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Bachelor-Thesis

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Optimization and Simulation of ULD's workload by means of an efficient build-up-process and utilisation of human resources at DHL Air Hub Leipzig/Halle

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II List of abbrevations

A300	Airbus 300 (Aircraft type)
ACS	Air Capacity Sales DHL Air Hub Leipzig/Halle
Approx.	Approximately
B727	Boeing 727 (Aircraft type)
BPR	Business Process Reengineering
cm	Centimetre
COY	Conveyable (Goods)
DC-10	McDonnell Douglas 10 (Aircraft type)
Ed.	Editor
kg	Kilogram
m^3	Cubic metres
Max.	Maximum
NCC	Network Control Centre DHL Air Hub Leipzig/Halle
NCY	Non-Conveyable (Goods)
NPG	Network Planning Group DHL Air Hub Leipzig/Halle
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ULD	Unit Load Device

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Abstract

These days in air cargo terminals the most important problems are the optimal workload of the existing airplane's capacity and the unobjectionable organisation of freight handling employees. In fact, these areas are particularly critical for achieving cost reductions while maintaining customer service levels. The main focus of operations in the terminal is breaking down incoming unit load devices (ULDs) for the cargo and building up outgoing ULDs.

This Bachelor Thesis aims at optimizing the operations at DHL Air Hub Leipzig/ Halle by utilizing the ULD's capacity and the organisation of manpower resources fully. Based on the demands of incoming and outgoing air cargo and handling capacities of the individual build and break workers, the density of the ULDs is needed to be 100% by using human resources, efficiently.

This is not the case in practice because the build-up process is not standardised in detail. Furthermore, the organisation, evaluation and motivation of employees, here especially builders, is not always guaranteed.

Therefore, this thesis looks for a fully developed functioning in the warehouse at DHL Air Hub Leipzig/Halle to find an ideal build-up process by optimizing resources organisation while maintaining high customer service levels.

This thesis also aims to find an ideal planning solution for the different departments at DHL Air Hub Leipzig/ Halle to guarantee a focused "Service of Excellence".

1 Introduction

Since the considerable globalisation of world trading, logistics service provider have been forced to deliver in correct quantity, to the right place and at the right cost. Because of the enormous competition at the European and World Market, another factor is becoming more and more apparent: transport time. Therefore, airfreight is nowadays the fastest transport mode available. The tremendous speed of airplanes together with the high frequency of flight schedules worldwilde is responsible for very short travel times.
Furthermore, with the considerable dimensions and the Maximum Gross Payload of airplanes, nearly all available goods in the world can be shipped at any time.

With the extension of air freight terminals in China, the USA or Germany, air cargo industry has been growing imposingly during the last 20 years. According to top-ranking scientists, this field of logistics service provider continues to accelerate. So markets are now more competitive than ever before.

Because of the fact that cargo capacity in airplanes is limited, companies have to make a big effort to schedule and plan air freight operations with high accuracy so that they can meet customers' demands. In order to be a global player, air cargo companies have to guarantee low processing times, a high handling capacity, low costs for customers and high quality of their quantity delivered.

Furthermore, air cargo terminals or hubs are forced to reduce costs by an efficient management of manpower resources. Three shifts in twenty-four hours need to be scheduled such a way that the highly irregular demand is covered at any time and at minimum cost. Also, the transportation process of goods by using information technology is a lot incluenced by the handling of cargo on ground, because freight handling only takes place at air cargo terminals, which work as warehouses and workstations.

Nowadays, there are a lot of possibilities to handle air freight. The most common means of transport is a container, called Unit Load Device (ULD). It has to be built and broken down at the workstation or in a warehouse.

1.1 New door to the world - built in record time

The DHL Air Hub Leipzig/Halle, the DHL headquarters in Germany and actually the most important and known air cargo service provider in Europe is one of the three most important hubs in the global DHL Express network. The state-of-the-art hub Europe, situated in the north-west of Leipzig, deals with a freight turnover of 1500 tons per working day and serves 46 destinations worldwide. Since September 2005, the company DHL has been invested 300 million euros at a total area of 2 million suqare meters. Destinations like Athens, the East Midlands, Hong Kong, Singapore or Wilmington(USA) are settled with modern aircrafts of Boeing and Airbus. Actually there are working approximately 2000 employees and 30 trainees. The sorting line is the largest of its type in Germany with a sorting capacity of 60 000 parcels and 36 000 documents per hour. The line runs fully automatically and avoids mis-sorting. In 2012, there will be approx. 3500 employees at DHL and in addition approx. 7000 jobs in the vicinity.

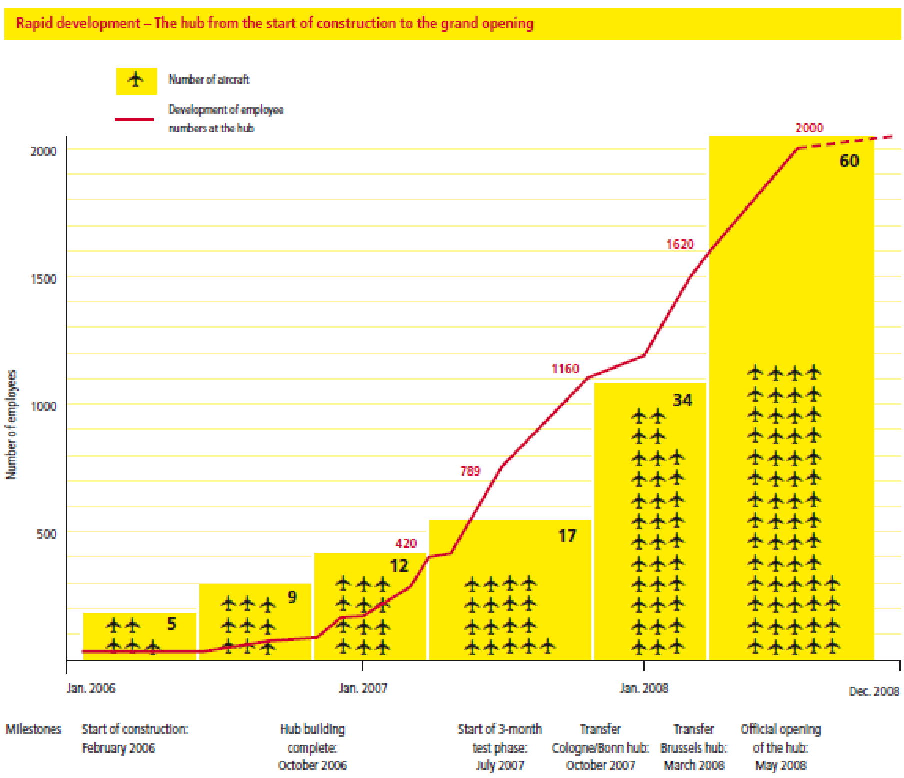

Figure 1: Development of employees and aircrafts at DHL Air Hub Leipzig/Halle [1]

In January 2006, DHL started with 5 air cargo planes at this hub, in 2008 there were already 60 planes and approx. 2000 employees that show its fast development.

1.2 Optimisation procedure

To guarantee a “Service of Excellence” the work at this hub needs constantly to be reviewed and controlled. This Bachelor Thesis targets the regular optimisation at the DHL Air Hub Leipzig/Halle and is has been written in cooperation with Francesco Gaddari, a Junior Expert dealing with the density and method of operation of ULD’s.

At first, the theoretical backround of hub-and-spoke processes at this company will be explained by the help of proper delimitations and definitions of key words. By starting at the entity of a logistics network, the system elements of the ULD-procedure will be accurately regarded to guarantee a concentration of the term "Density". With the help of the supervision of existing procedures, the principal causes and critical success factors will introduce the following simulation and optimisation. For this optimisation, reflections on Reload organisation, staff supervision and belly loading procedures will be needed. Furthermore, a test version of a logistics software of the "Fraunhofer Institut für Materialfluss und Logistik " in Dortmund will help to get new ideas and methods of resolution for this set of problems.

At last, risks and challenges for the DHL Air Hub Leipzig/Halle concerning the ideal ULD - capacity utilisation are mentioned.

Methods of solution have already been reviewed by DHL managers and employees. But until these days, an ideal planning for this ULD-problem respectively "Density-problem" (term used by DHL Air Hub Leipzig/Halle) or "Weight-Watching-Method" (term used by DHL Air Hub Leipzig/Halle) is not detected. Therefore this thesis should help to get new and more practical ideas.

2 Main part

2.1 Theoretical backround

2.1.1 Definition and characteristics of a logistics network

With the evolution of globalisation, the science of planning, organizing and managing activities, that provides goods and services has become a question of searching and finding efficient logistics networks [2] . These are "a number of sources and swales, that are related by transport systems"[3, p. 568]. A logistics network is traversed by flows of commodity, goods and individuals, that are operated and controlled by Information and Data flows. According to Gudehus [3, p.568] they can be divided in 3 types corresponding to their caracteristics:

- Intralog-networks, i.e. intra-company networks within one place of business of the enterprise
- Extralog-networks, i.e. external networks between the places of business of an enterprise
- Interlog-networks, i.e. networks of all enterprises and economic agents

Table 1: Characteristics of logistics networks [3, p. 568]

Characteristics	Intralog	Extralog	Interlog
Classification	Intra-company network within one place of business	External network of a company	Company-wide networks with high number of participants
Business location	One	Multiple	Various
Connecitivity	Low	Medium	High
Logistics chains	Intra-company	Intercompany	Business to Business(B2B)
Sources	Input of products Production	Suppliers Other places of operation	Enterprises Budgets

Swales	Points of consumption Output of products	Customers Other places of operation	Enterprises Budgets
Subsystems	Machine systems Storage systems Comission system Conveyor and transport systems	Procurement systems Distribution systems Disposal systems Intralog-systems	Intralog-systems Extralog-systems Transport systems Forwarding systems
Place of operation	Enterprise	Service provider	Service provider
Resources	Enterprise/ Service provider	Enterprise/ Service provider	Service provider
Trail network	Enterprise	Transport operation/ State	Transport operation/ State
Means of transport	Enterprise/ Service provider	Enterprise/ Service provider	Service provider

Logistics networks are therefore complex systems including multiple functions, that are composed of functional subsystems. The DHL Air Hub Leipzig/Halle belongs to the Interlog systems and is part of a so called Hub-and-Spoke-network. It is composed of company-wide networks with a high number of participants all over the world, various business locations, a high connectivity and B2B - logistics chains. Transport operations are particularly executed by this service provider.

2.1.2 Hub structure and cargo flows

The company DHL serves destinations in more than 220 countries and territories around the world. Indeed, there do not exist direct connections between all these airports because the number of flights and costs would be huge. Therefore, it is obvious to pool items at a central point. At this central point, the DHL Air Hub Leipzig/Halle, parcels are re-sorted, consolidated into sensible loading units and then transported to their final destination; to their spokes. Such a system is called hub-and spoke system with the European Hub of DHL (Leipzig/Halle) in the International Express Network.

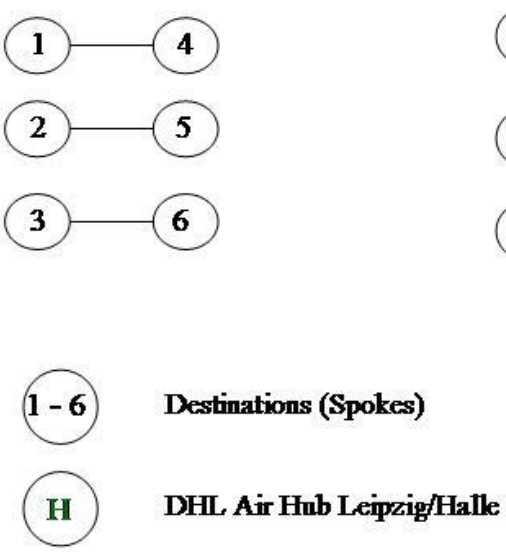

Figure 2: Multiplier and concentration effect of DHL Air Hub Leipzig/Halle

[4, p.33]

Figure 2 shows the main advantages of hub configurations. The multiplicator effect expresses the fact, that with n connections to the hub n(n+1)/2 destination-pairs can be connected. The concentration effect also shows economies of densities because of a relevant cost reduction (transport sealing on spokes). Furthermore, the DHL Air Hub Leipzig/Halle is able to achieve Economies of Scope by its inter-connecitivity. By using several types of the biggest cargo planes of the world on the spokes, this hub records Economies of Scale and has competitive advantages related to the difficulty of market entry of competitors.

The functioning of an Air Hub is divided into different steps and application areas. The following diagram supports the explanations by showing the information and physical flows:

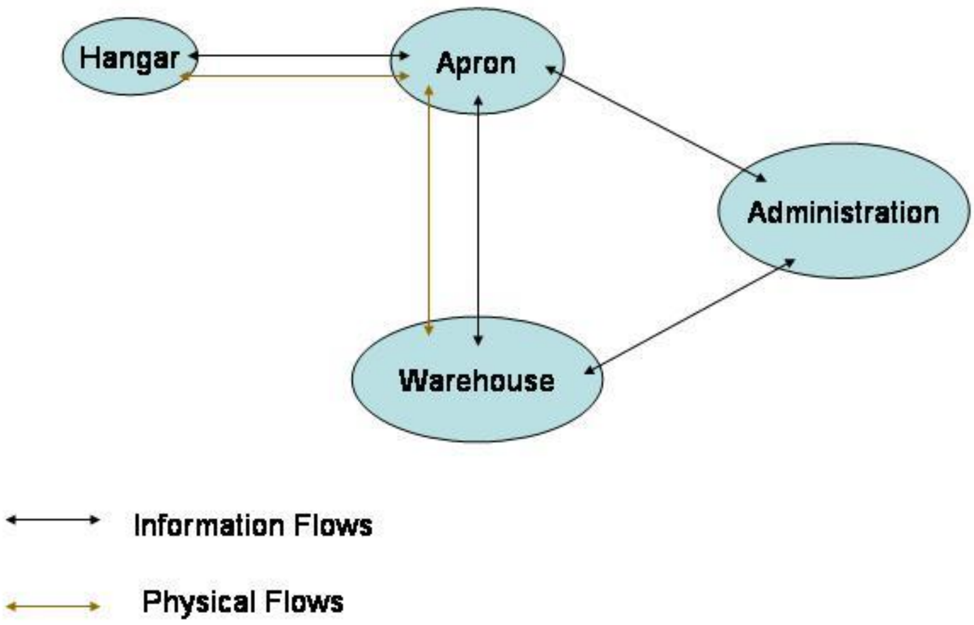

Figure 3: General Flows at DHL Air Hub Leipzig/Halle [5]

When an aircraft of DHL lands at the airport with approximately 150 000 items, ULDs are unloaded to the apron and from there off the aircraft. Special trailers for this ULDs are needed to move containers to the Offload Area of the Warehouse. Here items that can be automatically sorted "are separated from those that cannot be fed into the sorting system, such as hazardous goods as well as bulky and heavy items"[1, p.16].

