

# Design of a material replenishment system for a CRU assembly line

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**Design of a  
Material Replenishment System  
for a CRU Assembly Line**

WPA 1305

Study report for the Technical University of Eindhoven, faculty of Mechanical engineering, WPA

Time period : September 1991 - April 1992 WPA NR 1305

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**RANK XEROX MANUFACTURING (NEDERLAND) B.V., VENRAY**

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## **Abstract**

In this report a proposal is made for a material replenishment system for CRU assembly at the Venray plant of Rank Xerox. This system consists of:

- an overhead conveyor from the main stores to the assembly line and back to the main stores (for parts containers and finished products);
- an assembly conveyor with flexible routings (for parts containers and products);
- a maximal use of small batches for the parts transport to the assemblyline.

The method with which this proposal is made, is described in this report. The proposed system makes possible an increase of assembly area, by reducing the floor surface that is being used for material replenishment.

## Summary

In this report a proposal is made for a material replenishment system. Due to the fluctuating character of the Strategic Planning Assumptions of the products (the CRUs), a method is determined with which replenish activities can be calculated from given production rates and products.

Such a system should be able to supply the assembly line with parts. With this calculated data a material replenishment system can be determined.

This system is divided in three main modules:

1. Transport from the main store to the assembly area.  
Chosen is for an **overhead conveyor** (from the main store to the beginning of the assembly line).
2. Distribution in the assembly area to the individual assembly stations.  
Chosen is for transport by the existing **assembly conveyor**.

The choices for module 1 and 2 have been made on basis of a cost analysis (comparison of the alternatives) and on basis of the fact that this combination of transport has a small floor surface occupation compared to its alternatives.

3. The moving of the parts within reach of the assembly operator.

For this module two proposals have been made:

- A. Manual parts handling,
- B. Automated parts handling.

The choice between these two can be made on basis of economic arguments: Alternative B is chosen when the arrival frequency of containers at a assembly station is so high that the costs of manual labour outweigh the automation costs.

The **automated parts handling** is worked out in a design, which is attached to this report. In this design the following modules can be determined:

- a **Push and Return unit**:  
a unit which pushes the full parts container off the assembly conveyor pallet into the lift unit and returns empty parts containers back on the conveyor pallets.
- a **lift unit**:  
a unit which lifts the containers to the required shelf level.
- a **store unit**:  
a unit in which the containers can be stored on shelves at the assembly line as work stock for the assembly operators.

## CONCLUSIONS AND RECOMMENDATIONS

The underlying problem, which is caused by increasing production rates and diversity of products (Customer Replaceable Units), is the lack of (assembly) space.

In the present situation wooden pallets (1×1.2m.) with parts are brought by forklift trucks from the main stores to the assembly stations. By introducing the proposed method of parts replenishment a reduction of space occupation can be achieved, compared to the present replenishment situation.

This reduction consists of:

- the reduction of the sizes of the aisles around the assembly lines;
- the reduction of the size of the parts containers at the assembly line.

The last mentioned reduction has the disadvantage that the transport batch size decreases. This decrease increases the transport frequency, which increases the parts handling. Automation of the high frequent parts handling in the main stores and at the exchange point needs still some research between the overhead conveyor and the assembly conveyor.

The design of the automation of the handling and storing at the assembly stations is added to this report

## **The company, its product and the assignment**

### **RANK XEROX MANUFACTURING (NEDERLAND) B.V., VENRAY**

Rank Xerox Manufacturing (Nederland) b.v., in Venray was founded in 1965 and was at that time the first Rank Xerox plant in Europe. Over the years it has grown and now it is the second largest production unit in the group.

The holding Company, Xerox corporation, started operations in 1961 as a manufacturer and distributor of photocopiers based on a xerographic process developed by the American physicist Chester Carlson. This method was unique in that it permitted dry copying on to ordinary paper with the aid of static electricity and semiconductors.

A joint venture with the Rank organisation Ltd. in England was soon established for the purpose of distributing the Xerox machines outside the USA. This is how Rank Xerox was founded. Since 1969 Xerox has been the major shareholder in Rank Xerox.

A total of 100,000 people are employed at the various Xerox companies, 30,000 of these with in Rank Xerox. More than 3000 people work for Rank Xerox in the Netherlands.

### **CRU MRT & MT Team**

(Manufacturing Resources & Manufacturing technology)

The start up of the CRU MRT & MT Team was in 1989. This team is devoted to the manufacturing of the Customer Replaceable Units. The CRU production is characterized by its high production volumes and its small product size, (compared to the usual copier production in Venray).

### **The production method**

The production of the CRU's consists of a assembly process at several assembly lines, which are situated in building B of the Rank Xerox plant in Venray. These assembly lines consist of a conveyor, besides which manual and automatic assembly stations are situated.

The present part replenishment is taken care of by forklift trucks, which bring the parts on pallets from the main store to the assembly grids.



