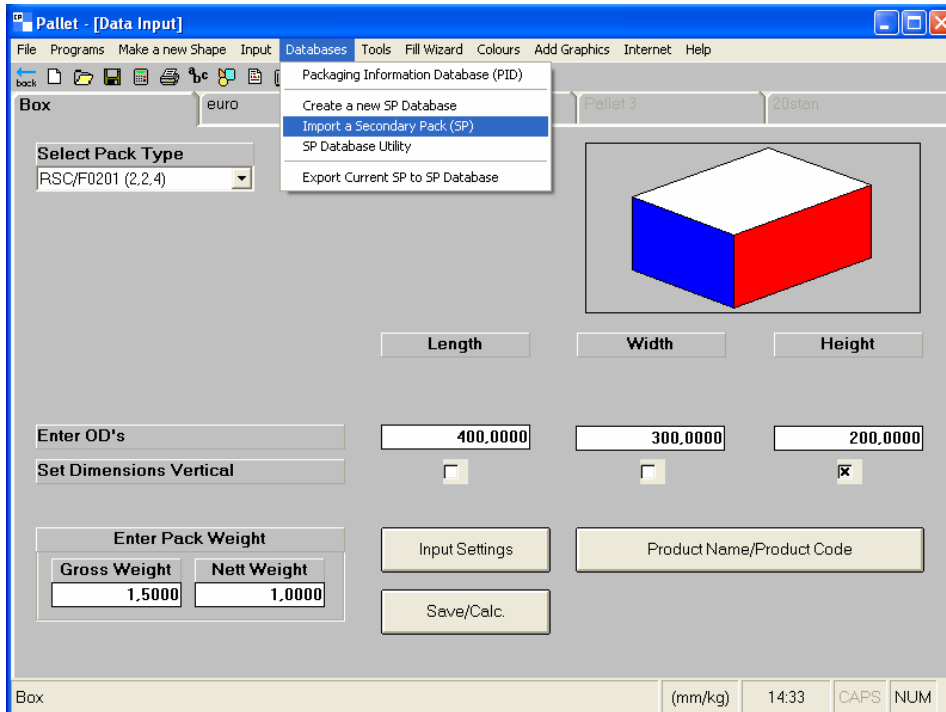


In the **Database Utility** window enter **Add** to add a new SKU box. If an already existing box should be changed or deleted mark the box and press **Edit** or **Delete**.

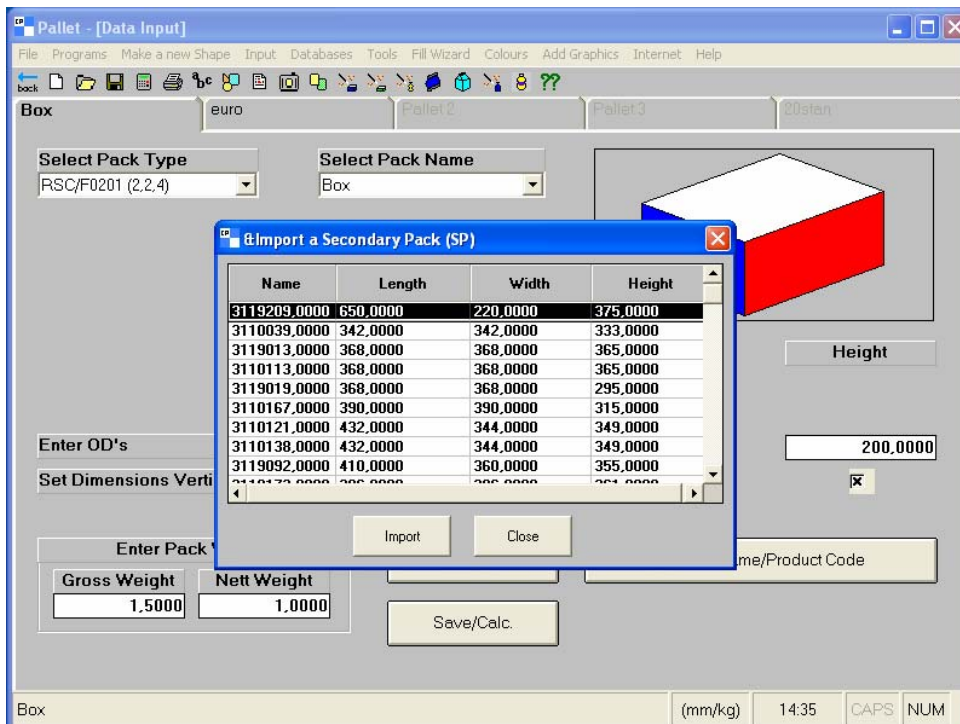


Calculate the external filling rate of the previous added SKU boxes.