They are first scanned and automatically separated into parcels and documents. Documents ("flyers") are separately sorted in the Flyer Sorter. "After sorting, the documents automatically land in red bags marked with the appropriate destination information"[1, p.16]. This part of the warehouse is able to handle 36000 items per hour for 500 destinations worldwide. By the help of conveyer belts all sortable parcels and documents are carried to the Reload Area. Here the ULDs are waiting to be loaded. After the build-up of the ULDs, they are transported by the help of trailers from the warehouse to the apron and from there on the aircraft. Packages destined anywhere within a radius of 300 kilometers are transported by truck or train. The hangar of the company has the function of maintaining all types of aircrafts. Appropriately premarked items are sorted out during this process and are check individually by customs inspectors.

The center piece of the DHL Air Hub is the Administration building where a series of networked computers collect all data from incoming and outgoing freight. This thesis is centered on the cooperation between the Network Control Centre (Administration), the Network Planning Group(Administration) and the work in the Warehouse.

2.1.3 General operations of ULDs

The handling of airfreight is a long process and does not depend so much on the flight duration but on how good cargo is handled while it is on ground [6]. Therefore, since usually speed is required, efficiency is absolutely necessary when it comes to handle the freight before and after the flight. Nowadays, there are several types of freight that can be handled in an air cargo terminal, but most of it is carried in containers or so called ULDs [7]. They are "used for the storage of cargo on the aircraft and are divided into two types; containers and pallets"[8]. According to Hermes Logistics Technologies, Pallets are in general secured by a net and attached to the rim of a pallet. The final contour needs to fit the choosen aircraft type. Containers "provide the shape so the contents are secured either by the container doors being closed and bolted"[8]. ULDs are often faster loaded and unloaded and have a better weather protection than pallets. But there can be some cargo that is difficult to fit into containers; therefore air cargo companies have to use pallets.

Figure 4: Loading of an ULD at DHL Air Hub Leipzig/Halle [9]

The DHL Air Hub Leipzig/Halle basically interacts with parcels or documents so these containers have standard dimensions that allow fitting them in most aircrafts (see Figure 4).

The following table shows details of a standard container of the DHL company to get a better impression of a ULD:

Table 2: General Information DHL AAC Container [10]

Code	**DHL AAC**
Base dimension	223.5cm × 317.5cm
Height	207cm
Tare weight	181kg
Max. Gross Weight	6033kg
Volume	11.8 m³
Aircraft types	A300, B727, B757, DC-8, DC-10

Nearly all ULDs are built of aluminium and polycarbon, which ensure durability but also lightness. They are verified, traced, labeled and registered in a Data system. The physical handling of ULDs at the DHL Air Hub Leipzig/Halle consists of two main operations, building up and breaking down. Both operations are done in workstations, so called Offloads (breaking down - process) and Reloads (building up - process).

Breaking consists of unloading some or all current parcels of a ULD. When the process is finished all parcels and documents are automatically sorted and sent to the Reload Area. Then the Building process starts. It consists of filling the ULDs with incoming parcels. The process can not be completed until all parcels are received, this means, that sometimes ULDs will have to remain at the Reload even though they are not being processed, just waiting for cargo to arrive.

By using ULDs, parcels can be consolidated in a very simple way. During the building process, it is unavoidable to use containers to full density by supervising the right gross load weight.

The process is carried out depending on urgency of orders, availability of resources, workers, availability of incoming parcels and arrival and departure scheduled times.

2.1.4 The Container Loading Problem

In literature, this ULD utilisation and its build-up are connected with the container loading problem [11, p.2]. A consignment "consists of n different types of small three-dimensional rectangular boxes that are required to be loaded into a three-dimensional rectangular container"[12, p.1]. Each box has to be completely packed in the container. It is not allowed to create an overlap with any other box or pallet. According to Dyckhoff [13], there are two main loading problems. The first problem consists of loading the entire part of the consignment into a single container. The aim is to maximize volume utilisation or to minimize the unused container volume. The second problem is to load the entire consignment into one or more containers. The objective is to minimize the number of containers used for the transport of a higher number of goods. These two main container loading problems contain the well-known "knapsack or rucksack problem". The basis of this problem delivers a set of items, each with a weight and a value, that has to be included in a collection so that the total weight is less or equal to a given limit.
The boxes have "k=1,...,up to k=6 orientations and are grouped in m types, each type t characterized by three spatial dimensions d_1tk, d_2tk, d_3tk, a volume v_t and a number q_t of boxes"[14, p.314]. Figure 5 shows that for each box placed in the container, three new empty spaces are created: the deptwise, widthwise, and heightwise spaces.

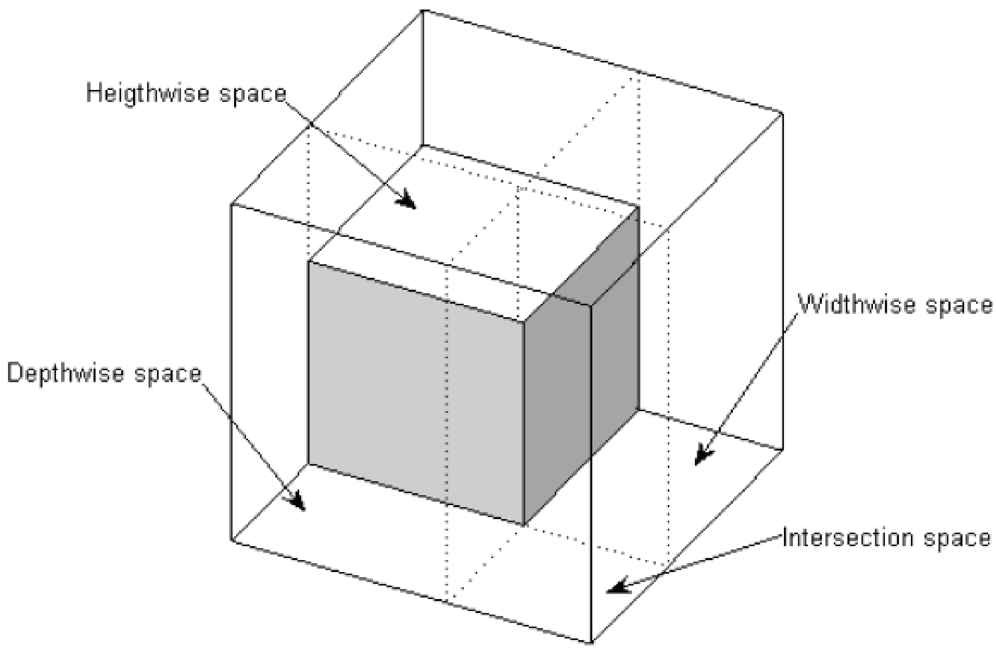

Figure 5: Spaces generated by the loading of one box [14, p.315]

While loading this box or pallet, the space between the depthwise space and the widthwise space comes into existence. It is called intersection space and is not considered as an empty space since it is contained in theses spaces. An empty space is generated if no unloaded box fits into the space.

Based on the number of different box types, the container loading problem can be classified into three categories [12, p.1]:

- the homogeneous problem
- the weakly heterogeneous problem and
- the strongly heterogeneous problem.

The homogeneous problem with only one typ of box can be disregarded. With relatively few box types, the weakly heterogeneous problem has to be neglected, too. For the strongly heterogeneous problem, nearly all boxes have different dimensions and have to be loaded into one container. Due to the problem's complexity most results on this topic are based on heuristics and meta-heuristics. Heuristics and Meta-heuristics are problem-solvings with minimal investment of knowledge and time. Satisfiying problem solvings require a lot more of time and knowledge (see later in this thesis: solving with "Puzzle" [15]).

The methods for heterogeneous boxes are based on wall-building and layer-building. The building of a wall means the construction of vertical walls accross length or width of the container. According to Bortfeldt and Gehring [16], a layer-building approach explains the building of a loadplan layer by layer from the floor of the container upwards. In the single container loading problem, the existence of "trouble-making" box types is widely observed. They are those box types, that are relatively large in relation to the dimensions of the container.

In the Greedy Heuristic [12, p.2] the procedure to divide the loading surface into sub-surfaces is implemented. Thereby the layer is always packed in the bottom-left corner of the loading surface. At DHL Air Hub Leipzig/Halle this is always the place of "Flyers" and "Dangerous Goods". The box types with a higher priority (e.g. express deliveries) are always packed onto lower surfaces of the container and the construction of a wall is already implemented (see 2.2.1).

2.1.5 Business Process Reengineering

The company DHL defines continuously its actual targets, aims and services. The initial point of this internal definition is the so called “Service of Excellence” that contains the decline of miss-connections and the perfect handling of the cargo. The general aim defines that a DHL plane needs only 105 minutes from block to block (from landing to departure).
In literature, these innovations in Management and Industrial Engineering are called Business Process Reengineering (BPR). "This technique provides companies with a powerful tool to quickly and radically adapt to any change in the environment and redesign its strategies, value-added processes, policies and structures in order to optimize the productivity and efficiency of the organisation” [17, p. 99].
The reason for this process reengineering are the technologies, the environment and the customer demands which are nowadays rapidly changing. For a company like DHL this means:

- Improve automatic or semi-automatic systems of the company
- Adopt updated concepts and methods of air cargo handling processes
- Reduce clerical assignements
- Improve cargo services through redefining specifications and responsibilites
- Develop effective methods to exchange required information and data as fast as possible
- Reduce the total time spent on shipment operations.

These thoughts are only some of the main targets. It's unambiguous that the results obtained when applying the BPR should help the DHL Air Hub Leipzig/Halle by a systematic method of optimizing the cargo flows per night at this hub.

2.2 Definition and Delimination of a Logistics System and its system elements

The DHL Air Hub Leipzig/Halle can be seen as a complex system including subsystems. Therefore it is necessary to define such a logistics system and to realise a delimination to the ULD-process. These system elements are identified with the help of the "Weight-Watching-Program 2009", executed by John Godfrey, DHL Network Manager, at this company. Consequently, ULD-system variables become apparent.

A logistics system describes the entity of at least two quantities of elements and a quantity of relations between these elements[18]. Every system has a function, a structure and a perfomance[19]. An element ist the smallest and no longer subdividable entity of a system.

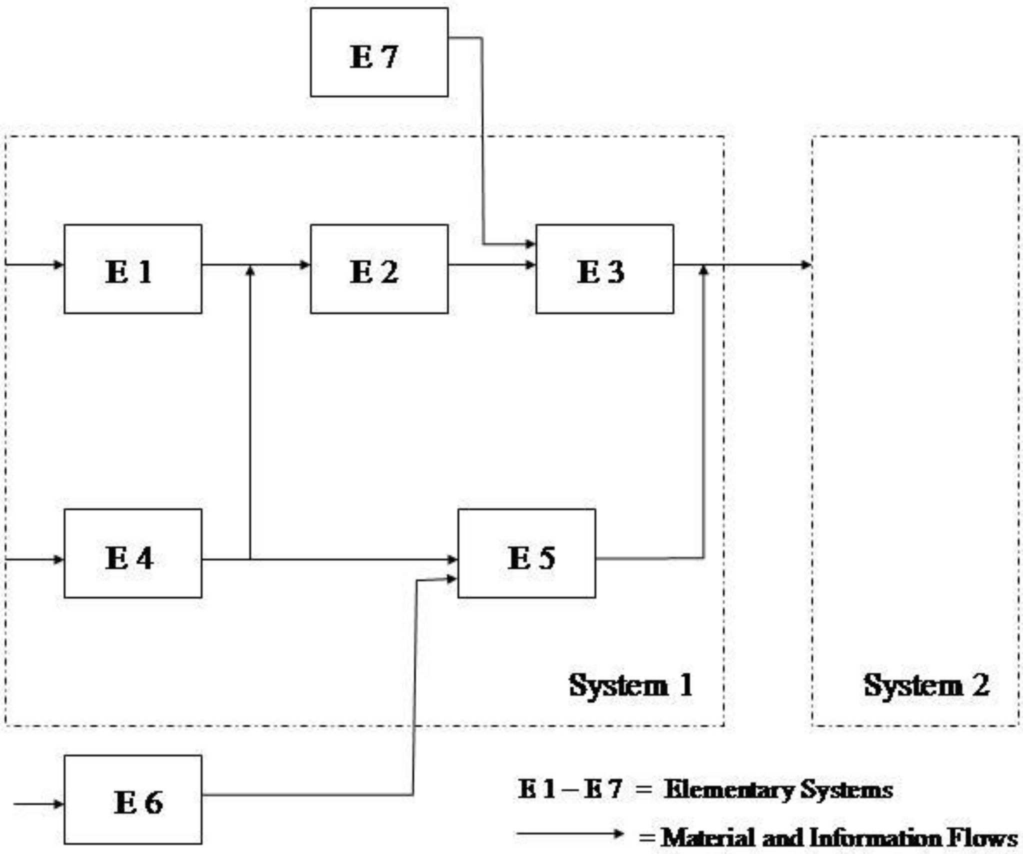

Figure 6: Delimitation Logistics System and Elementary systems

The Elementary systems in a system depend on each other by means of several correlations (see Figure 6).

Elementary System E 6, for example, is not directly part of the system 1, and is also known as indirect elementary system in the environment of system 1. System 2 is connected with system 1 by elementary system E3 and is therefore indirectly part of system 1.

In view of the DHL Air Hub Leipzig/Halle this system theorie presents the initial point of the "Density "- respectively the "Weight - Watching" - complex of processes (ideal ULD capacity utilisation) concerning the Unit Load Device - system.

The ideal ULD - system can be seen as system 1 (see Figure 6). In this system 1 actually exist a high number of elementary systems. Therefore, the following essential system elements have to be identified, classified and explaint:

- Current ULD build-up model
- Staff Training
- ULD capacity planning
- Belly loading procedures
- Handling of conveyable and non conveyable goods

2.2.1 Current build-up model

A build-up model explains the theory how an ideal Unit Load Device has to be built. Because of the high number of arriving parcels at DHL Hub every night, it is necessary to analyse the existing methods of operation.

To have a more detailed idea of a build-up process, it is very important to know that in general there are a high number of builders at every Reload Area. The main task consists of picking the arriving parcels at the end of the conveyor belt (slide) and to put them into the designated container. In general, every builder can work at different work stations of a Reload Area and there is still an exchange of builders at every slide.

The DHL Air Hub Leipzig/Halle has consequently developed the following composite method.