## The product

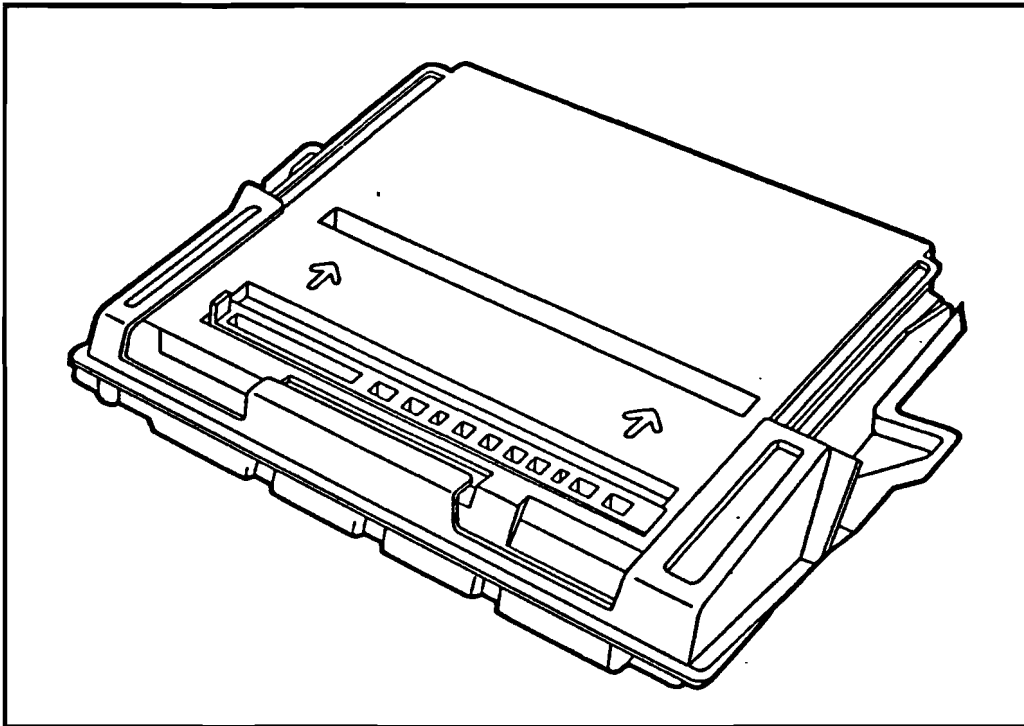
The assembled product is a CRU (Customer Replaceable Unit). A CRU is a part of a copier, which the user can replace by a new one, when the lifetime of the old one has expired.

In a CRU the following major parts can be determined:

- a fotoreceptor: a drum or a belt;
- a corotron: a thin wire which brings the static charge on the fotoreceptor.
- (optional): a toner cartridge (toner=print powder).

Its measurements are  $\pm 500 \times 300 \times 100$  mm.

The description of the copy process is given in appendix 2.



The 5028 CRU.

## Project assignment description

After considering the projects system area, requirements and other conditions, a assignment description was made after consultation between the Technical University of Eindhoven and Rank Xerox. Briefly worded, this project assignment description is:

One or more proposals must be made for:

- the use of the operational or activateable functionality of the JIT material replenishment system and
- the design of a modular parts supply mechanism,

for the transport of parts, which are needed for assembly of several Customer Replaceable Units on a (future) mix build assembly line. For the comprehensive project assignment description, see appendix 1

## Introduction:

### **Possibilities, design conditions and requirements for a material replenishment system.**

There is a need for a material replenishment system. This system must meet the design conditions and requirements.

The problem with designing of a material replenishment system is that these design conditions for a major part are not fixed and one should take into account the large range of possibilities.

Some important data for (the design of) a material replenishment system are:

- SPA dependable data (SPA = Strategic Planning Assumptions):
  - The transport units: Boxes, pallets, etcetera.
- Transport frequency: Transports per time.
  - Transport quantities: number of parts in a box, number of boxes per transport.
- Further data:
  - Transport distances: the beginning and ending point.
  - Floor space division: assembly, working floor store & transport.

These data and design conditions are not yet fixed.

When these and design conditions are not known it is not possible to point out problems which occur with a certain design. That is why one must attend to potential problems; these are problems that may occur in the CRU production process and may block the achieving of the main objectives of the CRU production.

Potential problems in the production process are:

1. Assembly  
Required: assembly must make a sufficient number of products (according to the SPA volumes).
2. Store space at the assembly line  
Required: the available space must be enough to contain the necessary products or product parts.
3. Means of transportation  
Required: must be able to deliver the products or product parts, that are necessary for assembly, on the right time and place.
4. Beginning point of transport  
Required: it must be able to deliver the products or product parts that are necessary for assembly.

Assembly has priority 1, because of it being a labour intensive process, so standing idle costs a lot of money. So problem 2, 3 and 4 may cause the assembly not to live up to its conditions/requirements (= SPA = dayrates). This makes the problems 2, 3 and 4 potential bottlenecks of the production process.

## The process of decision making.

There is a need for a method with which one can decide if choices can be made, whilst carrying out a designing project.

The following working method has been chosen:

The entrance of the process of decision making is divided in a variable part and a input part and it has "problemless alternatives" for a material replenishment system as output of the process.