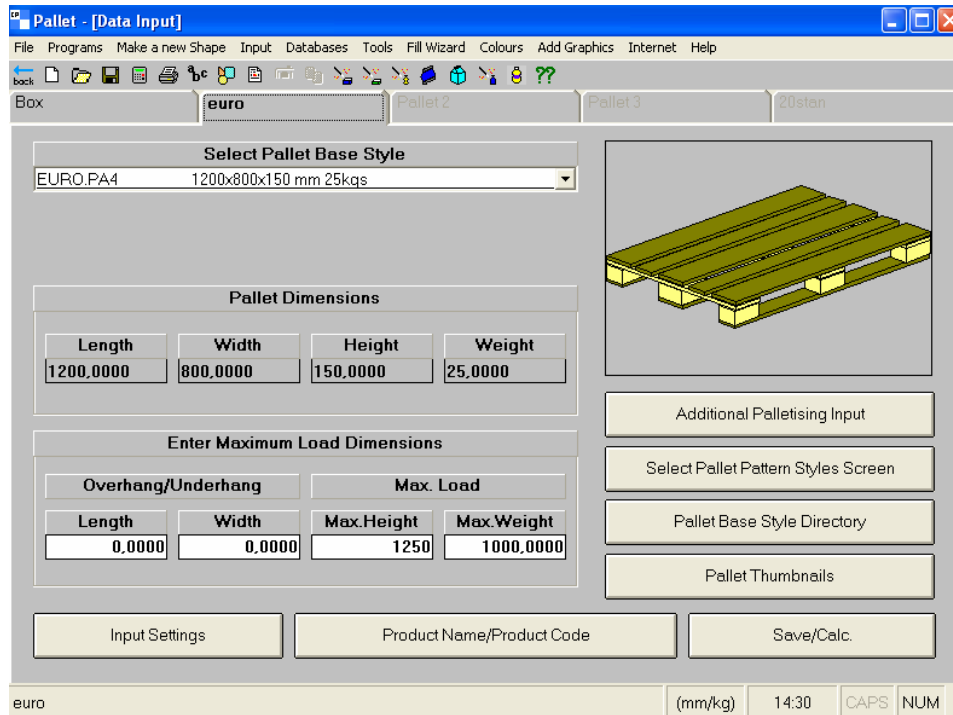
To calculate the external filling rate of previous added SKU boxes, choose **Import a Secondary Pack (SP)** in the **Database** menu.



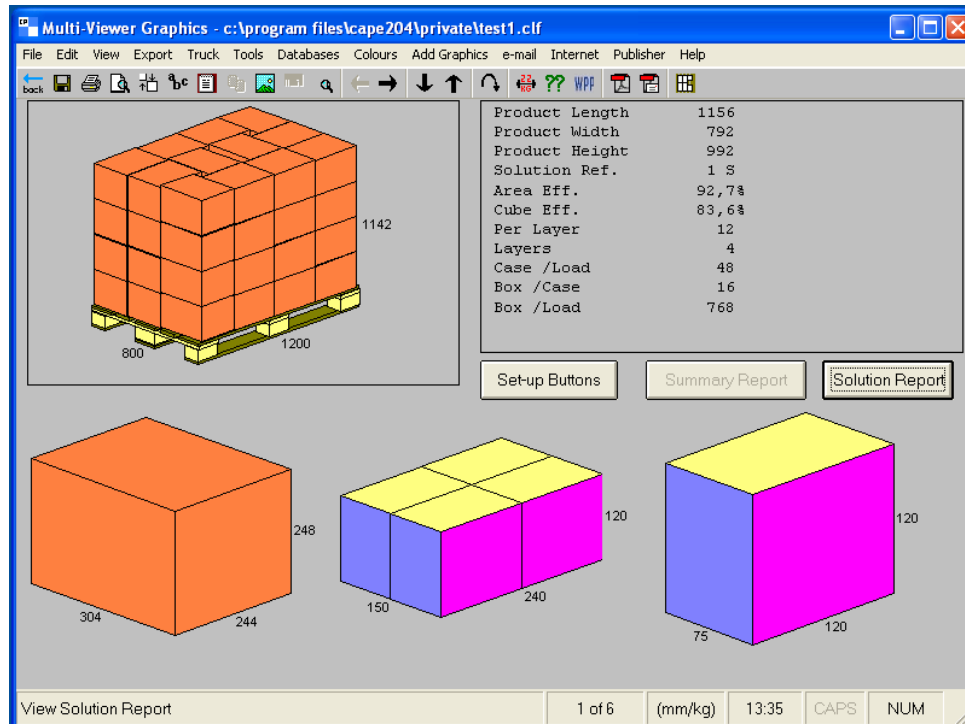
Choose the specific box in the **Import a Secondary Pack (SP)** window and press Import.



Press the **euro** flap to select which load carrier the SKU boxes should be loaded onto (EURO PA 4 1200x800x150 mm 25 kgs = normal EU pallet). Enter the maximum load dimensions for the pallet (Max.Height = 1250 mm and Max.Weight= 1000 kg for an EU pallet).



When all settings are done, press **Save/Calc** to calculate the external filling rate.



By pressing the **Solution Report** button, all possible solutions are shown.

The screenshot displays a software window titled "Multi-Viewer Graphics" with a 3D model of a pallet load on the left and a data panel on the right. Below this is a "Numerical Solution Report (Pallet #1)" window containing a table of six different loading solutions.

Product Specifications:

- Product Length: 1156
- Product Width: 792
- Product Height: 992
- Solution Ref.: 1 S
- Area Eff.: 92,7%
- Cube Eff.: 83,6%
- Per Layer: 12
- Layers: 4
- Case /Load: 48
- Box /Case: 16
- Box /Load: 768

Numerical Solution Report (Pallet #1) Table:

Sol. No.	Box Arrangement	Length	PP (OD) Width	Height	#/ Layer	# of Layers	# Per Case	# Per Load	Length	SP (ID) Width	Height
1	4W-2L-2H	120,00	75,00	120,00	12	4	16	768	300,0	240,0	240,0*
2	4L-2W-2H	120,00	75,00	120,00	11	4	16	704	480,0	150,0	240,0*
3	6W-2L-1H	120,00	75,00	120,00	7	8	12	672	450,0	240,0	120,0*
4	6W-2L-2H	120,00	75,00	120,00	7	4	24	672	450,0	240,0	240,0*
5	4L-4W-1H	120,00	75,00	120,00	5	8	16	640	480,0	300,0	120,0*
6	4L-6W-1H	120,00	75,00	120,00	2	8	24	384	480,0	450,0	120,0*