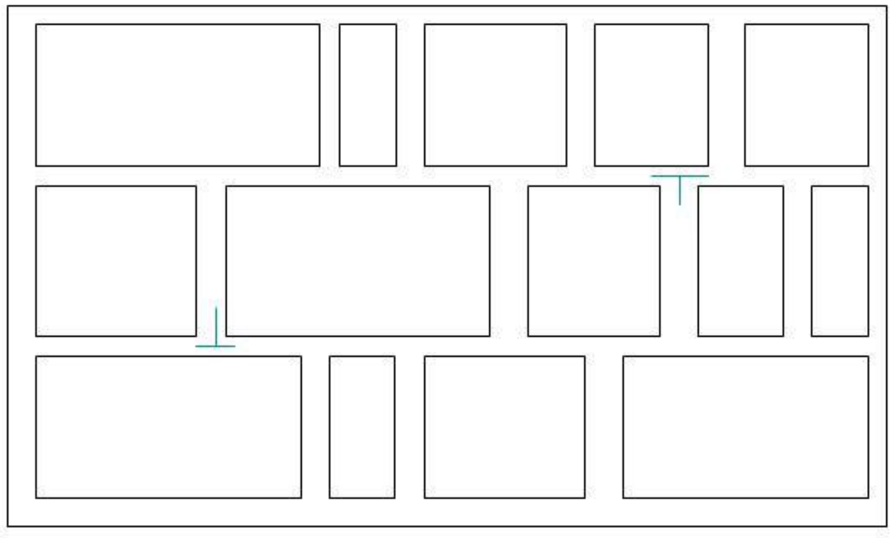

Figure 7: Composite-method DHL Air Hub Leipzig/Halle

Figure 7 shows the front view of one row in a DHL - ULD. The aim of this method is to build the parcels after scanning as one composite-aggregate to avoid the tilting over of parcels. Also, a builder has always to start building the container at the last row (at the end of the container) by building certain walls on the layer. So called "Flyers"(Documents) are always in bags and have to be put at one place of the ULD. The express goods are always placed on the left side and in the front part of the ULD.

The following figure 8 shows the partitioning of areas in every DHL - ULD.

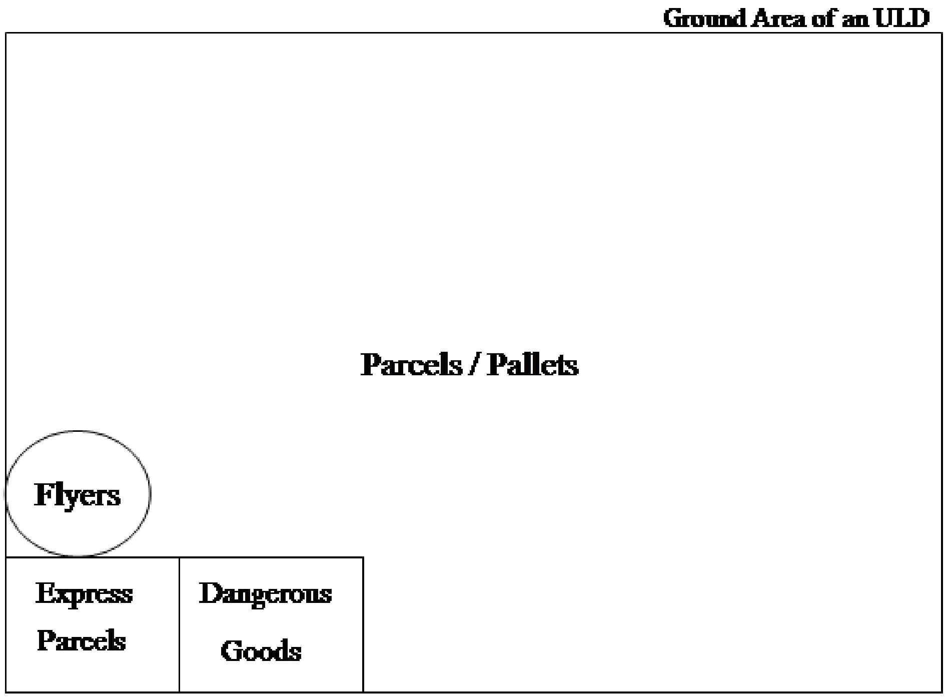

Figure 8: Ground Area of an ULD

Also, pallets are transported by the help of ULDs. Several parcels in this area are labeled with the words "Fragile", "Glass" or "This way up". So these goods have to be handled with care like dangerous goods that are also transported in such Unit Load Devices.

Another important point for every builder is the observation of spreading. Every ULD and floor area of an airplane has a certain maximum floor loading:

ULD:	≤	2000	kg/m²
Belly:	≤	750	kg/m²

The maximum gross load weight and the spreading of an ULD or parcels for an air cargo plane are calculated by the Network Control Centre and by the Network Planning Group.

2.2.2 Staff Training

Staff Training is an important element of the ULD - system. It is needed to ensure that employees of DHL develop the necessary skills which enable and qualify them to contribute to the growth and success of the business.

Research shows that staff training can increase productivity and quality of work, increase profit, reduce staff turnover and absenteeism, improve customer satisfaction and improve motivation.

Training that achieves these results is typically linked to business goals and performance, is part of a company-wide strategy, focused on setting tangible objectives for employees and part of a company policy, which sets out who is responsible for planning, implementing and evaluating training.

Active ways of learning are characterized by using initiative, by doing, by exploring, by testing. Passive ways of learning are by observing, by questioning, by interpreting and by reviewing.

Actually, a certain percentage of builders and breakers have to pass a "ULD Build Up Course" after and during employment. This "ULD Build Up Course" contains a detailed overview of DHL airplanes and their maximum gross loads. It also shows the main characteristics of ULDs including the base dimension, tare weight, maximum gross weight and volume. Furthermore, it explains the load securing in ULDs, special deliveries, Dangerous Goods, Spreading and the Composite-method needed when building up an ULD. During this "ULD Build Up Course" all participants have the possibility to use their knowledges to build up one ULD at the warehouse.

During this training, there is still a difference between the ages of workers. Currently, there are working students and for example 50-year-old people inside the company at Offloads and Reloads. All of them are guided by a trained supervisor during their shift. This supervisor is responsible for one Reload, but not always present there.

2.2.3 Capacity Planning

The three most important departements of correct ULD capacity planning at DHL are the Network Planning Group (NPG), the Network Control Centre (NCC) and the Sort (Warehouse). The NPG has the main function of planning the correct ULD quantity and the maximum gross payload of every ULD to reach optimized ULDs for every flight with a perfect density. The NCC is responsible for the correct place of ULDs at every airplane. This means, that with the help of an internal software, the place of every ULD can be assigned. The Sort (part of the Warehouse) has to build up every ULD on time and to transport it to the adequate airplane.

In this thesis the basic ideas of this chapter concern the work of the NPG and therefore the question in how far DHL can plan the optimization of the ULD – procedure, in advance. Also, the interaction between breakers, belts and builders has to be reviewed.

The first point of ULD planning is shown in table 4 [20, Appendixes]. There, the flight number, the net weight, and the optimal ULD quantity can be scheduled. It is also possible to plan the density of every container. With this extrapolation the available and needed containers are determined, too.

Table 5 [20, Appendixes] is another instrument of showing the actual capacity planning at DHL Air Hub Leipzig/Halle of several past flights. In this table, the flight number, destination, maximum payload, planned ULD density, and the actual flight density is shown. By using internal software and several schedulers, the equivalent containers and flight densities are planned in advance. The number and places of parcels in every ULD are evaluated by extrapolations. The correct place of every parcel in an ULD is not exactly determined. The maximum gross weight of every flight is also known in advance, but not the exact weight of every parcel.

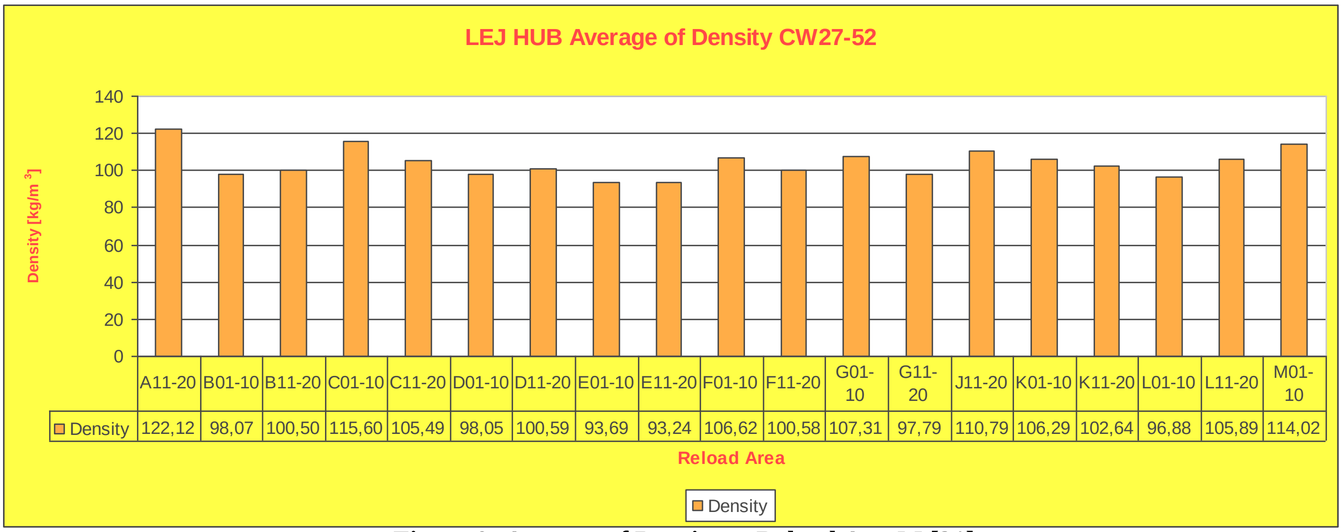

Figure 9: Average of Density at Reload A to M [21]

Figure 9 shows the reached density at every reload after a detailed capacity planning from 5 July 2010 (27th calendar week) to 31December 2010 (52nd calendar week). The differences at every Reload may often be due to a different high quantity of parcels and different handling methods of employees. I suppose, that every ULD capacity planning at every Reload can be seen as nearly similar. The target density of 140kg/m^3 is not reached at every Reload, because the best Reload A11-20 only reaches approx. 122 kg/ m^3.

2.2.4 Belly loading procedures

In every cargo aircraft, cargo compartment space for ULDs is provided in the lower and main deck. In addition, parcels or relative small goods can also be transported in small-sized parts in the belly of an aircraft (in bulk).

A frequent belly loading at DHL Air Hub Leipzig/Halle is another important elementary system of the density-process.

Therefore, it is relevant that this belly loading in bulk is only needed when the capacity of ULDs is exhausted. Very often, express parcels are transported in the belly to discharge them very quickly at the destination.

All parcels that are assigned for the belly loading, have to be stored and concentrated at one place at the Sort of the warehouse to transport them together to the relevant cargo aircraft.

2.2.5 Handling of conveyable and non conveyable goods

After the arrival of a DHL cargoliner at DHL Air Hub Leipzig/Halle, ULDs including parcels are transported to the warehouse to break them down for the transport on conveyor belts. But not all goods (for example: pallets) can be transported on so-called conveyor belts. Therefore, it is necessary to distinguish between non-conveyable goods (NCY) and conveyable goods (COY).

Non-conveyable goods are parcels that can not be sorted by means of the automatic sorting system of DHL in the warehouse because of its dimension, its content or its material (example: parcel). They pass through other processes.

Conveyable goods are parcels that can be sorted by means of the automatic sorting system of DHL in the warehouse because of its right dimension, its right content or its right material.

This elementary system is an important determining factor for the density-process. The loading procedure of an ULD with the basic of a pallet has to be clarified.

2.3 Density Enhancement Initiative Prerequisites

2.3.1 Objectives

To improve ULD density, optimize flight capacity and create the condition to sustain and improve density achievements, concrete aims have to be defined.

The main objective is to improve ULD density up to 140kg per m³ at DHL Air Hub Leipzig/Halle and all over the world (Lej Build and Overall). So the so-called target loading density has to be reached on intercontinental and continental flights. If it is possible to reduce the number of ULDs per flight by increasing the effiency of the build-up process, loading capacity will be available for further logistics provider. Therefore, loading capacity for several DHL flights could be sold for other market participants. By increasing the qualifications of builders and breakers and the ULD-loading-process mainly cost reductions, economies of time and augmentation of parcel's quality can be achieved.

2.3.2 Principal Causes

In 2009, employees of the DHL Air Hub Leipzig/Halle started a "Weight-Watching" - initiative. But in fact, Density is actually very low and to far from the target. This is not acceptable for overload issues and cost efficiency. Therefore, it is necessary to start the density enhancement program including the following detailed causes analysis. Table 3 has been constructed with the help of internal restricted DHL data and several weeks of observation in the warehouse.

Table 3: Principal Causes for Density Enhancement Initiative Prerequisites

Field	Cause
General	- Density to far away from the target (112kg/m³ instead of 140kg/ m³ in July 2010) - Delay of aircraft (Table 6 [22, Appendixes])
ACS (Air Capacity Sales DHL)	- Density below target → Capacity Incident: Overvolume (Figure 13 [23, Appendixes]
Current build-up model	- Incorrect Building of Transfer ULDs - Damage of light parcels by heavy parcels - Lack of staff supervision
Staff Training	- Insufficient usage of loading techniques (Table 7 [22, Appendixes] - Problem of motivation (Figure 14 [Appendixes]) - Missing Training of new staff
Capacity Planning	- No detailed capacity and weight forecast for every ULD - Problem of scheduling - Half-filled ULDs

Belly loading procedures	- Excessive Belly loading because of limited ULD capacity - Damage of parcels (Cause: heavy vs. light bellies)
Handling of conveyable and non conveyable goods	- NCY mix COY usage rarely used - Poorly built container
Transfer Goods	- Low density on transfer ULDs
Splits	- Split inefficiencies (Early closure of ULDs)

Table 3 shows the different cause in every field that causes have to be consequently regarded.
Splits are display panels at the Reload that show a builder the destination and closure time for several ULDs. They are expressed by means of a letter code (example: CGNGTW = Cologne Gateway).
Breakdowns or so called business interruptions can always appear in such a complex system. By reason of an excellent service of maintenance and very low error rates at DHL Air Hub Leipzig/Halle, they can be disregarded.

2.3.3 Critical Success Factors and Key deliverables

Before starting an initiative or amelioration campaign clear critical success factors and key deliverables have to be defined.

The ULD Build-up training to all Sort Operations and the staff/ daily supervision are two main success factors. In addition, the right forecasting in planning for all lanes and ULDs is inevitable. The awareness to this density-problem shows the means of understanding the following approaches and solutions.

Key deliverables like the full coaching on the job at the reload level, the weekly review of non-compliant density sectors, new techniques and tools plus focused reporting, new standards and a needed communication campaign are the basis for the following ideas to solve the problem.

2.3.4 Terminology of Optimisation and Simulation

Before starting Densitiy Enhancement Initiative Approaches and Solutions, it is necessary to distinguish the terminologies of optimisation and solution.

According to Rothab [17, p.106], the term optimisation refers to the study of problems in which one seeks to minimize or maximize a real function by systematically choosing the values of variables. Techniques for optimisation vary a lot depending on what the exact problem is. A logistics system depends on a lot of variables and system elements. Optimisation can quickly provide a theoretical solution for many problems, but when it comes to reality these solutions are difficult to apply. Therefore, basics and so-called system elements are needed to develop new ideas by the help of knowledge.
Simulation has already been largely discussed in several papers and has become a very useful tool for companies to make their decisions. It aims at being as similar as possible to real environment, that is why uncertainty and variability are included in the simulation process. This variability simulation can for example been shown with the help of several software tools.