The process of decision making is represented in the following figure:

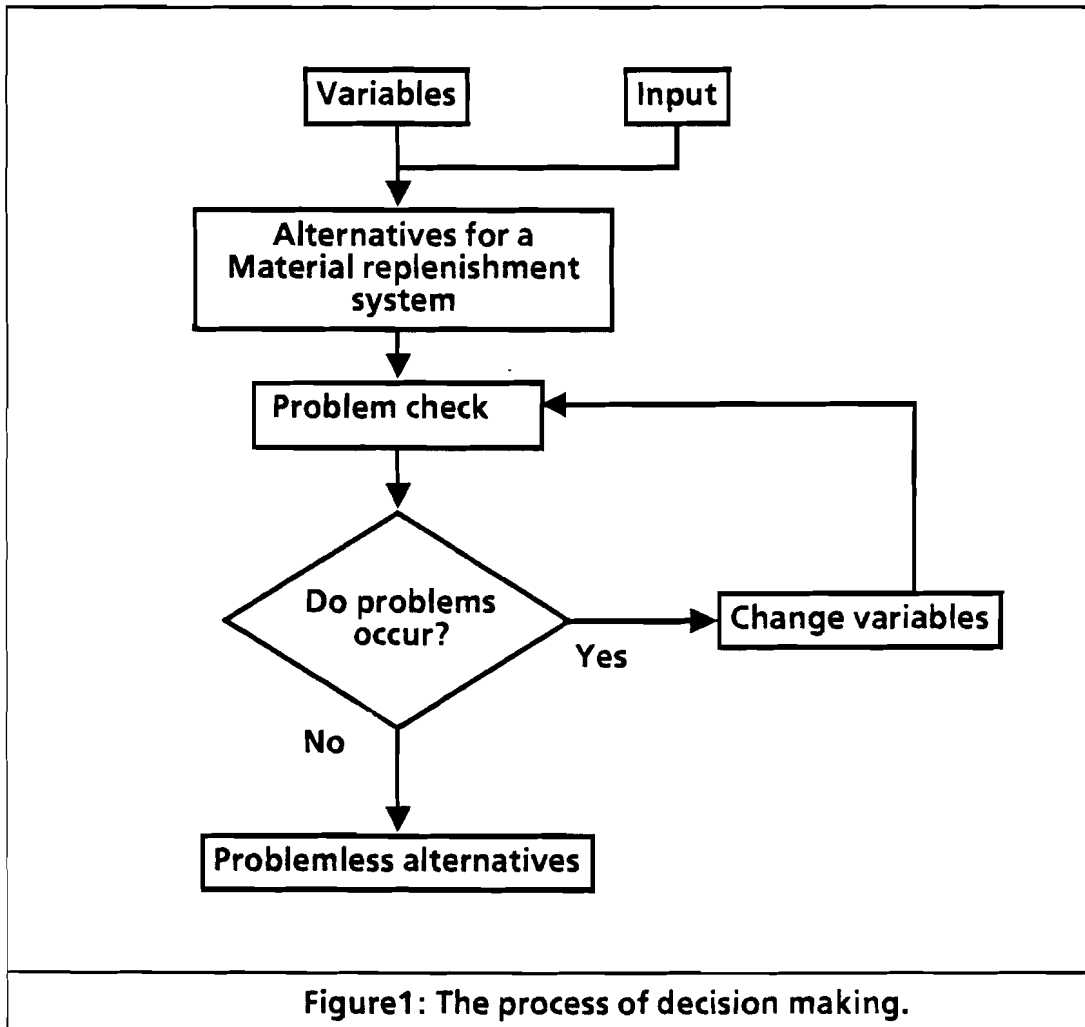


Figure1: The process of decision making.

## Explanation of the process parts:

### **Variables:**

Variables are variable data and design conditions for several subproblems. These variable data and design conditions are variable by the designer.

### **Input:**

Input consists of fixed data and design conditions, that is mostly caused by the Strategic Planning Assumptions or SPA volumes.

**Alternative for a material replenishment system.**

An alternative consists of several sub alternatives, which are chosen from the possibilities for the subproblems, considering a certain input and variable assumption.

**Problem check**

Compares the chosen alternatives (the taken decisions) with the problem functions for exceeding the acceptance limits (=designconditions / requirements).

**Do problems occur?**

When the combination of subproblem alternatives does not live up to the requirements, a problem occurs.

**Change variables.**

To adapt variable (design )data , so a material replenishment design will be accepted (=problemless alternative). This adapting can be done several ways, due to the fact that there are several variables to vary.

**Problemless alternatives.**

All previous decisions result finally in one or several solutions or designs: a material replenishment system that lies within the acceptance limits of the sub problems of the system.

**The working out of the process of decision making.**

To be able to work according to this decision schedule the following must be done:

1. Formulate the sub problem functions.
2. Define and work out the possibilities for the sub problems.
3. Choose from the alternatives for the subproblems.

# 1. The formulating of the sub problem functions

## Introduction:

To get a clear view of the functions of all sub problems, all aspects of these sub problems as well as the connection between the sub problems must be known. That is why the following three actions must be taken:

1. The structuring of the connection of the sub problems of the production process.
2. The specification of the input and sub problems.
3. The formulating of the sub problem functions.

## 1.1.The structuring of the connexion of the sub problems of the production process.

### Main Sub Problems:

- MSP 1. Assembly;
- MSP 2. Store / handling unit at assembly line (14);
- MSP 3. Way(s) of transport (9);
- MSP 4. Originating point of transport. (15)

### General subproblems.

The main subproblems 1 to 4 are not only dependable on each other, but also on other, general subproblems. These general subproblems can influence more than one main subproblems. That is why the enlargement of the subproblem division by adding of "general subproblems" is needed for getting a full understanding of the total design problem. These general subproblems belong to the group of variables (variable data and design conditions, that is changable by the designer).

The general subproblems are:

- Parts control (3);
- Safety stock (4);
- Batch sizes for the parts supply; frequency of the parts supply (5);
- Product containers (6);
- Way of floor geography (10).