Arrange/Design Group (use a fixed or variable primary pack to create a new case size)

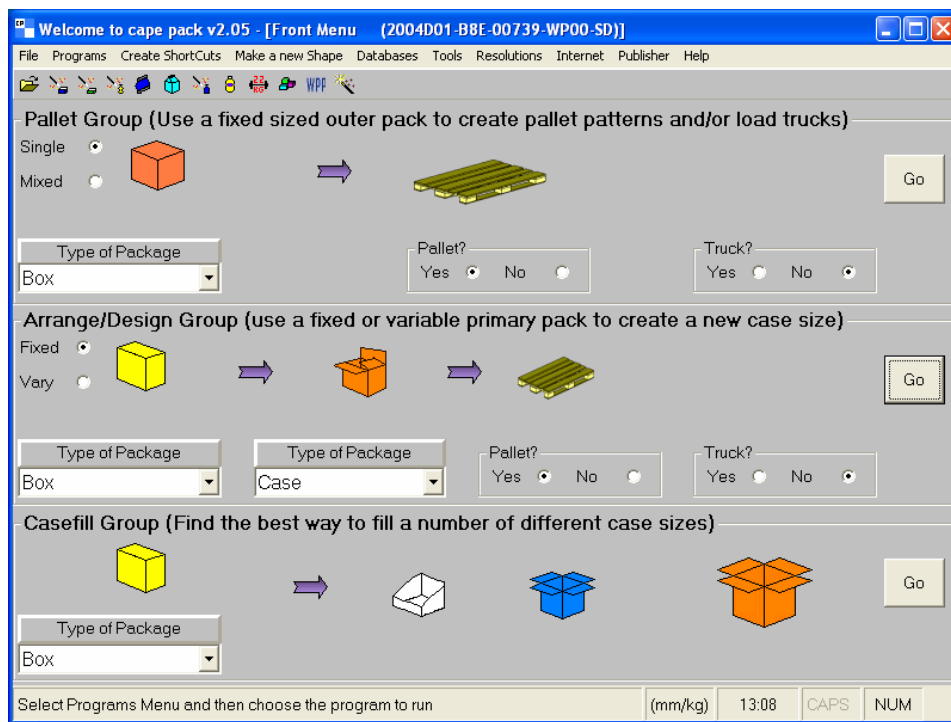
Within **Arrange/Design Group** it is possible to determine the maximum number of primary packages (CU's) loaded onto a pallet. By entering the dimensions of the CU's and how the packages should be bundled, the program finds an optimal package solution (SKU). The **Arrange/Design Group** function is an important tool during new product development to find a new package solution, when there are no exiting SKU's suitable for the specific CU.

Create a new secondary package (SKU) for a CU.

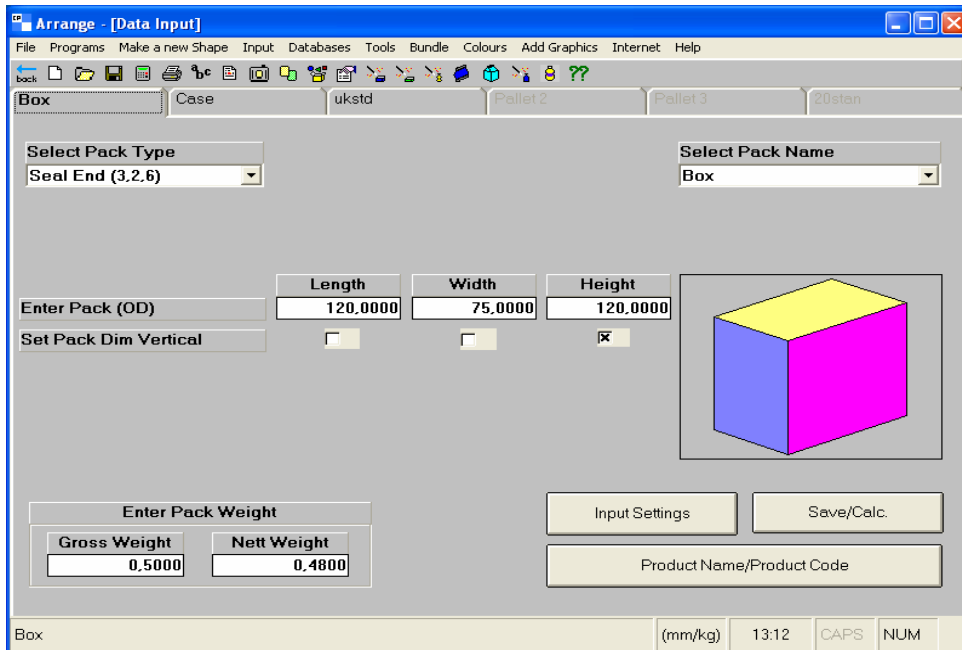
A new SKU package can either be created for a package with fixed or varying dimensions.

CU with fixed dimensions.