The following point of this thesis describes a more efficient usage of ULDs by the simulation of the work between Sort Control, NCC and the physical and information flows between Offload and Reload by the help of a case study with "Puzzle"[15] from the "Fraunhofer Institut für Materialfluss und Logistik" in Dortmund. After this simulation, clear optimisation ideas are mentioned by the understanding of basic processes at the DHL Air Hub Leipzig/Halle.

2.4. Densitiy Enhancement Initiative Approaches and Solutions

For this Density Enhancement Initiative, planning horizons for every change has to be defined. According to Schulte [24] theses planning horizons can be divided in:

- Long-term planning horizon
- Medium-term planning horizon and
- Short-term planning horizon.

The Long-term planning horizon is a component of the strategical level of the company and includes a planning time of more than one year. The basis for this horizon shows a preceding business year.

The Medium-term planning horizon, also known as tactical level of decision making, composes a planning time of 6 to 18 months. A previous month or quarter can be seen as basic element for this planning.

Short-term planning is part of the operational decision and proceeds within a time of 1 day to 6 months. A day, a week or a month are the basis for the further developement of the project.

2.4.1 Long-Term Simulation Approach: Case Study of "Puzzle"

2.4.1.1 Preliminary observations

After the transport of a DHL container to the Offload Area, every parcel of the ULD needs to be broken down, transported on a certain conveyor belt to find automatically the way to the Reload Area where it is built up. Non-conveyable goods are transported in other ways (e.g. with a forklift) to the Reload Area. For the whole process, the cooperation between the warehouse, Sort Control and NCC is decisive.

At first, it is essential that the company DHL is only able to make estimates concerning the volume and number of parcels arriving at Leipzig Hub per night. Therefore, it is not possible to plan the accurate place of parcel or pallet in the certain ULD, in advance. Furthermore, a breaker at the Offload Area can only break down level for level of an ULD. In addition, his order of picking the parcels is an indeterminable variable. The first detailed data information of a parcel or pallet for the Sort Control and NCC is delivered by the barcode-scanning of every parcel or pallet by a breaker. This information only includes the volume and weight of the goods. Until now, DHL does not know the dimension (Length*Width*Height) of every parcel. After this scanning procedure, every item arrives in approx. 7 minutes at the Reload Area where it is scanned again and built up by the composite method.

2.4.1.2 Economic assumptions for Simulation

The aim of the simulation of "Puzzle" [15] is the realization of a perfect operational procedure between the Offload Area and the Reload Area by using data and physical flows fully and introducing a new software tool, developed by the "Fraunhofer Institut für Materialfluss und Logistik" in Dortmund.

A basic assumption describes the correct utilisation of every DHL bar code. According to several economic agents, barcodes of parcels and pallets can already contain not only the volume and weight of every item but also the right dimensions [25]. This information can be implemented very easily from (e.g. a customer) by completing the parcel label.

Consequently, after scanning every parcel, the Offload Area and Sort Control could know the weight, the volume and the dimensions of every parcel by entering 3 other variables to the barcode.

Furthermore, dangerous goods and pallets, even if they pass trough a separate process, have to include these information, too. With this first scanning, it is possible to generate a virtual loading procedure of every parcel, pallet and dangerous good for every ULD.

Another assumption is the determinability of every parcel's way by the automatic sorting system. This data secure the correct Reload-slide for every scanned parcel. After the Offload procedure and the transport on several conveyor belts, the several way of every parcel is determined in advance by Sort Control.

During the Offload of for example 4 ULDs with 4 parcels for the destination Bergamo, it is not guaranteed which parcel arrives at first at the corresponding reload chute, that can be neglected and is not relevant for the software.

Radio Frequency Identification (short: RFID) can be seen as another important assumption for implementing this software. It is "a generic term that is used to describe a system that transmits the identity (in the form of a unique serial number) of an object or person wirelessly, using radio waves"[26]. With RFID, the 2D-Code (Barcode or Matrixcode at DHL Air Hub Leipzig/Halle) can be replaced. This new tool allows the identification of every parcel without intervisibility, the disregard of polluted identification codes, a high data capacity and a bulk capturing. Therefore, in future, it can be possible to have a lot more detailed, quicker and listed information because of the memory chip in this system that allows a faster identification.

2.4.1.3 Execution of "Puzzle" - Cargo

By scanning every parcel at the Offload Area, every corresponding ULD is dedicated by the Sort Control. During this scanning-and identification procedure, every parcel can be virtually loaded in the corresponding ULD what the following case study explains.
The figures 15 to 25 in the appendix show the main clarification of this case study and are part of my further explications.
During the scanning procedure, the Sort Control has to create a so called "New Project" on the user interface of "Puzzle" (see Figure 15 [15, Appendixes]). After this procedure, the corresponding order has to be defined (see Figure 16 [15, Appendixes]). Therefore the correct ULD type has to be chosen. The software provides a choice between 18 types of ULDs and Air Cargo Pallets. Goods for this container are named Box, Bundle, Crate, Cylinder, Pack or Production Pallet and can be introduced in a very easy way. For this study, 5 boxes and 1 pallet (with standard dimensions) are chosen.
Figure 17 [15, Appendixes] shows the dimensions and information of the used AAY-container. The dimensions are standard dimensions of air cargo ULDs and include the interior and exterior measurements. The weight of this ULD can also be seen as very common in air cargo industries.
The next Figure 18 [15, Appendixes] shows the diversity of a box in "Puzzle". Because of the high number of parcels arrving at DHL Air Hub Leipzig/Halle every night, the Box Outer Dimensions (Lenght, Width, Height) and the weight are relevant for this field of study.
The examination of the chosen Production Pallet is mentioned in figure 19 [15, Appendixes]. The term "Production" has to be neglected because of the fact that DHL only serves as logistics provider. However, this part of the software also shows the most important details of an air cargo pallet; the exterior dimensions and the weight of the pallet.
Figure 20 [15, Appendixes] shows the most important point of this software tool; the introduction of the quantities of every box and pallet. In this case study, 5 boxes with comparative and different dimensions and weights are part of the corresponding ULD. One pallet is introduced with a Length of 1200mm, a Width of 1000mm, a Height of 800m and a weight of 150kg. Of course, at the DHL Air Hub Leipzig/Halle there are a lot of different boxes with different dimensions per container. They could be introduced in this software, too. With a quantity of 530 parcels and one pallet, this container is

loadable according to Weight usage of the loading device and the Volume usage of the loading device. The number, the sequence, the delivery date and the delivery group can be neglected. Before starting the execution of the loading calculation, different setups are generated (Figure 21 [15, Appendixes]). An optimized calculation expresses the utilisation of 10 different strategies (A to K). The ULD's height and the act of ignoring delivery groups is also used within this study.

After the execution of this calculation the 10 different loading strategies are passed through in a very short period of time (Figure 22 [15, Appendixes]). In the next Figure 23[15, Appendixes], the results obtained are mentioned in a very clear design. Actually, there are 531 goods in this container that can be built up by the help of the different visualisation possibilites that are shown in the Figures 24 and 25 [15, Appendixes].

2.4.1.4 Built-up process Reload

The idea of supporting the known composite method by the visualisation of assembly instructions by the help of this software is only possible when data flows between the Offload Areas and the Sort Control operate free from defects. In addition, new data flows have to be established at every Reload Area. In advance, it has to be guaranteed that the data flows between the Offload and the Sort Control have to function without any problems. The software "Puzzle"[15] is compatible with a high number of planning and controlling systems which is also a precondition at the reload.

In future, at this hub Reload activities could be influenced by the visualisation of load plans of every ULD and of every Split. Theses visualisations could be introduced by numbers of "step-by-step" loadplans, because the Offload Area also needs to have a certain time to break down the relevant ULDs. Another visualisation method could be the accomodation of display screens that show the different loadplans and that are updated by the Sort Control.

Consequently, a composition of virtual and physical building-up is standardised (see Figure 10). It supports the understanding of the developed processes between Offload, Automatic Sorting System and Reload.

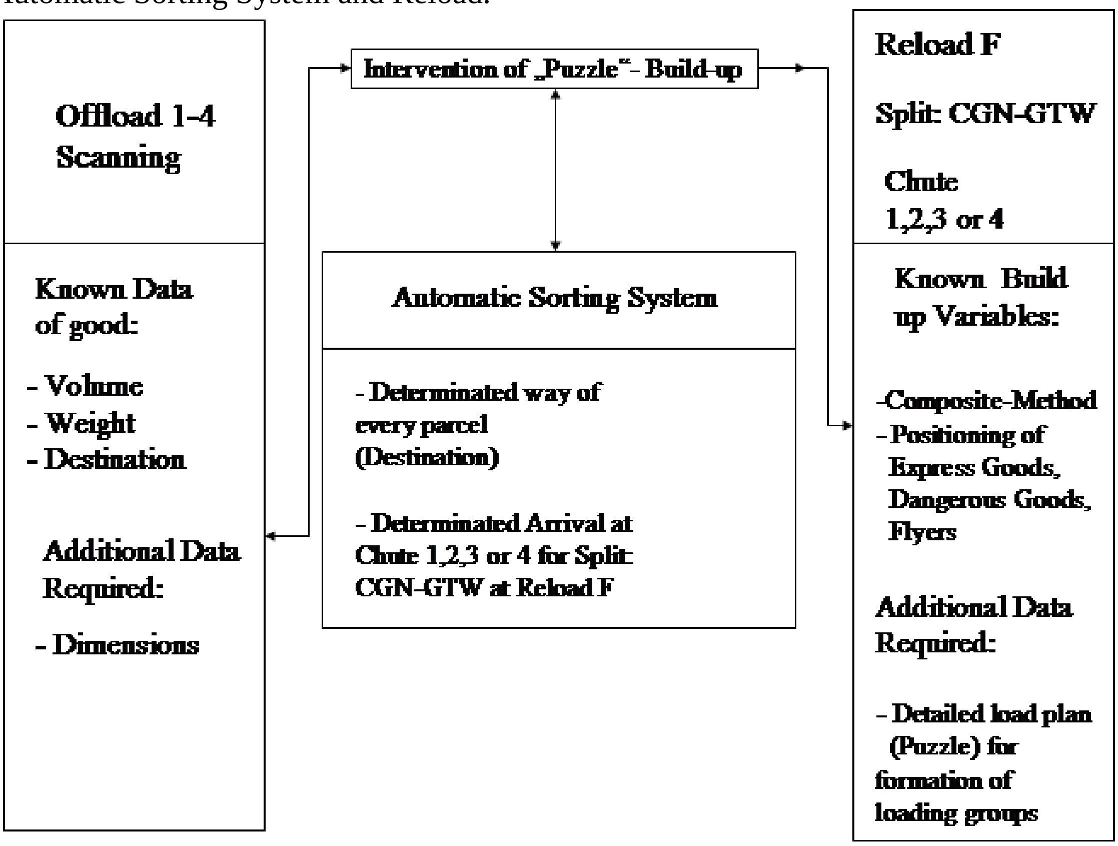

Figure 10: Intervention of "Puzzle"[15] in Offload and Reload

2.4.1.5 Agreements

The software "Puzzle"[15], part of the expression of intelligent logistics, allows without question a more detailed build-up and scheduling of ULDs and especially transfer ULDs. It integrates the improved coordination of heavy and light parcels and the standard positioning of "Flyers", "Express Deliveries" and "Dangerous Goods".
But a builder is not able to identify every parcel in "Puzzle"[15] because of the high number of parcels with different dimensions. But for all that, this software shows, that it is impossible to start the build-up of a ULD by beginning with light and small parcels. Because of the variable, that every parcel is introduced in this logistics system by the customer choice of its dimensions, a high number of parcels will never be placed exactly where it is needed. "Puzzle"[15] allows an illustration of this complex build-up by choosing the right place for pallets and parcels with big dimensions. Then, a relevant formation of groups is possible.
The calculated and accurate shipment density can only be reached when a small ULD with big parcels has to be built up.

2.4.2 Medium-Term Optimisation Approach: Training of staff

According to internal data of the Human Ressources Departement of DHL Air Hub Leipzig/ Halle, only 35 % of builders and breakers actually benefit from the ULD Build Up Course where new staff is trained by a “theory part” and an "on the job training".
Here an “on the job training” consists of Coaching, Job Rotation (between Reload and Offload), Job Enrichement and Job Enlargement (possibility of being a supervisor).
Therefore it is first of all necessary to guarantee this training for every worker before the beginning of an employment. After the active and passive training before and during the first weeks of employment, it is also necessary to guarantee regular training tests for builders and breakers.
Theses tests could be a kind of control of accomodated knowledge in the past that are relevant for every ULD-loading.
According to the course Coaching "Persona" from the University of Applied Sciences in Jena, every builder and breaker is surrounded of a team. Every team needs to have a mix of experienced staff and young professionals that affirms Figure 11:

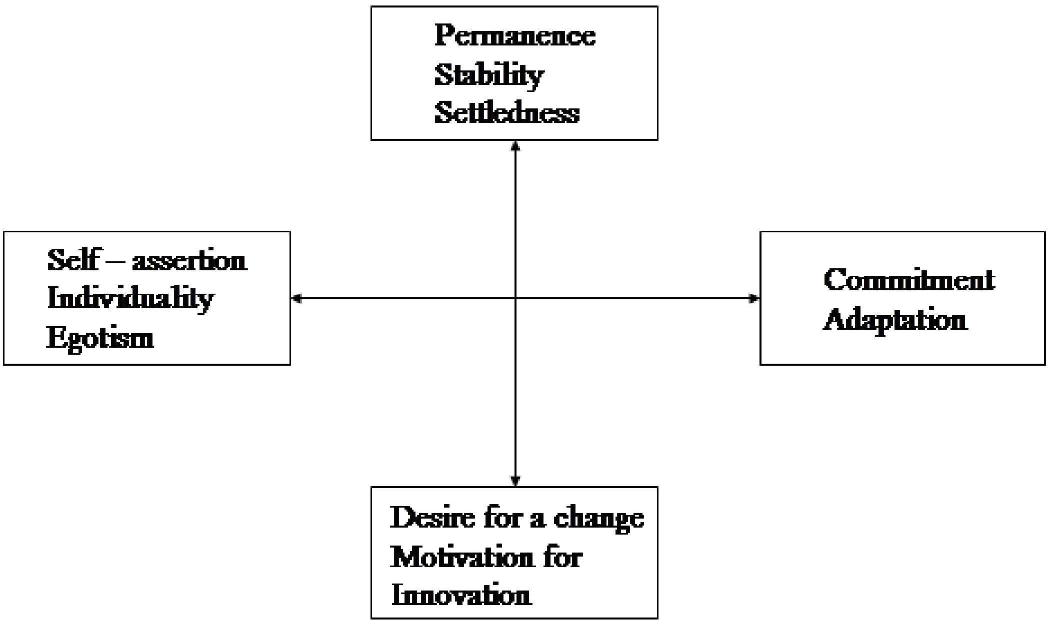

Figure 11: Social role - Homoeostasis in a system [27]

A team always consists of these 4 different characters with different ambitious efforts. The desire for change can meet the extremes permanence and stability. Adapatation is contrary to Self-assertion. But it is the composition and the medium of these characters that express the sort of teamwork; because it is teamwork that is a suitable means to increase motivation and awareness. Therefore, every team at an Offload or Reload has to be composed accurately. Also, DHL has to guarantee the right mixture of experienced staff and new staff.