### Input is:

- The product (parts) classification and volumes (1);
- Way of producing: Blockbuild, mixbuild: batch sizes (2).
- Total available area of the working floor (7);
- The assembly layout (8);
- Ergonomical demands (for the handling of / the supplying of the assembly operator) (11);
- Automation requirements (for the handling of / the supplying of the assembly machines) (12);
- Further design requirements: modular (13).

The subproblems depend on eachother as follows:

- 3: depends on (4, 5, 9)
- 4: depends on 1, 2, 3, (5, 9)
- 5: depends on 1, 2, 3, 4, (9)
- 6: depends on 5
- 9: depends on 5, 6, 7, 8, (3)
- 10: depends on 7, 8, 9
- 14: depends on 4, 6, 9, 10, 11, 12
- 15: depends on 5.

This corresponds with the following sketched diagram:

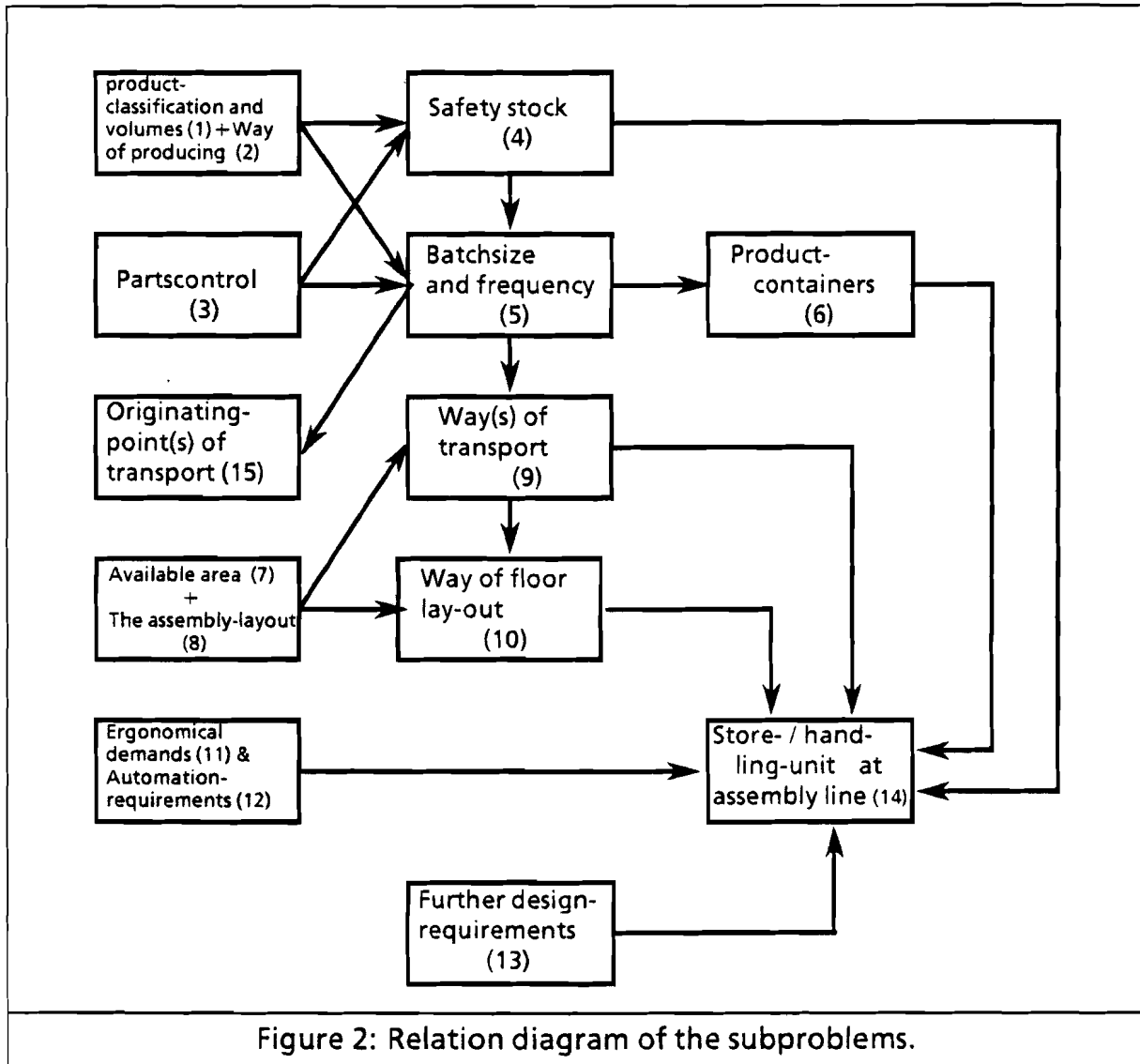


Figure 2: Relation diagram of the subproblems.

The sub problems are numbered in a working order, which is the best order to solve the sub problems, because working this way it is possible to have the data or possibilities which are needed for the solving of the next subproblem(s). This diagram points out the main solving direction; each problem has some degree of feed back to the previous sub problem (See paragraph 1.3.).

## 1.2. The specification of input and subproblems.

For specification of input and subproblems see appendix 12.

### 1.3. The formulation of the sub problem functions.

A sub problem can have more than one subproblem function. A subproblem function represents a property of a subproblem or a group of subproblems, which is a function of several data (variable and input or fixed data).