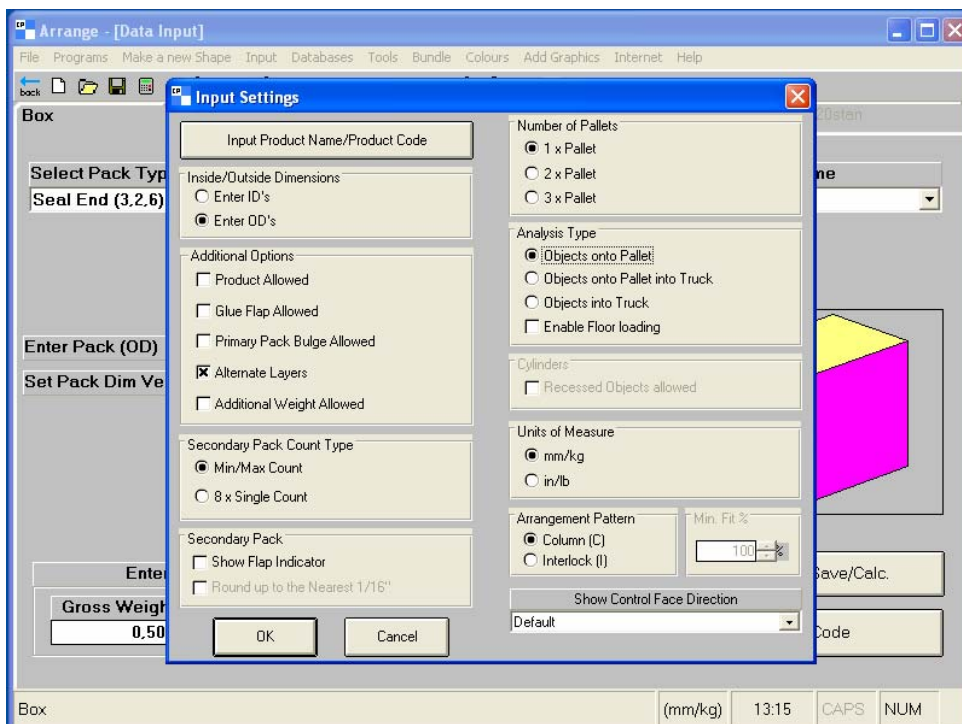
In the start menu, tick for **Fixed** CU dimensions and choose **Go** in **Casefill Group**.



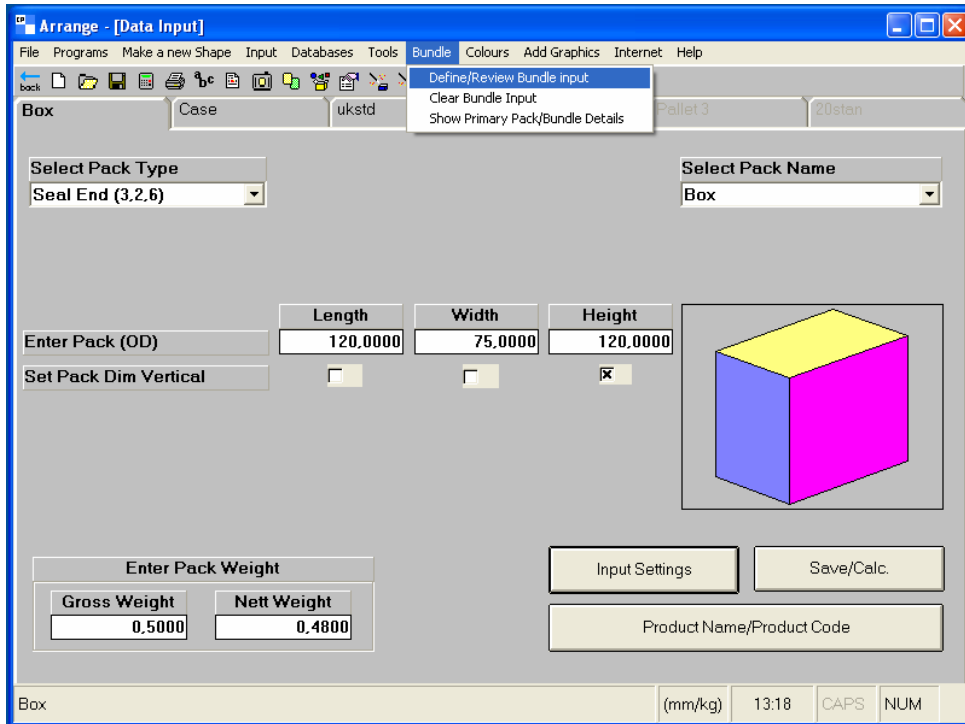
In the **Arrange** window, enter the outbound dimensions of the CU package. Decide whether the CU's should be standing up or laying down inside of the SKU, by ticking in squares in the **Set Pack Dim Vertical**.