2.4.3 Medium-Term Optimisation Approach: Staff Supervision

At the DHL Air Hub Leipzig/Halle, supervisors at every Reload Area are established to control, guide and navigate the builders during their shifts. Figure 12 shows the essential position of such supervisors for every company. They are the alliance unit between the Middle Management and the workforce (followers).

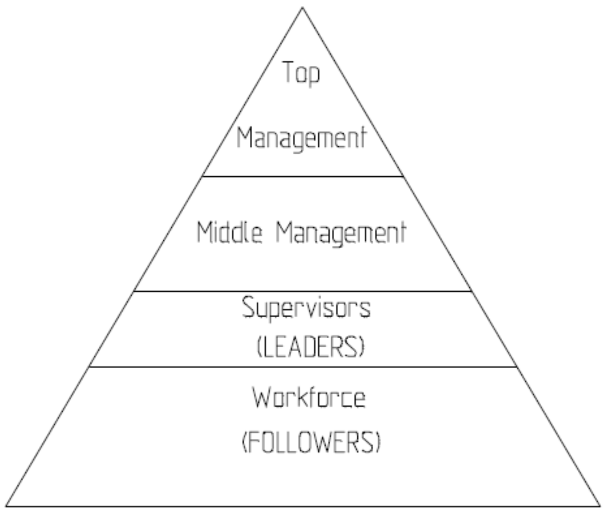

Figure 12: Position of a Supervisor at DHL Air Hub Leipzig/Halle

Supervisors at the Reload receive orders from the Middle Management and give reports to them. They give orders to workers and receive orders from them.
Supervisors already exist in this company, but they are present only a certain period of time in each shift at every Reload. All supervisors are experienced staff and appoint the workers for every chute or slide before a shift. If necessary, they delegate a second employee to a chute, if the number of parcels is acutally too elevated.

A high number of supervisors at the Reloads in the company have a good knowledge of technical facts, a theoretical knowledge to support the demonstrations, authority and self confidence[28, p.6].

Further ameliorations are necessary and include the following points:

- better planning and communication of high numbers of parcels arriving at certain chutes
- augmentation of teamwork by increased support of builders in periods of high numbers of arriving parcels
- appraisal and short interviews with every builder once a month
- better communication between the Middle Management and workers to increase workers' motivation.

2.4.4 Short-Term Optimisation Approach: Belly loading procedure/ Handling of COY and NCY

Actually, belly loading is too excessive at DHL Air Hub Leipzig/Halle. Therefore, when dealing with belly loading standard time agreements have to be established[4]. Furthermore, a difference between light and heavy bellies in terms of the positioning at the aircraft is needed. Goods in bulk very often show a lot of differences in its weight. Therefore, the difference of light and heavy bellies ist now always considered. Every good has a huge status in the logistics chain according to the customer service level. Therefore, the perception to do it for the goods' quality of every worker dealing with belly load is needed, too[4]. Also, it is necessary to choose departure times for drivers at the warehouse with belly load to guarantee the scheduled arrival of every aircargo plane.

The NCY mix COY usage is an other elementary system where processes have to be improved. Due to the anticipated and early closure of units, the incorrect or missing planning and due to the lack of knowledge of techniques, this handling method is rarely used. By means of the software "Puzzle Pallet"[15], also pallets can be composed and planned in advance for every ULD [29, p.4]. It is adequate to scan the needed parcels at the Offload for the designated ULD to build up a safe and well-constructed pallet by the loadplans of "Puzzle Pallet"[15]. They are comparable with the loadplans of "Puzzle Cargo"[15] for every ULD. By the use of "Puzzle Pallet"[15] also transfer ULDs can later on be optimised.
In addition, the general low volume of inbound transfer splits can be maximized.

3 Discussion

Optimisation chances in companies are the product of a high number of human ressources and complex processes. The treated subject of this bachelor thesis describes a kind of "virgin soil", because of the limited confirmations in literature and the contingently available data of reasons at DHL Air Hub Leipzig/Halle.
A few years ago, the first basic approaches of pallet- and ULD-optimisation were developed by the help of the mentioned forms of heuristics [12, p.1].
The first approach of the so called Strip Packing Problem (SPP) considers a container where two of its dimensions are fixed (e.g., width and height) and the third dimension (e.g., lenght) is a variable of the problem [30, p.2]. The problem consides in how to load all boxes of different sizes inside the container, so that the variable dimension(lenght) is minimised. The Bin Packing Problem consists of multiple containers of the same fixed sizes and costs, and of deciding how to load all boxes, so that the total number of used containers is minimised. Another problem is the Multi-Container Loading Problem (MCLP) where containers do not necessarily have the same sizes and costs. The problem consists of deciding how to load all the boxes so that the total cost of the chosen subset of containers to be loaded is minimised [30, p.2].
Logistics specialists have also identified the Multiple Heterogeneous Knapsack Loading Problem (KLP) that composes "a strongly heterogeneous set of small items, each of which is characterised by a specific weight and profit, has to be packed into a set of knapsacks and distinct capacities"[31, p.14]. With the help of complex formulas and adumbrations [32, p. 9, fig.3] density and optimisation problems were solved. This means the identification of all fully supported spaces, the identifaction of all feasible placements of single boxes, the evaluation of the box-space combinations found, the selection of the combination with the highest score and the placement of the box and at the end the update of all relevant parameters [13, p. 956]. But also, these heuristics do not show the optimal ULD utilisation.
Nowadays, with the enormous developement of air cargo logistics and the defined ground time of cargo planes, the combination between computer science (especially integer linear programming) and executing employees is the key to success.
For the efficient application of this thesis it is therefore necessary to distinguish several aspects.

3.1 Dependencies

The demonstrated approaches are firefighting actions instead of a step-by-step planned approach and have to be effected according to their time horizons. After every time horizon a certain review can be seen as a kind of real control. In addition, there is the need of the belief that “Density” is the responsibility of every employee of DHL and a real teamwork. It is the note of exclamation of this hub and the concentration of mentality for this problem is needed by the help of everyone. The whole process can be seen as a kind of density-kaizen (what, who, why, how, when, and where). Furthermore, light volumetric shipments in a minimum of time are only possibly with volume patterns.

3.2 Powerful appearence of virtual logistics

These days, flows and processes of a logistics company can be represented with the help of so-called virtual analysises. This means, that there are a high number of logistics software providers who optimise pallets, containers or significant unitised traffic flows by software tools like the used "Puzzle"[15]. At present DHL uses this software tools to control the chain of ULDs. But with "Puzzle"[15], I suppose to provide evidence that a lot more virtual fields at the company are still unexplored. And between these software firms like Ortec [33], Multiscience [34] and Erpa [35] already exists the competition that is needed for fast improvements of the existing products. It is possible to optimise all kinds of means of transport but in advance it is obvious to realise the needed interrelation of processes.

3.3 Pros and cons of "Puzzle"

This interrelation with "Puzzle"[15] was simulated in this thesis and reaches a density of 140kg/m³ with optimal used ULDs (Figure 26 [Appendixes]). But with the possible introduction of "Puzzle"[15] pros and cons have to be regarded.

The software "Puzzle"[15] is compatible with a high number of guidance systems, a relatively low initial cost and a high useability. It can bring an active support and an augmentation of motivation for the builders at the Reload. In addition, it shows a

general decision-making aid for the start of an ULD loading. Furthermore, "Puzzle"[15] is able to group different zones within the ULD and is mainly helpful for the loading of pallets and big parcels. Particular pallets that have to be loaded in an ULD, can be composed by means of "Puzzle[15]", too.
Therefore, the software smooths the way for a reduction of the ACS overvolume (Figure 10 [23, Appendixes]). Enormous costs savings can be reached by the improved ULD-scheduling.

With the introduction of "Puzzle"[15] certain cons have to be regarded, too. Therefore, a big work consists of the change of the Bar- or Matrixcode with the introduction of RFID (Radio Frequency Identification) for parcels or pallets. In addition a certain time, additional personnel and product costs (e.g. 1 RFID – label per parcel = 0,20 €) have to be planned, too. The actual software does not follow a proper identification of every parcel. Also, costs have to be allowed for the input of printers (for the loading plan) or virtual display panels at every Reload.

3.4 Risks and Challenges

The augmentation of quality work of breakers and builders beside the introduction of "Puzzle"[15] is only possible by regular training and the exchange of builders/breakers and the Middle Management (by the expression of Staff Supervision). The Density awareness has to be improved regarding all belly loading procedures.
The better handling of conveyable and non conveyable goods can be reached by the software "Puzzle"[15].

3.5 Outlook

"Puzzle"[15] shows the image of real ULD loading factors and utilises common dimensions and weights. It is necessary to sustain the already existing relationship between DHL and the "Fraunhofer Institut für Materialfluss und Logistik" [36]. This alliance has to be used to optimise "Puzzle"[15] to use it for all operational days at the DHL Air Hub Leipzig/Halle. Another method is the maintenance of contacts to other software companies because the development of these software tools is actually growing very fast.

The future will be the automatic identification with expensive reading devices of every scanned parcel, the visualisation by a corresponding software and the scheduling of its place at the ULD. So every builder can see the appropriate placement and has only to put it in the ULD without personnel planning of the ULD.

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DHL Air Hub Leipzig/ Halle: Capacity Planning.Network Planning Group.August 2010

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DHL Air Hub Leipzig/Halle: Average of Density (calendar week 27 - 52 / 2010)

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Junqueira L., et. al.Three-dimensional container loading models with cargo stability and load bearing constraints. Computers and Operations Research, 2010

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URL:http://lamp.urz.uni-magdeburg.de/~mansci/themes/ManSci/daten/daten/public2007/typology.pdf
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Transport Research: Loading optimization of palletized products on trucks(2000):
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4.4 Training Programs

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ULD Build Up Course and training material, August 2010

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4.5 Software

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PUZZLE – CARGO. Optimisation of loading and shipping units (Trial version), Fraunhofer Institut Materialfluss und Logistik, May 2009

5 Appendixes

5.1 Tables

Table 4: Capacity Planning 1 at DHL Air Hub Leipzig/Halle [20]

FLIGHT	ORG	DST	SPLIT	ULD ORG	NET WEIGHT (MD)	OPTIMUM ULD ABU 7,9	AAX 14,3	PAG 12,0	AAA 12,5	AAC 11,8	AXY 6,8	AAJ 10,3	ALP 7,1	AKE 4,3	AVAILABLE VOLUME	DENSITY SPLIT	DENSITY FLIGHT (basis 120	ACTUAL DENSITY P/U 16.09.	DEVIATION ABSOLU	DEVIATION RELATIV
BCS6411	LEJ	LTN	LHRTRAESO	LEJ	4284	0	3	0	0	0	0	0	0	0	42,9	99,86	115,89	100,90	-14,99	-0,13
BCS6412	LEJ	LTN	LHRGTWEXPDOX	LEJ	12412	0	6	0	0	0	0	0	3	0	107,1	115,89	115,89	100,90	-14,99	-0,13
BCS6413	LEJ	LTN	LHRHUB	LEJ	8357,5	0	2	0	2	1	0	0	0	0	65,4	127,79	115,89	100,90	-14,99	-0,13
BCS6414	LEJ	LTN	LHRTRAESO(IN)	LEJ	2876,5	0	0	0	0	0	0	2	0	1	24,9	115,52	115,89	100,90	-14,99	-0,13
BCS6415	LEJ	LTN	NBOHUB	LEJ	452	0	0	0	0	0	0	0	0	1	4,3	105,12	115,89	100,90	-14,99	-0,13
BCS6416	LEJ	LTN	LHRTRALAT(AU)	LEJ	3719	0	0	0	0	1	0	2	0	0	32,4	114,78	115,89	100,90	-14,99	-0,13

Table 5: Capacity Planning 2 at DHL Air Hub Leipzig/Halle [20]

for proper view, please filter column "B" for "nonblanks"

Weight Load Factor: 82% | Target = 80% | Density All Flights: 106,9 | 24.Sep.2009

Page	Flight Number	Destination	Registration	Net Load kg	Gross kg	Max Payload kg	Underload	Volume Load Factor	Weight Load Factor	Avg. Available Uld Density	optimum (plan ULD) density	Used Net kg	Used Volume m³	FLIGHT density act	Net Loose Weight kg	Not used Uld Pos.	late trf freight	op. uld not avbl	non follow-up allocation issue		allocation issue details	overload details
2	BCS6351	TKU	TFBBE.	7880	9044	**18989**	9945	38%	48%	124,8	123,5	7720	61,8	124,9	160	4						
4	MNB949	IST	TCMNA.	30047	34675	**35368**	693	30%	98%	128,4	125,7	12875	102,4	125,7	0	4						
4	PO948	HKG	N416MC	50339	57242	**78897**	21655	77%	73%	112,0	102,2	41546	372,3	111,6	0	0	X					
5	BCS6276	VIT	GBMRH.	20484	23462	**24807**	1345	73%	95%	107,7	105,2	19117	179,0	106,8	1367	0	x		x	x	2 ULD ex BGY ira 1, 1 ULD ex CGN ira 2, 7 VITHUB ex LEJ ira 4, 2 LIS ULD ira 0, no SVQ	
5	BCS6358	VIT	ECKVD.	9681	11615	**18283**	6668	61%	64%	82,0	81,9	8363	102,1	81,9	1318	0			x	x	1 LIS AAA ira 2, 2 SVQ ira 1, 2 VITHUB ira 4, 2 OPO ira 0	
5	BCS6257	CPH	OODLD.	26908	32462	**36611**	4149	85%	89%	94,4	91,5	26908	285,1	94,4	0	1	x		x	x	BRU send 2 AAC CPHHUB ira 4, EMA send 1 AAC CPHHUB ira 2 AAA, Sort build no AAC CPHHUB, Frau didn't send 1 AAC CPHHUB, loaded 4 AAJ CPHHUB and 4 ALP,	
5	BCS6011	BUD	GBIKM.	21154	24222	**28385**	4163	71%	85%	114,8	113,4	19186	167,9	114,3	1968	1			x			
5	BCS6142	BLQ	GBMRA.	12406	15466	**26416**	10950	49%	59%	97,9	94,2	12406	128,3	96,7	0	4			x	x	2 FLR GTW iso 1	
5	BCS6296	WAW	ECKDY.	12723	14605	**17872**	3267	70%	82%	103,4	102,1	9987	97,1	102,9	2736	0			x	x	used one AAA for MSQ iso AAJ	
7	BCS6466	CIA	OODLP.	21924	25239	**28383**	3144	64%	89%	113,3	111,3	17453	154,0	113,4	3802	0			x			
9	BCS6765	CDG	OODPJ.	24782	27894	**28719**	825	44%	97%	128,0	119,1	12711	99,4	127,9	2866	0	0	0	0	0	0	0
9	BCS6848	CDG	OODPN.	21030	24399	**28757**	4358	67%	85%	95,1	93,6	17009	175,5	96,9	4021	0	0	0	x	0	0	AAA5432DHL/CASACS
9	BCS6915	GVA	GLOFD.	8063	9549	**12604**	3055	72%	76%	95,5	95,0	7559	79,6	95,0	504	0	0	0	x	0	0	0
9	TUP602	SVO	RA6403	20684	23558	**25216**	1658	39%	93%	117,5	125,5	11448	91,2	125,5	1490	0						
9	BCS6802	LNZ	TFBBF.	11904	13611	**16124**	2513	76%	84%	106,1	103,5	10571	101,4	104,3	1333	0			x			