These functions (together with their acceptance limits), must be formulated in such a way, that these functions meet the design conditions and requirements.

When several subproblems are dependable on each other, sub optimization can be avoided, not by making an individual choice for each subproblem, but by determination of all possibilities of the subproblems, after which the total subproblem group can be optimized. Such an optimization is the most favourable combination or combinations of the alternatives of the subproblems, that belong to the subproblem group.

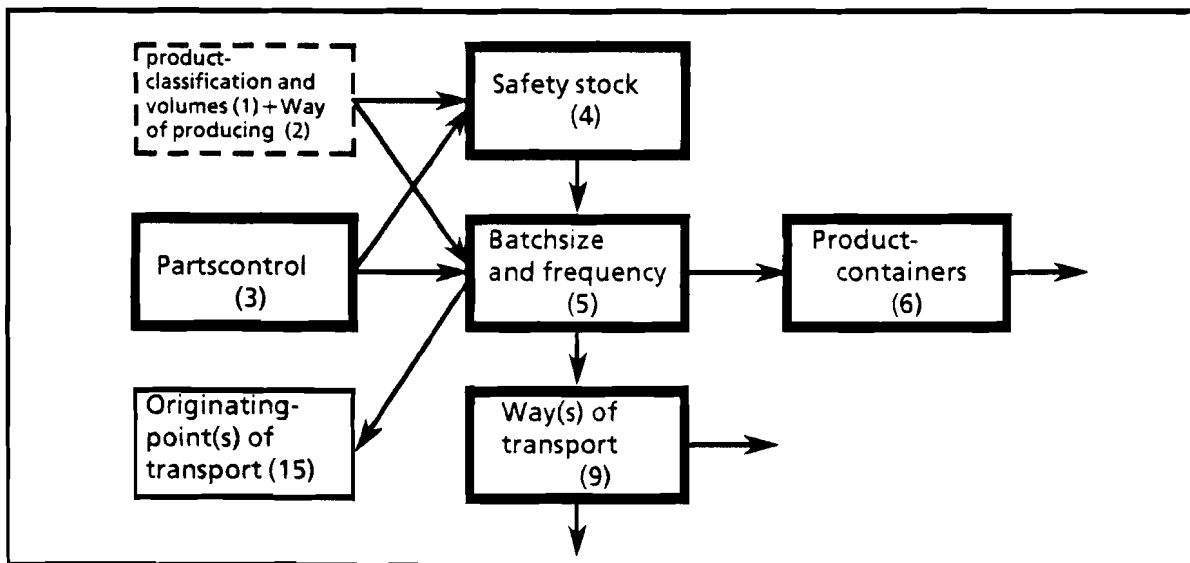
#### Subproblemgroup 3-4-5-6-9:

The following subproblems, which belong to this sub problem group, are depending on each others:

- Alternatives for the parts control (3);
- The size of the required safety stock on the workingfloor (4).
- The transportvelocity (9);
- The limitations to the transport capacity (9);
- Productcontainers (6);
- Material, shape, length, height width, volume (determines the minimal/optimal transport batch size (5) or larger).
- Handling requirements,
- Special requirements or adaptations.

#### Problemfunctions:

- Storing costs (minimalize) (3-4-5-9);
- Transportation costs (minimalize) (3-4-5-9).
- The batchsize of the parts supply (5);
- The frequency of the parts supply (5);



#### Assembly (Msp1).

Function: producing CRU's;

Requirements: Number of produced CRU's must be equal to or larger than the volumes prescribed by the S.P.A..

Way of floor lay out (10).

Function:

Total (available) area on the work floor (7) minus the area that is needed for transport (9) minus the area that is required for assembly (8) equals the area that is available for the handling and storing unit at the assembly line.

Store / handling unit at assembly line (14).

The properties of the design have been being determined by the choices that were made in subproblem 4, 6, 9, 10, 11, 12, 13 (see also 1.2.).

Originating point of transport (15).

The (possible) design of a buffer;

Input: (Dynamic) process properties.

Function: Buffer size.

When the required (dynamic) process properties (5) are not sufficiently covered by the process properties of the originating point, there must be searched for a solution of this problem. A possible solution is the design of some sort of a buffer. Design requirements are being determined by the input data and by the previous choices (see 1.2.).



## **2. Define and work out the possibilities for the sub problems.**

### **Introduction:**

When the properties and connections of the subproblems are known, the alternatives for the different sub problems must be examined to make an optimal design or combination of alternatives. This is handled in the next chapter.

### **Chosen working order (see chapter 1):**

1. The product( parts) classification and volumes;
2. Way of producing: Blockbuild, mixbuild: batch sizes.
3. Partscontrol;
4. Safety stock;
5. Batchesizes for the parts supply; frequency of the parts supply;
6. Product containers;
7. Total available area of the working floor;
8. The assembly layout;
9. Way(s) of transport;
10. Way of floor lay out .
11. Ergonomical demands (for the handling of / the supplying of the assembly operator);
12. Automation requirements (for the handling of / the supplying of the assembly machines);
13. Further design requirements: modular.
14. Store / handling unit at assembly line ;
15. Originatingpoint of transport.

### **2.1. The product( parts) classification and volumes;**

#### **2.1.0. The product classification.**

(classification of the materials that must be transported).

There is a need for a product classification, because of the lack of data of the productparts, that must be assembled. We do know what products must be made and if we know what products resemble eachother, we can make a good estimation of the effect of all parts on a material replenishment system by assuming that the effects within a class or group are identical.