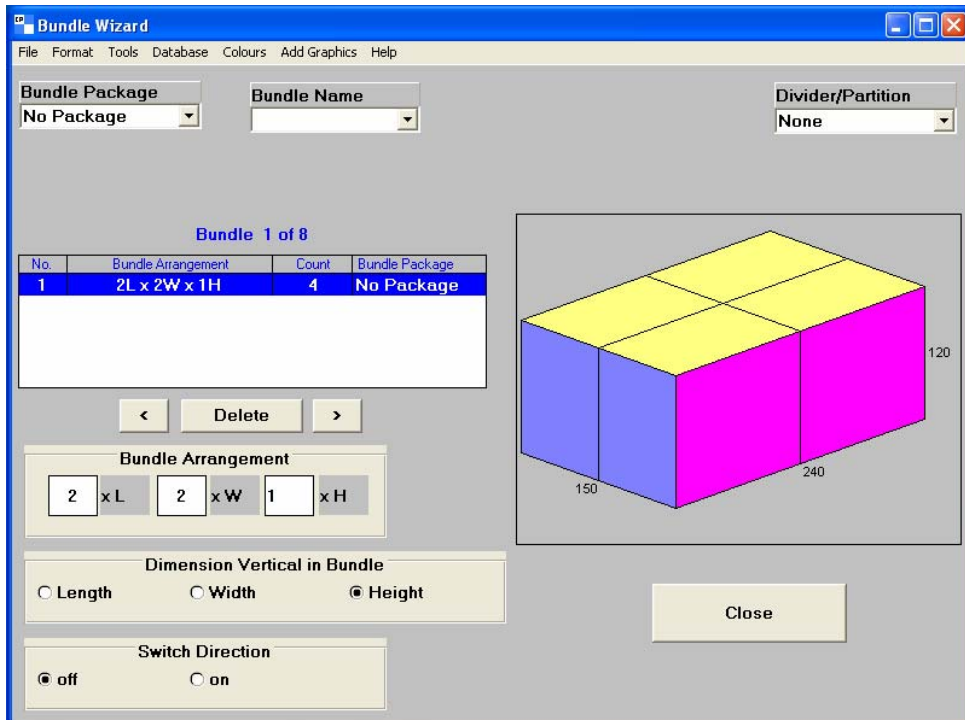
Press **Input Settings** in the **Arrange** window to enter fill restrictions.



To decide how the CU's should be arranged inside of the SKU, choose **Define/Review Bundle input** in the **Bundle** menu.

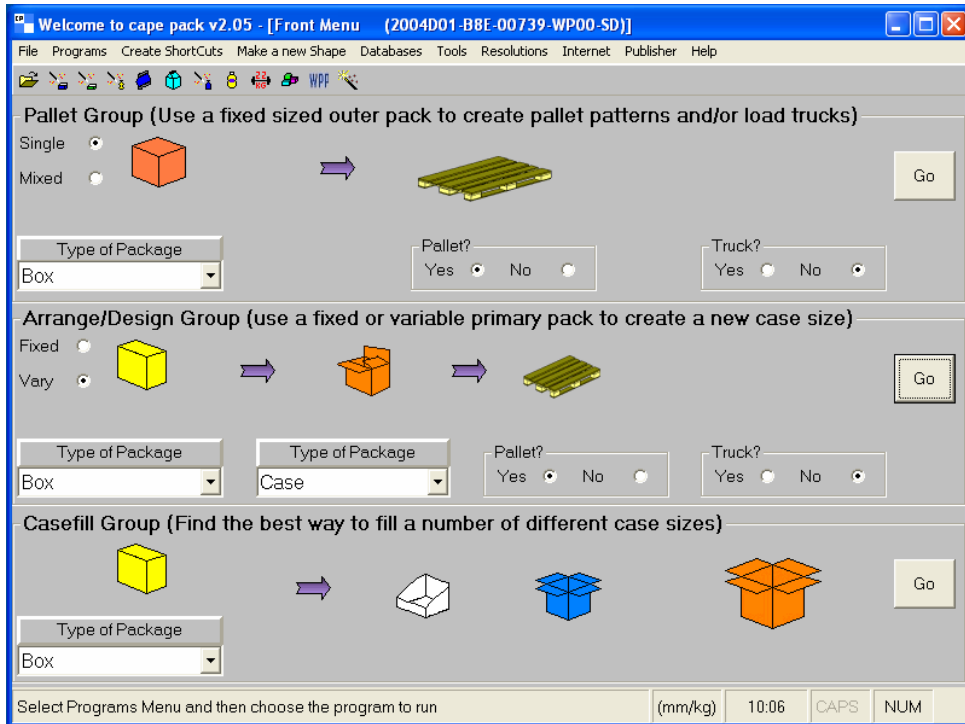


Adjust the **Bundle Arrangement** to attain the right arrangement of CU's wanted.

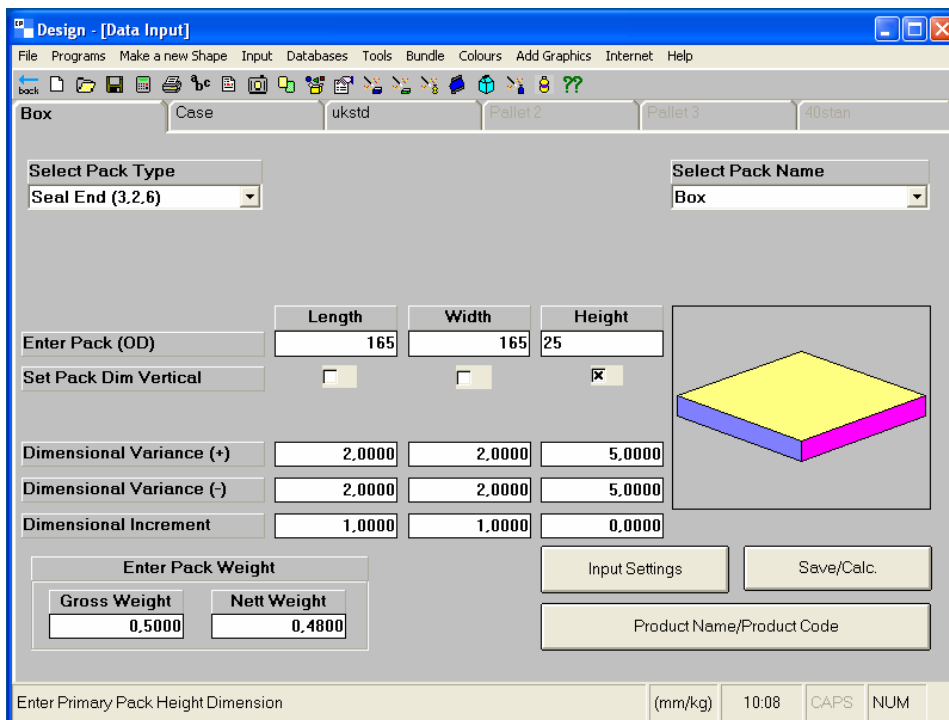


CU with varying dimensions.