Table 6: Reasons for Delay of Aircrafts at DHL Air Hub Leipzig/Halle[22]

OUTBOUND	
Total Departures (AIR)	58
Ground Operations Delay	**20**
Operator Delay	1
Reactionary Delay	3
Uncontrollable	1
Ground Operations Performance	65,52 %
Overall Performance	56,90 %
Airfreight Tonnage	1,273,211kg
Road Tonnage	135,125kg
Total Weight	1,408,336kg

Table 7: Insufficient usage of loading techniques at DHL Air Hub Leipzig/Halle [22]

OUTBOUND AIR
Selected days were:
3. BCS6296 (LEJ-WAW) ATD 05:05LT - 12,570kg departed 51 minutes late because of late completition by loading rescources
4. BCS6351 (LEJ-TUK) ATD 05:55LT - 13,079kg departed 50 minutes behind plan because of late completition by loading resources
5. WLX6063(LEJ-LUX) ATD 05:17LT - 4,816kg departed 47 minutes after scheduled time due to late completition by loading resources

5.2 Figures

revision 22/04/2010

etter code of OH location, **otherwise** leave it blank and use **column A**

either	or	and	and	and		and/or				
Flagging	**ORG mtl**	**DEST mtl**	**Product Group**	**COY/NCY**	**MVT#**	**Sector** ORG-DEST		**Net Volume**	**Weig in %**	**Capacity Incident**
* ICEATHONLACP(GME)NCYFRA PIO1	FRA	ATH	ACS	NCY	BCS6754	LEJ-ATH		463	100	OVERVOLUME
* ATHONLACPORGAMS PIO1	AMS	ATH	ACS	N/A	BCS6754	LEJ-ATH		614	90	OVERVOLUME
* ICEBUDHUBACSACP/DNCYLEJ PIO1	LEJ	BUD	ACS	NCY	BCS6011	LEJ-BUD		1150	80	OVERVOLUME
* DGRSOFGTWACP/DNCYORGLEJ	LEJ	SOF	ACS	NCY	BCS6321	LEJ-BTS		2009	100	OVERVOLUME

Figure 13: DHL Air Hub Leipzig/Halle Air Capacity Sales Overvolume [23]

Figure 14: DHL Air Hub Leipzig/Halle Insufficient Container Organisation

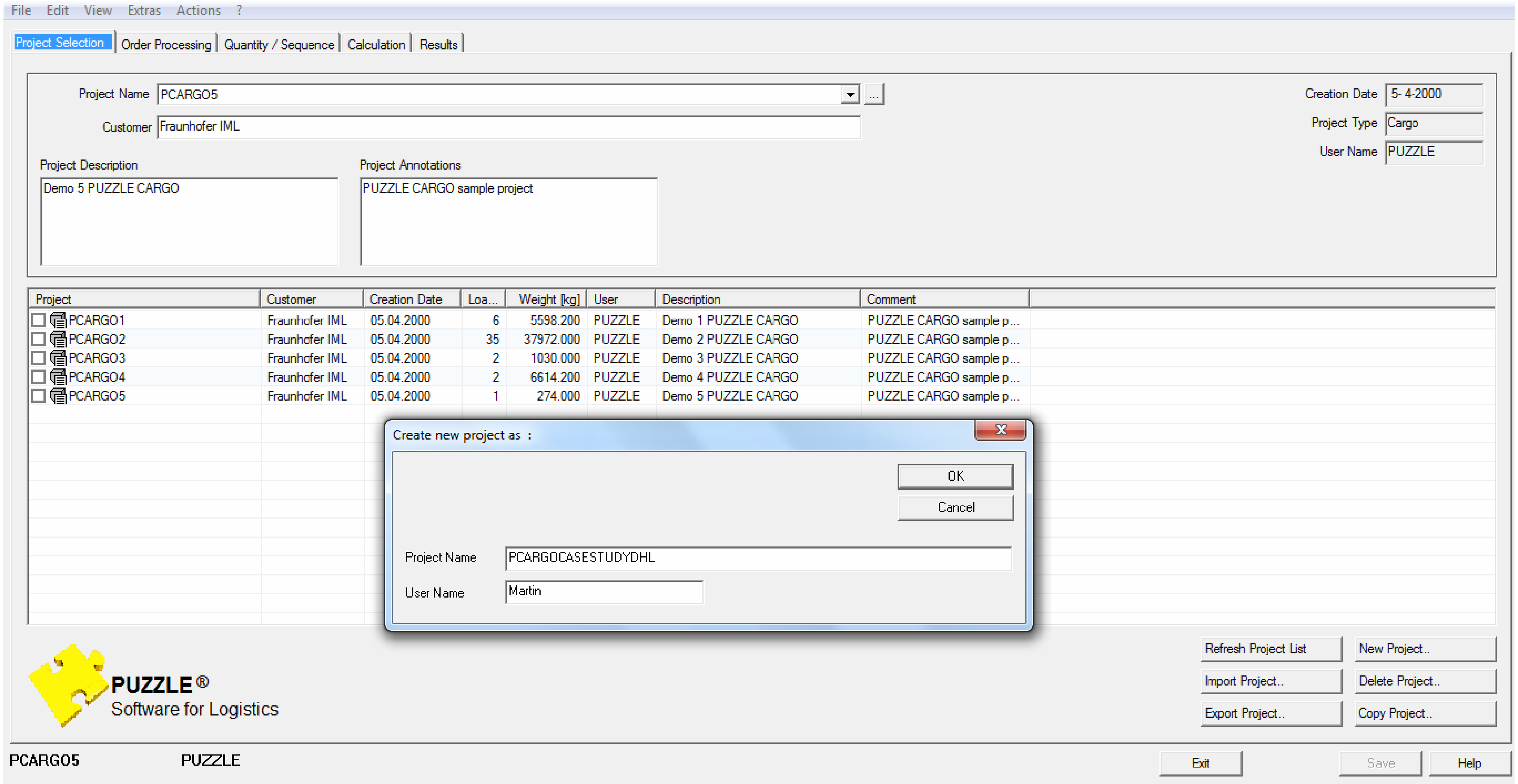

Figure 15: Start of a new project [15]

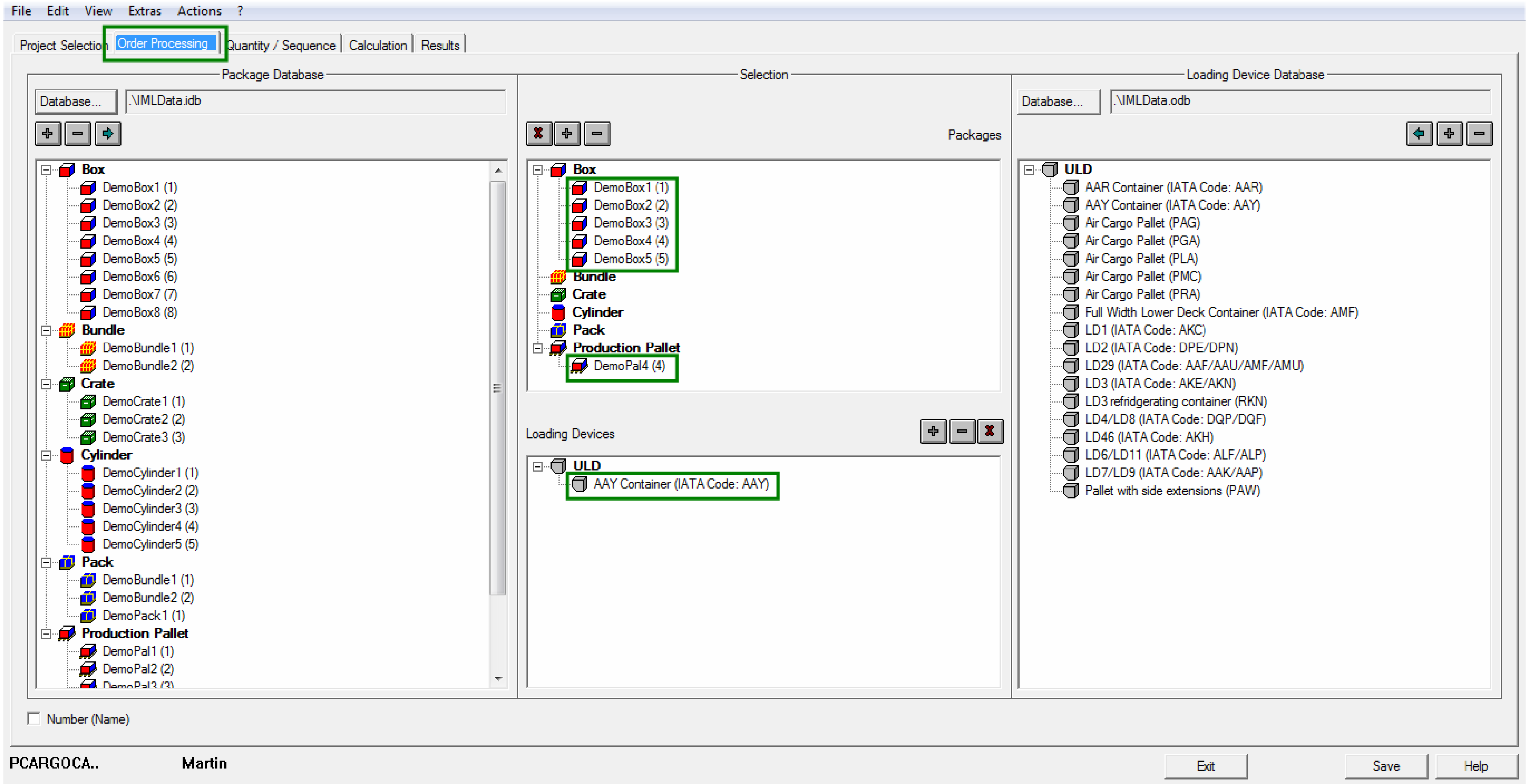

Figure 16: Definition of corresponding order [15]

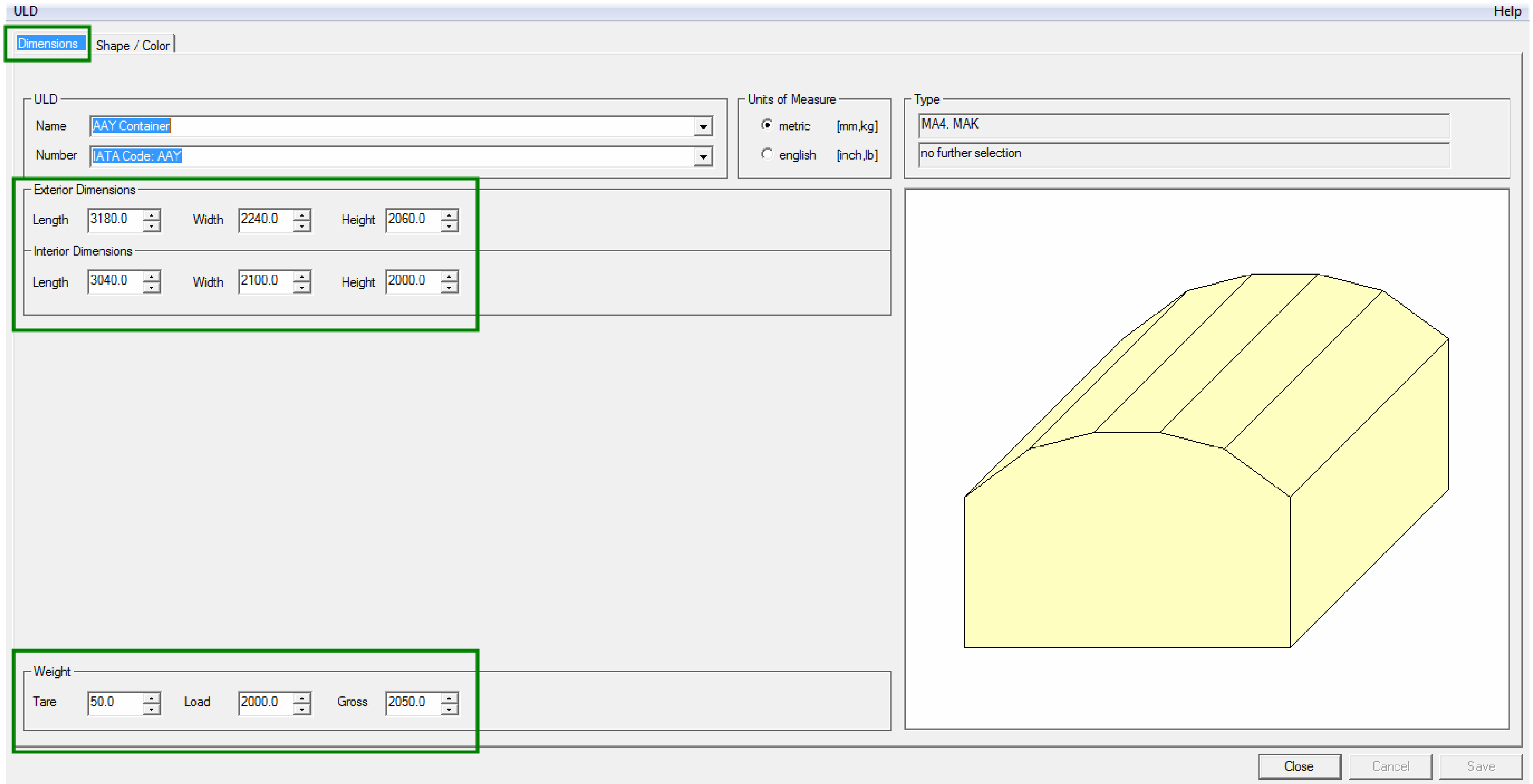

Figure 17: Dimensions and weights of the used AAY - Container[15]