The Systematic Handling Analysis (R. Muther) prescribes the classification of materials by using the following main properties:

#### **PHYSICAL PROPERTIES:**

1. Measurements: Length, width, height;
2. Weight per unit or per volume unit (density);
3. Shape: Flat, bent, compact, nestable, irregular, etc.
4. Damaging risk: Breakable, explosive, perishable, poisonous, corrosion forming, etc.
5. Condition: Sticky, hot, wet, dirty, to eachother belonging pairs, the containers in which it's being transported.

#### **OTHER PROPERTIES:**

6. Quantity: Volumes, both in total as in batchsize.
7. Time: regularity, urgency, season conditions.
8. Special requirements: Legal regulations, company regulations, business politics.
9. Origin and destiny: As a consequence of the way of producing, storing and assembling, the origin and destination are both product specific properties.

The physical properties are often the most important aspects, which influence the choice of the material classification. Quantity however, is also a very important aspect; goods in great quantities normally are transported in another way than smaller quantities.

**PROCEDURE FOR CLASSIFICATION:**

When classifying materials, one should work by the following procedure:

1. Identify all goods or groups and put them on a list.
2. Analyse the properties of each material or material class and determine the dominant or extra important distinguishing marks.
3. Register and combine the properties.

One should remark, that goods and their packaging are often of primary importance. That is why the classification is supposed to be done in the smallest practical unit (bottle, tin, box, etc.) or the most probable transport unit in which is being transported (a cardboard box with bottles, bundles of clothes, pallets, tote tins, etc.).

It speaks for itself that the classification is built up out of classes, which are built up out of sub classes (classes within classes).

**2.1.1. Identify all goods or groups and put them on a list.**

The groups in which the products, (and their parts), are divided are called families.

The family division for the different CRU models on basis of commonality in assembly, are as follows:

Familyname	Familymembers
5014	1012, 5012, 5014, 5012B, 5014B.
5017	5017, 5317.
XBOW	CROSSBOW (=CROSSBOW40, CROSSBOW50, SCIMITAR40, SCIMITAR50), LV4 AD, LV4 95, LV4.
5028	5028, YANKTON.
SUMIDA	SUMIDA, SUMIDA DEC.
SUPERSTAR	SUPERSTAR
LV3	LV3, LV3 94.

**2.1.2. Analyse the properties of each material or material class and determine the dominant or extra important distinguishing marks.**

The part properties of the CRU's can be arranged on highest importance, considering the material classification.

Beginning with the most important:

- I. Measurements (1), weight (2), shape (3),
- II. Quantities (6), the number of parts (per product).
- III. Condition, the way it is transported.
- IV. Destiny & Origin (9).

**I. Measurements (1), weight (2), shape (3).**

Measurements, weight and shape determine the transport volume. The maximum size of the volume and/or the weight of the transport unit of a transport system depends on the sort of transportation and the sort of transport container/ unit. So measurements, weight and shape determine indirectly the capacity of transport that is required is therefore of a major importance.

**II. Quantities (6).**

Quantities or the number of parts per product are of next importance, due to the fact that they determine the intensity of the transport flow, which is of importance when choosing a transport system.

Quantities are expressed in boxpallet equivalents (BPeq.), which stands for the number of boxpallets (=storing unit), that is needed required for the storing of an amount of parts.

**III. Condition, the way in which it its being transported.**

The condition, or the packing / container in which the parts are delivered into the store determines the transportbatchsize, provided that one should decide to repack.

When present, the transport batch size data is collected and when absent, then an assumption will be made for the missing transportcontainer information.

In the present situation the 88P311 packing standard for the transportation and storing of parts is used as much as possible. This standard consists of the following:

Containertypes / sizes:

Transport / storage units:

Codes:

- A: In use for RX Venray: High wooden boxpallet;
- C: In use for RX Venray: Half high wooden boxpallet;
- H: Block style pallet / ground pallet.

From these codes the following codes for pallets can be formed:

- AA : High wooden boxpallet, with destination high wooden boxpallet store;
- CC : Half high wooden boxpallet, with destination store;
- CC X: Half high wooden boxpallet, with destination half high wooden boxpalletstore, loaded with a special containertype;
- HH : Ground pallet, with destination ground pallet store;
- HHK: Ground pallet, with destination ground pallet store, loaded with MN 5 boxes;
- HHQ: Ground pallet, with destination ground pallet store, loaded with MN7 boxes.

The codes for pallets with tote tins (=MN2 size) are:

- HD D: Ground pallet, with destination tote tin store, loaded with MN2 boxes.
- AD : High wooden boxpallet, with destination tote tin store, loaded with MN2 boxes.

CONT	MEASUREMENTS [mm]	CODE
MN 1	264 * 115 * 110	B
MN 2	476 * 282 * 122	D
MN 3	480 * 282 * 238	E
MN 4	575 * 383 * 122	J
MN 5	587 * 381 * 238	K
MN 6	955 * 575 * 400	P
MN 7	1160 * 968 * 396	Q
MN 8	1160 * 968 * 946	R
others:		
Exeptional	Special container type.	X

Tabel1: *Containertypes/formaten.*

#### IV. Destiny & Origin (9).

The origin and the destiny of the parts are of importance when determining the transport distance, that is needed for the determination of the transport labour. (The transport labour is directly proportional to intensity×distance). The origin possibilities are:

- The store (code 2P);
- The PMS (code 1SB);
- Special materials (code 1JB).