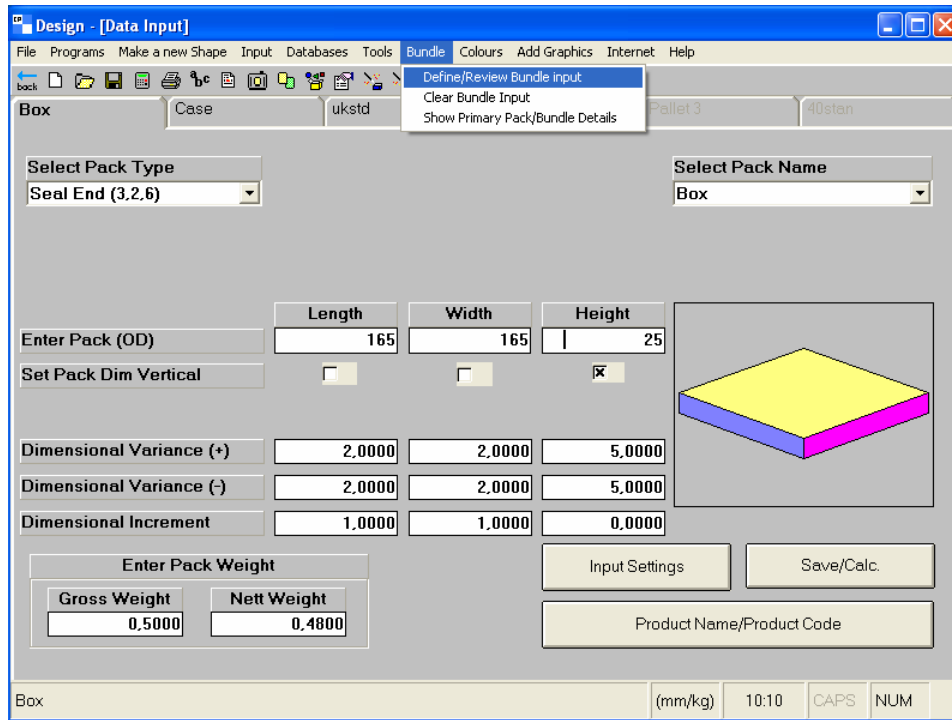
In the start menu, tick for **Vary** CU dimensions and choose **Go** in **Casefill Group**.



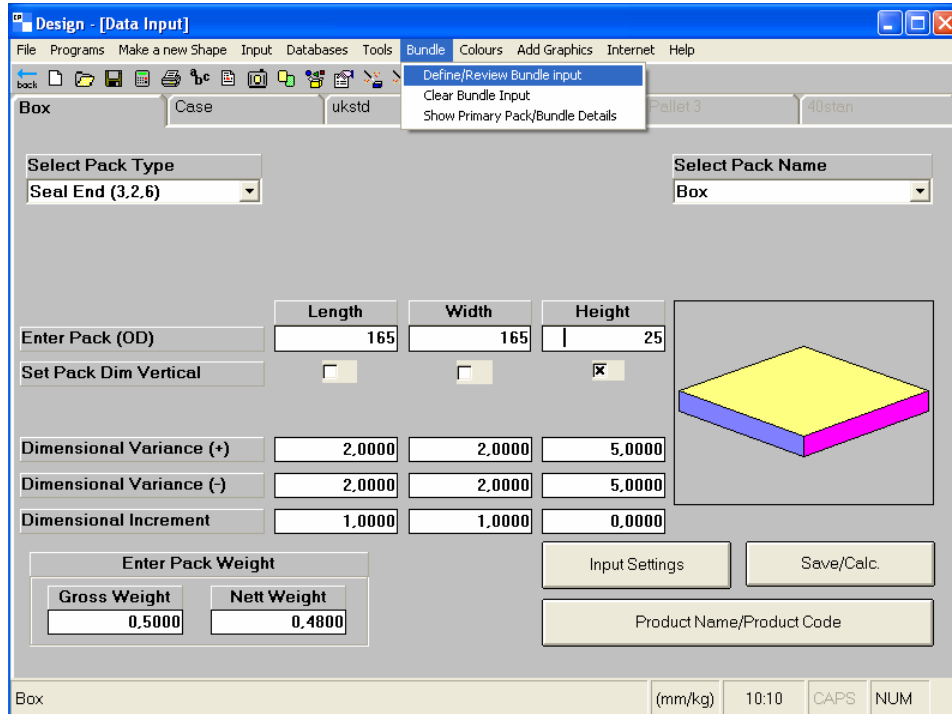
In the **Arrange** window, enter the outbound dimensions of the CU package and the dimensional variance (+/-). Decide whether the CU's should be standing up or laying down inside of the SKU, by ticking in squares in the **Set Pack Dim Vertical**.