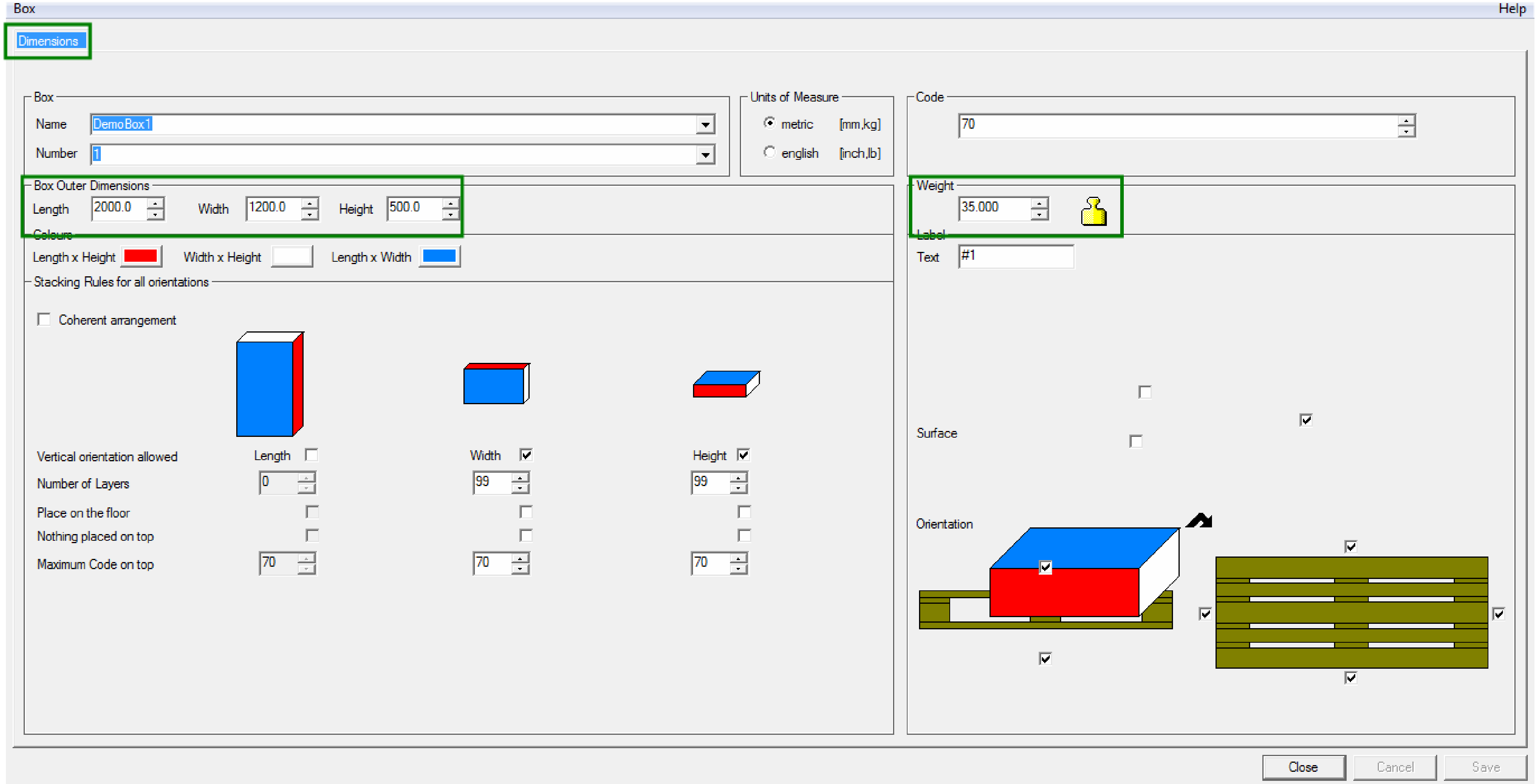

Figure 18: Dimensions and weights of a box [15]

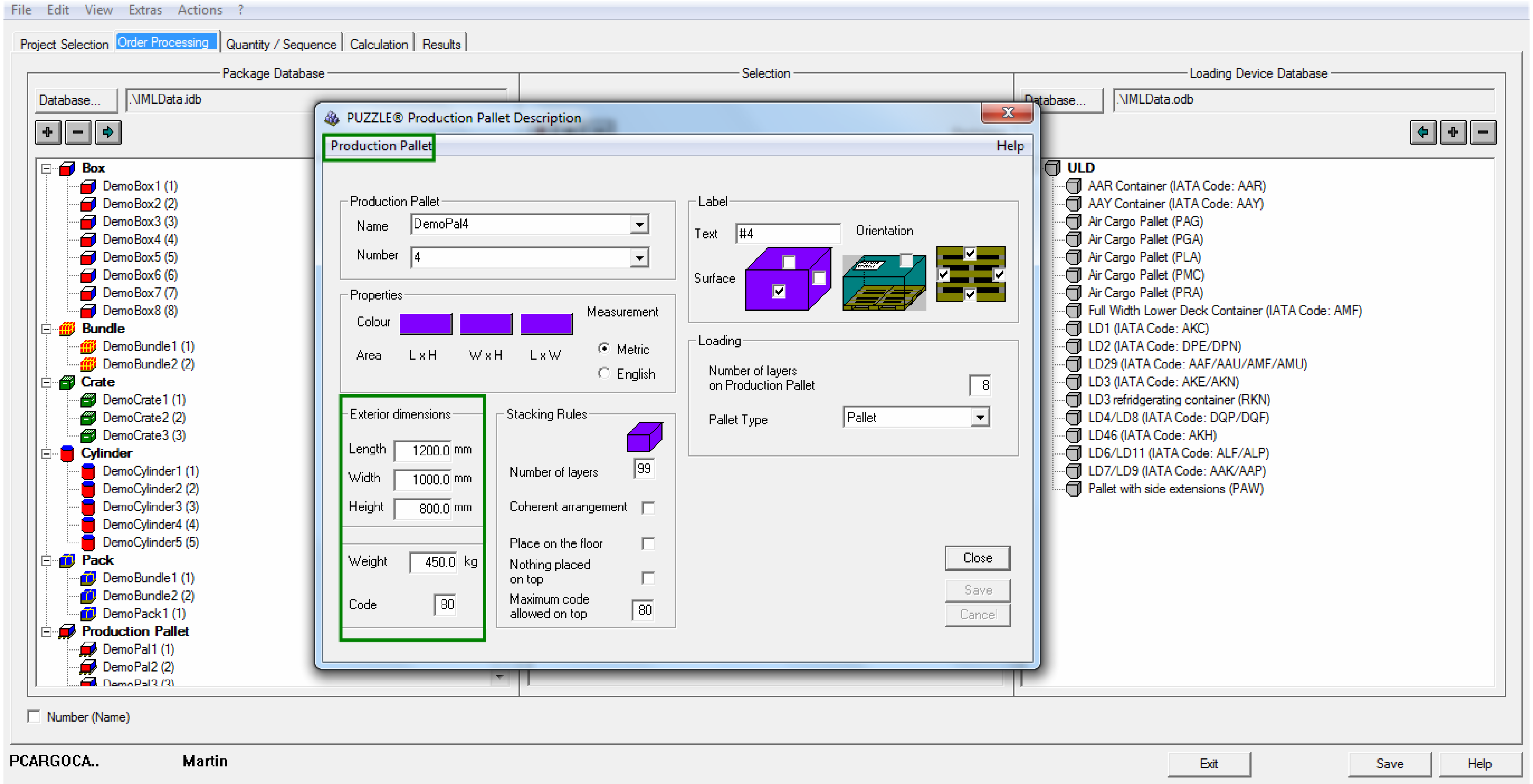

Figure 19: Dimensions and weights of a pallet [15]

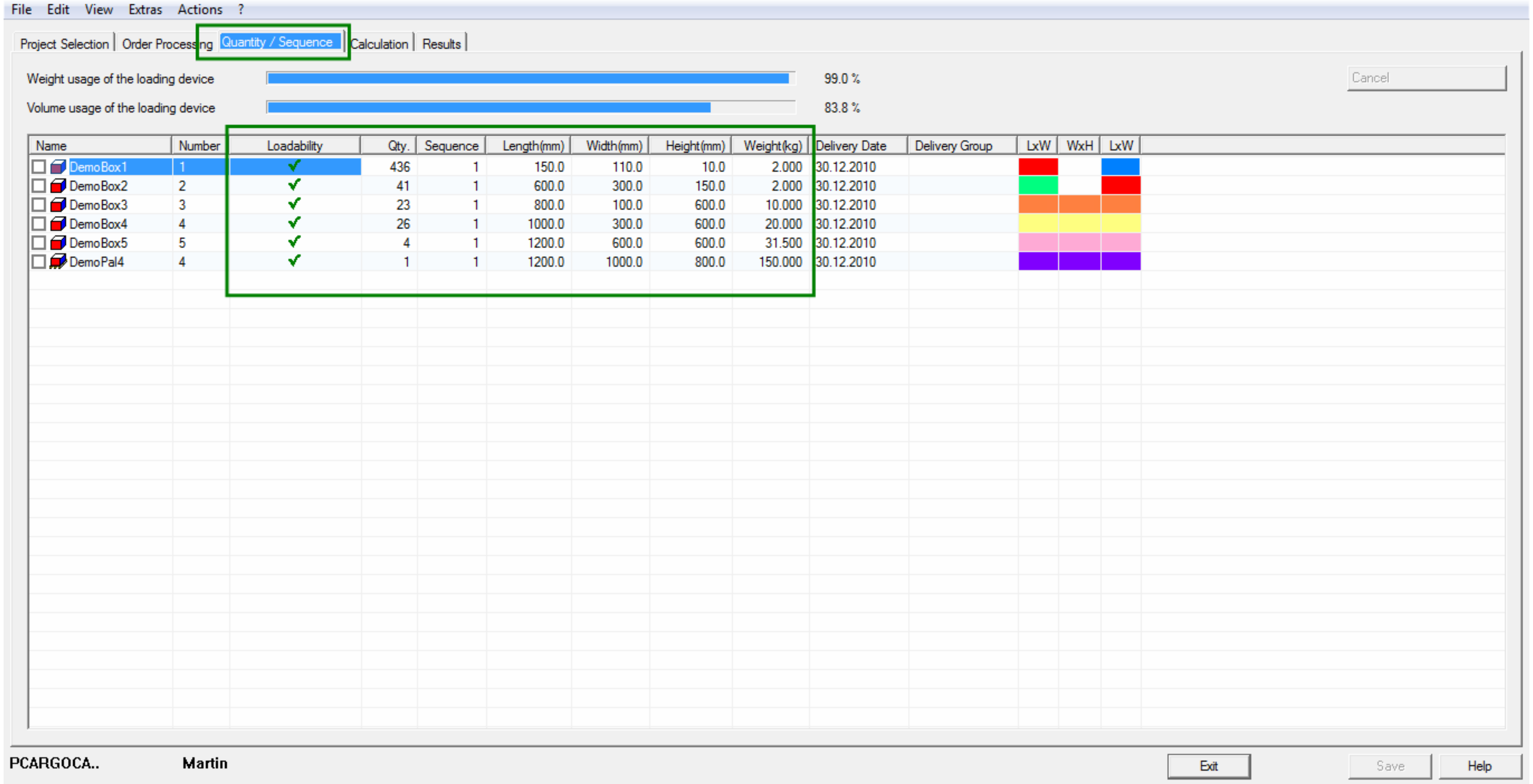

Figure 20: Introduction of quantities and sequence [15]

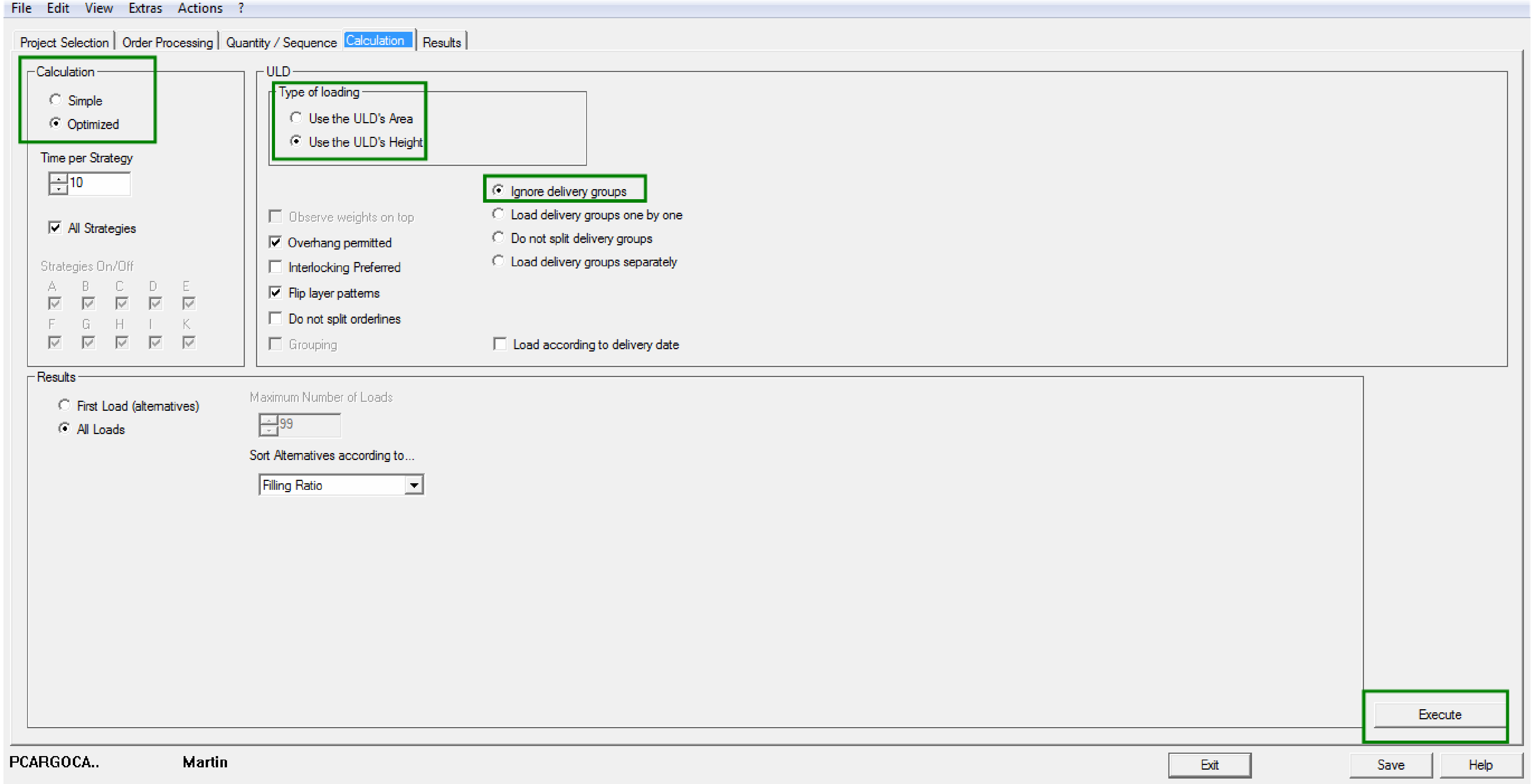

Figure 21: Calculation [15]