By determining which quantities are required in which form at each (AGV) station on the working floor, it is possible to determine the required capacity per destiny place.

The code in the LOTUS worksheets are: AGV + #. (AGV station does not mean that a AGV must be used; you may read: work or assembly station).

#### 2.1.3. Registrate and combine the properties.

Registrate the properties ("physical" and "others") and determine the material class by combining those materials, which have dominant or extra important properties of the same kind.

In a LOTUS 1 2 3 spreadsheet parts are combined in two ways, so the materialclasses or, if you like sub materialclasses, consist of a group of parts with:

- The same destiny and the same packing / (transport) container,
  - or,
  - The same origin and the same packing / (transport) container
- (See 2.1.2., III and IV).

This spreadsheet is presented in appendix 4.

This spreadsheet needs (an assumption for) the production planning. This is subproblem 2.: Way of producing.

**2.2.: Way of producing.**

To make an assumption for the different scenario's for the production planning, the following data must be filled in:

- a. SPA volumes: product families & dayrates;
- b. Guidelines:  
 A constant labour occupation for the complete line,  
 a minimal and / or maximum period length which is allowed or demanded  
 between the product changes, (when a mixbuild production is chosen).
- c. needed labour per product (or product part).

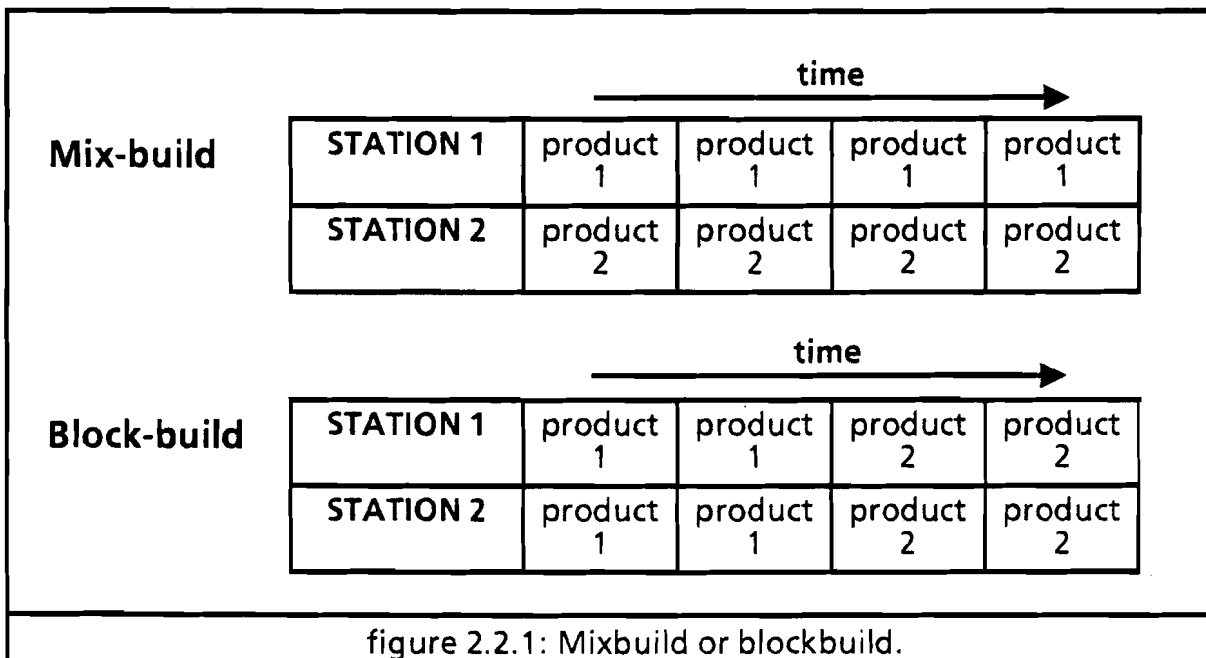
This data can be combined in a LOTUS 1 2 3 spreadsheet, after which it can be optimized, so that it meets the guidelines (see b.).

This spreadsheet is presented in appendix 3.

**Mixbuild or blockbuild.**

Mixbuild producing is a production method with which the assembly line is divided into stations, at which only one product( family) is built.

Blockbuild is the production method with which the assembly line is divided into stations, at which the production of different products is being interchanged at certain time intervals (see figure 2.2.1).



To make a well considered choice between mix and block build, one must look at all advantages and disadvantages, which are represented in the following table:

Way of producing	Advantages	Disadvantages
Mixbuild	<p>Dedicated production at each station: no learning-losses.</p> <p>Lesser days of supply (DOS).</p> <p>No "batch-rest" problem.</p>	<p>A small production rate may lead to few workstations per product which can result in a unfavourable line-balance (large number of parts at one assembly station).</p>
Blockbuild	<p>A more optimal line balance.</p> <p>It is possible to make several products with small production rates on a normal balanced assembly line.</p>	<p>Periodical change of product: relatively high learning-losses.</p> <p>Little more days of supply (DOS).</p> <p>Measures must be taken to solve the "batch-rest" problem (storing place or batch adoption).</p>

### 2.3. Problemcluster 3 4 5 9:

- Parts control,
- transport batchsize,
- safety stock at the assembly line,
- the transport batch size and the way of transport.