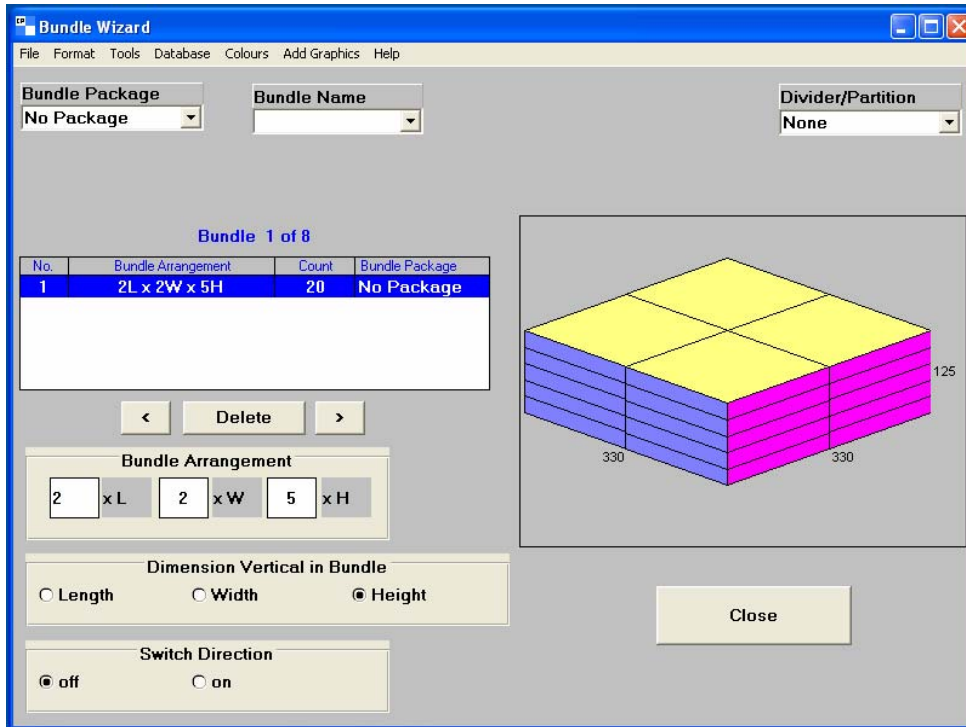
Press **Input Settings** in the **Design** window to enter fill restrictions.



To decide how the CU's should be arranged inside of the SKU, choose **Define/Review Bundle input** in the **Bundle** menu.

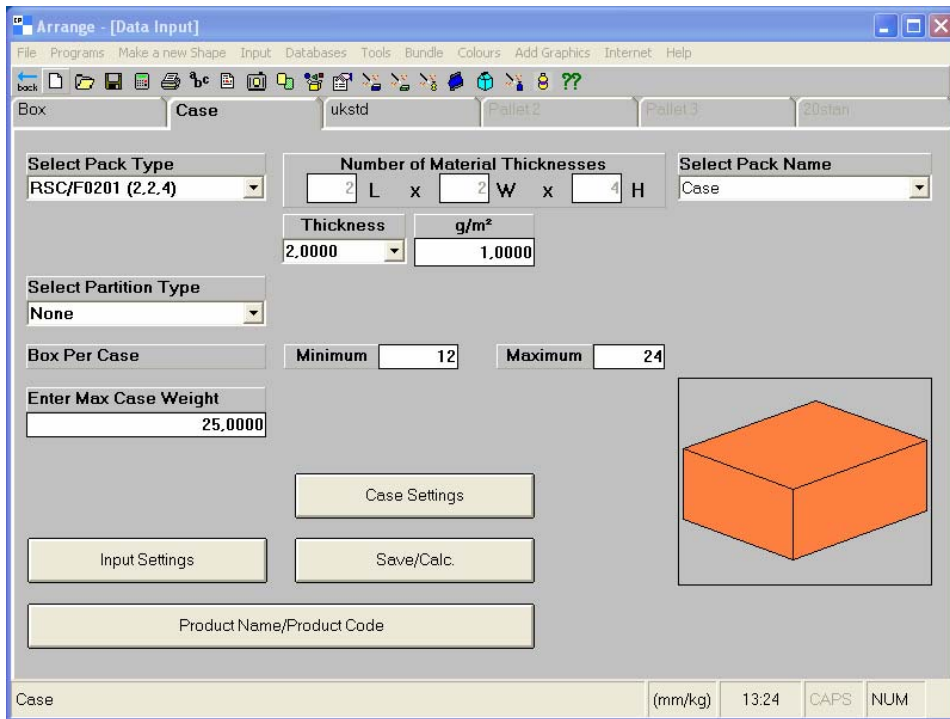


Adjust the **Bundle Arrangement** to attain the right arrangement of CU's wanted.