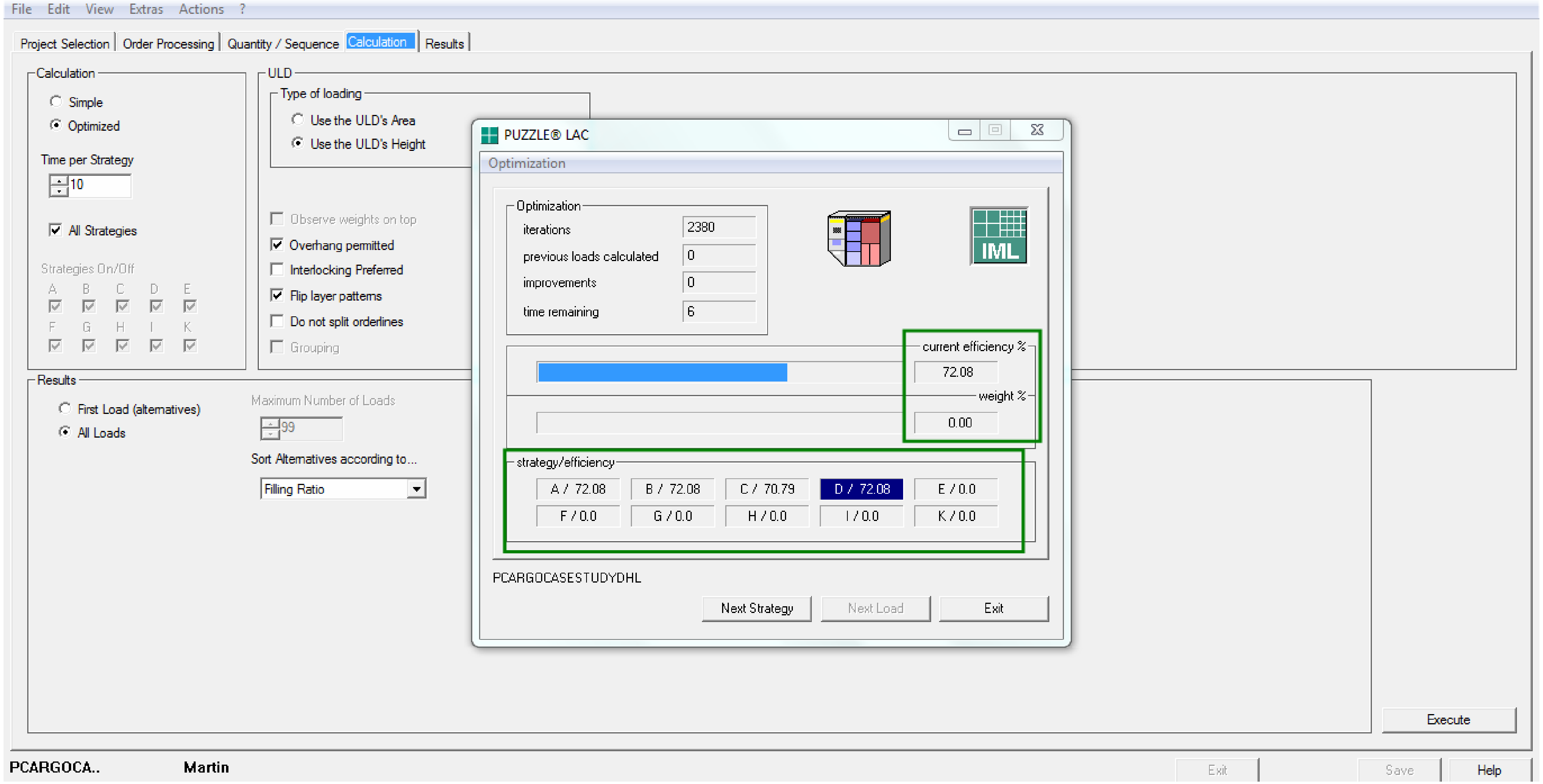

Figure 22: Execution procedure [15]

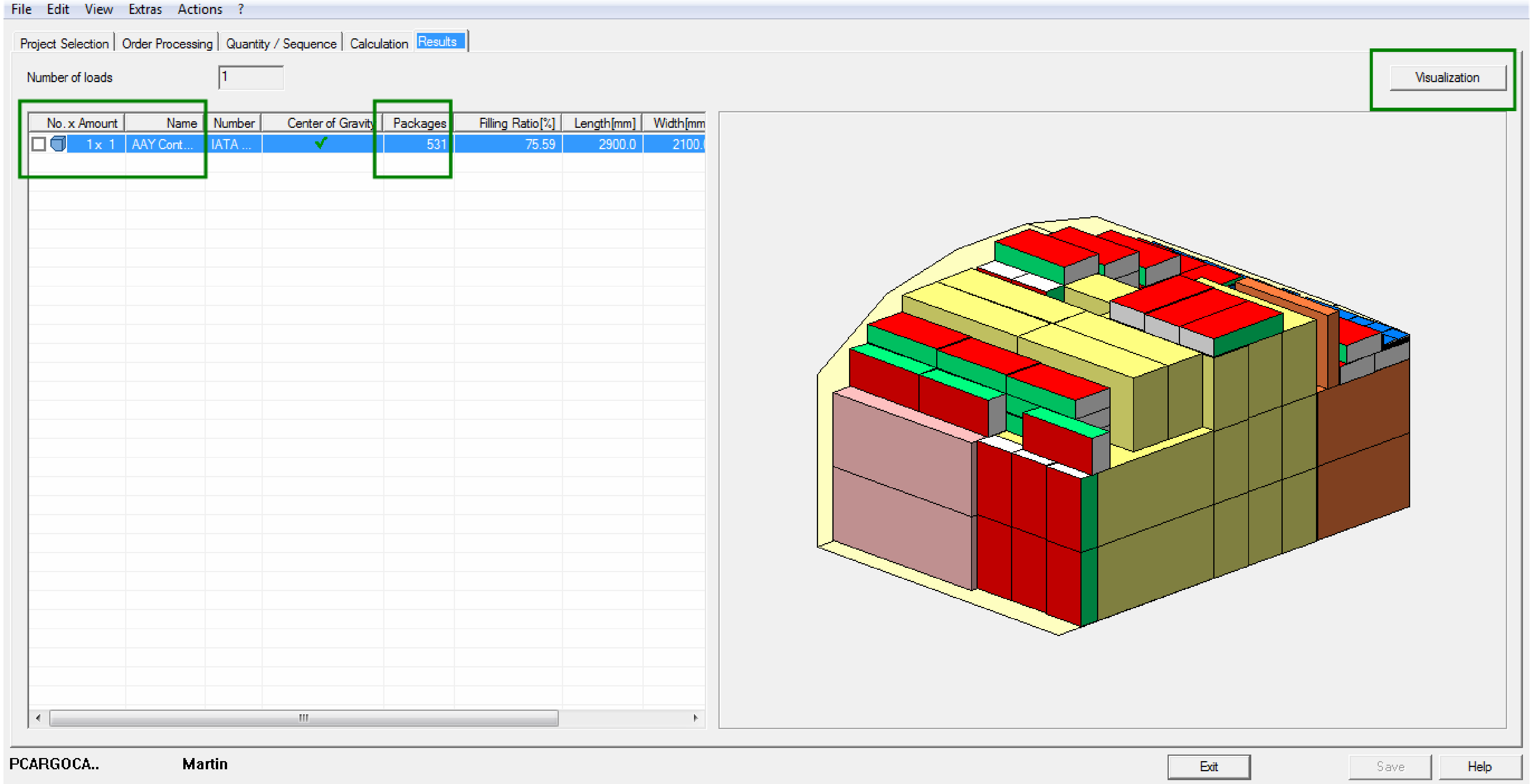

Figure 23: Results obtained [15]

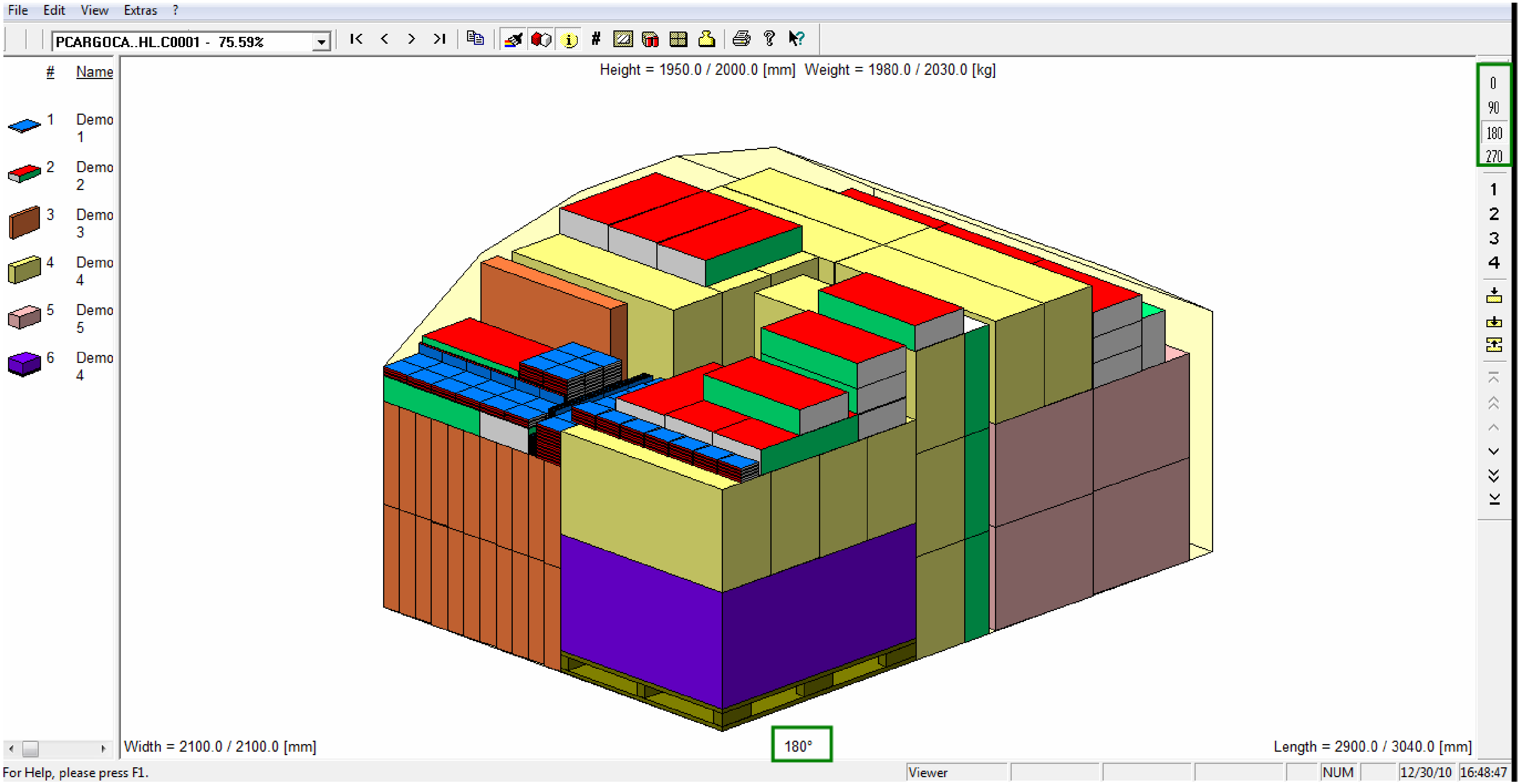

Figure 24: Visualisation 1 for Builders [15]

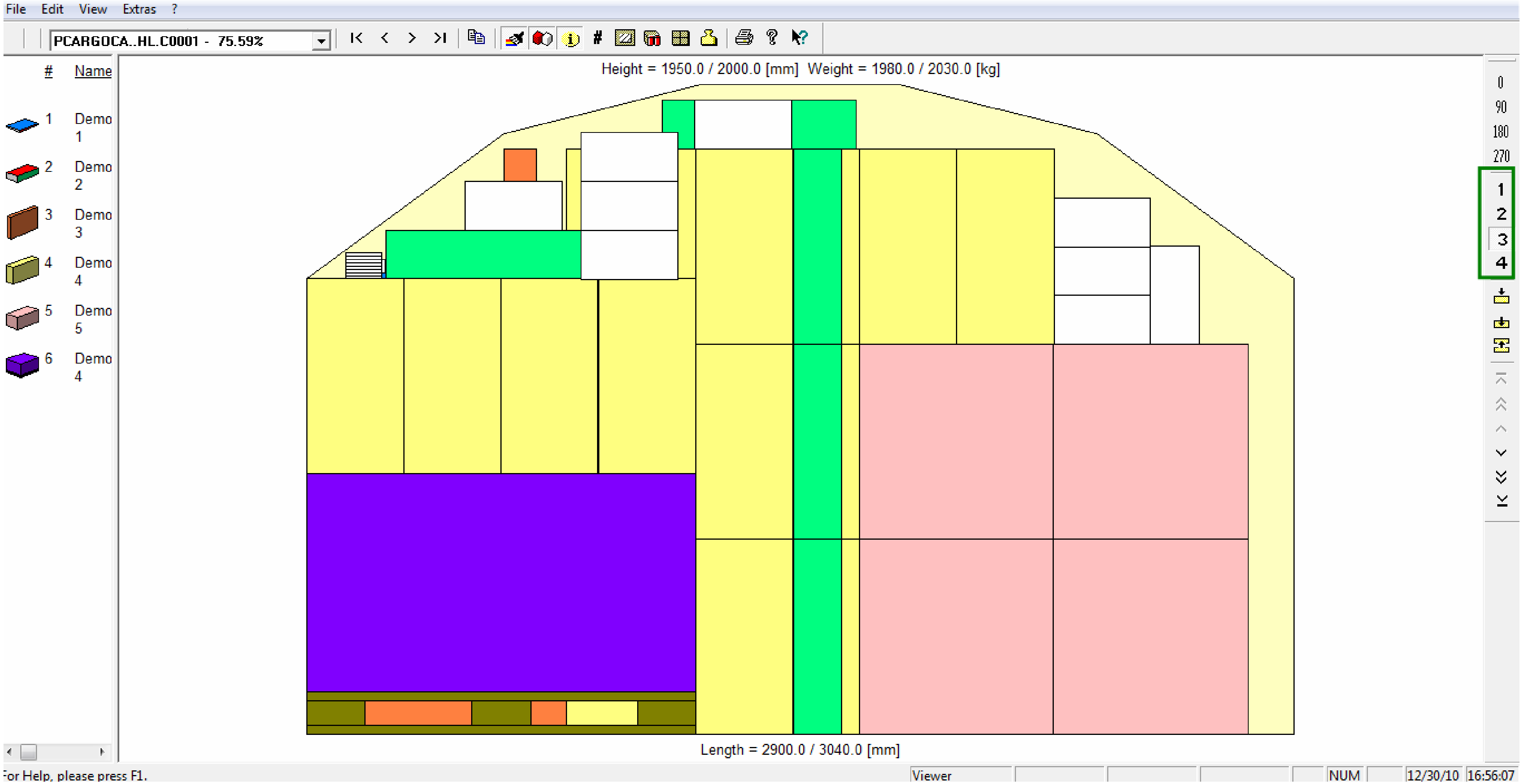

Figure 25: Visualisation 2 for Builders [15]

Figure 26: Optimised ULD

5.3 Statutory Declaration

I assure

that I have composed this bachelor thesis independently.

that I have only used quoted resources and no other unauthorised help.

that I have not submitted this thesis (whether at home nor abroad) to any judge for making so far.

that this thesis is consistent with the marked thesis from the tutor.

Place and Date

Signature