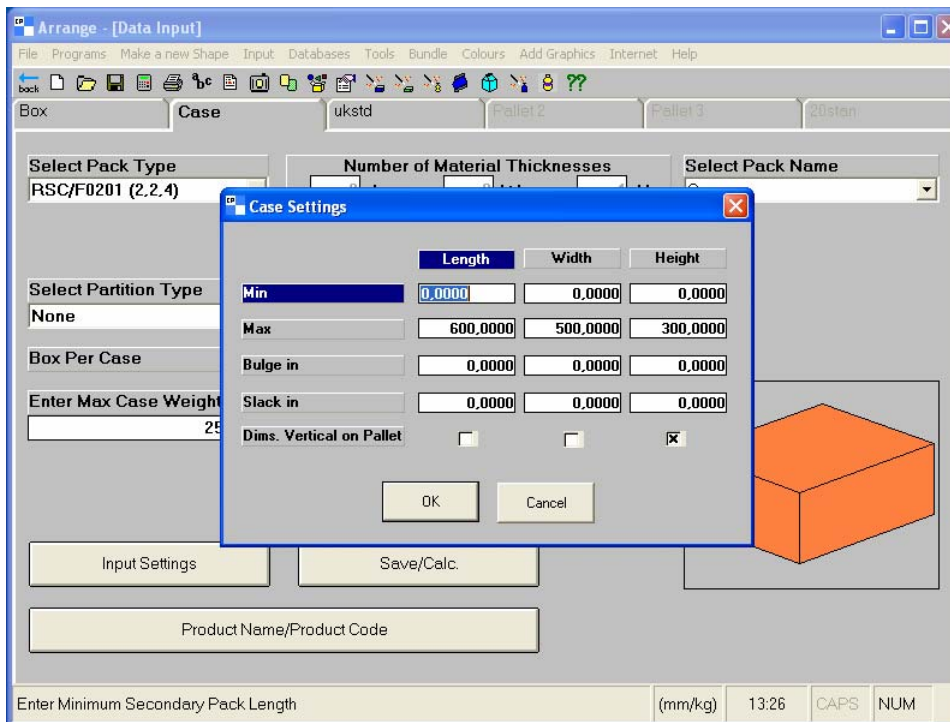


Arrange the SKU's onto a pallet.

In the **case window**, enter the min/max number of CU's/SKU and the maximum weight of the SKU.



Press **Case Settings** to enter the min/max box size and the slack inside of the SKU.



Press the **euro** flap to select which load carrier the SKU boxes should be loaded onto (EURO PA 4 1200x800x150 mm 25 kgs = normal EU pallet). Enter the maximum load dimensions for the pallet (Max.Height = 1250 mm and Max.Weight= 1000 kg for an EU pallet).

The screenshot shows the 'Arrange - [Data Input]' software interface. The window title is 'Arrange - [Data Input]'. The menu bar includes: File, Programs, Make a new Shape, Input, Databases, Tools, Bundle, Colours, Add Graphics, Internet, Help. The toolbar contains various icons for navigation and editing. The main interface is divided into several sections:

- Select Pallet Base Style:** A dropdown menu is set to 'EURO.PA4 1200x800x150 mm 25kqs'.
- Pallet Dimensions:** A table with the following values:

Length	Width	Height	Weight
1200.0000	800.0000	150.0000	25.0000
- Enter Maximum Load Dimensions:** A table with the following values:

Overhang/Underhang		Max. Load	
Length	Width	Max.Height	Max.Weight
0.0000	0.0000	1250	1000
- Right Panel:** Contains a 3D image of a pallet and four buttons: 'Additional Palletising Input', 'Select Pallet Pattern Styles Screen', 'Pallet Base Style Directory', and 'Pallet Thumbnails'.
- Bottom Buttons:** 'Input Settings', 'Product Name/Product Code', and 'Save/Calc.'.
- Status Bar:** Shows 'euro', '(mm/kg)', '13:29', 'CAPS', and 'NUM'.

When all settings are done, press **Save/Calc** to calculate the optimal solution. By pressing the **Solution Report** button, all possible solutions are shown.

The screenshot shows the 'Multi-Viewer Graphics' software interface. The main window displays a 3D model of a pallet load of orange boxes. The pallet dimensions are 800mm by 1200mm, and the total height of the load is 1239mm. To the right of the 3D model is a parameter list:

- Product Length: 990
- Product Width: 660
- Product Height: 1089
- Solution Ref.: 1 C
- Area Eff.: 68,1%
- Cube Eff.: 67,4%
- Per Layer: 6
- Layers: 8
- Case /Load: 48
- Box /Case: 20
- Box /Load: 960

Below the parameter list are three buttons: 'Set-up Buttons', 'Summary Report', and 'Solution Report'. Below the main 3D model are three smaller 3D models showing different box orientations with their dimensions:

- Model 1: 330 x 330 x 136
- Model 2: 326 x 326 x 128
- Model 3: 163 x 163 x 26

At the bottom of the main window, there is a status bar showing '1 of 20', '(mm/kg)', '10:21', 'CAPS', and 'NUM'. Below the main window is a 'Numerical Solution Report (Pallet #1)' window with a table of solutions:

Sol. No.	Box Arrangement	Length	PP (OD) Width	Height	#/ Layer	# of Layers	# Per Case	# Per Load	Length	SP (ID) Width	Height
1	2L-2W-5H	163,00	163,00	25,62	6	8	20	960	326,0	326,0	128,1*
2	2L-2W-5H	164,00	163,00	25,46	6	8	20	960	328,0	326,0	127,3*
3	2L-2W-5H	164,00	164,00	25,31	6	8	20	960	328,0	328,0	126,5*
4	2L-2W-5H	165,00	163,00	25,31	6	8	20	960	330,0	326,0	126,5*
5	2L-2W-5H	165,00	164,00	25,15	6	8	20	960	330,0	328,0	125,8*
6	2L-2W-5H	165,00	165,00	25,00	6	8	20	960	330,0	330,0	125,0*
7	2L-2W-5H	166,00	163,00	25,15	6	8	20	960	332,0	326,0	125,8*
8	2L-2W-5H	166,00	164,00	25,00	6	8	20	960	332,0	328,0	125,0*
9	2L-2W-5H	166,00	165,00	24,85	6	8	20	960	332,0	330,0	124,2*
10	2L-2W-5H	166,00	166,00	24,70	6	8	20	960	332,0	332,0	123,5*
11	2L-2W-5H	167,00	163,00	25,00	6	8	20	960	334,0	326,0	125,0*