In this paragraph the relation between the above mentioned items will be explained.

#### Transportfrequency and the transport batchsize.

The assembly line has a production speed which is related to the dayrate that is planned and is represented by the SPA volumes. This production speed determines the need for parts to be transported to the assembly line. There are several ways to transport the parts, but the total quantity within a certain timerange is fixed, so:

$$\text{Total transported quantity} = \text{frequency} \times \text{quantity},$$

in which frequency stands for the number of transports per time and the quantity stands for the transport batch size (the batch size with which the parts are transported).

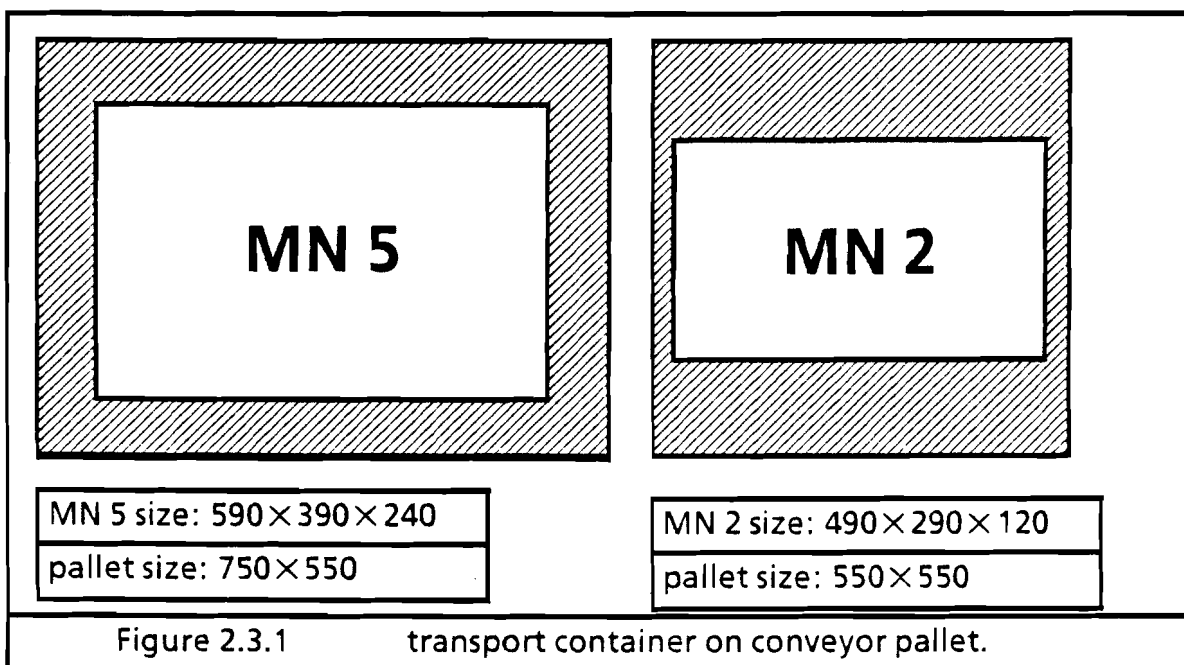
#### The way of transport and transport container (subproblem 9 & 6).

The way of transport determines which transport containers can be transported, by for example its size, or its carrying capacity.

For example: a transport conveyor can not transport containers that are larger than the size of the conveyor or *conveyor pallet*. When a pallet with the size of 550 × 550 mm. is used a container must be chosen which *makes optimal use of this pallet*; for example the MN 2 box (see figure 2.3.1). Therefore the MN5 & MN2 containers are chosen for transport from the store to the assembly line, because of the following advantages:

little space occupation at the assembly line.

these containers are transportable on a (assembly) conveyor.



### Ways of transportation.

There are three different groups of ways of transport selected to be examined:

1. Transport on the floor.  
There are three possibilities for transport on the floor:
  - Manpowered;
  - Automatic Guided Vehicles;
  - Forkliftrucks.
2. Transport overhead.
3. Combinations of different ways of transport.
  - Assembly conveyor + overhead conveyor
  - Sub assembly conveyor + overhead conveyor

Their characteristics are:

- transport velocity;
- the (maximum) size of a carryable transport container;
- the used/needed space;
- pick & placing time;
- transportation costs.

This leads to this table:

Way of transport	Transport-velocity	Maximum size of a carryable transport container	Space: aisle width	pick & placing time
On the floor: - Manpowered - AGV - Forkliftrucks	0.82 m/sec. 0.71 m/sec. 1.70 m/sec.	PALLET PALLET PALLET	2.0 m. 2.5 m. 3.0 m.	40 sec.* 110 sec. 60 sec.
Overhead conveyor	0.45 m/sec.	MN5	N.A.	10 sec.*
Sub- conveyor	0.45 m/sec.	MN5	N.A.	10 sec.*
Assembly conveyor	0.40 m/sec.	MN5	N.A.	10 sec.*

\*: estimates.

### Area / floor geography & assembly line mapping (Subproblem10+7/8).

From the spreadsheets, earlier mentioned in paragraph 2.1.2 sub problem 1&2, the floor occupation can be derived by placing the correct number of pallets or boxes in the drawing of the assembly line.

The need for space (the needed pathwidth) for different ways of transportation is represented in the characteristics table of "Ways of transportation".

So when we choose for forkliftrucks we must use the grid as it is currently available in building B (3 AGV grids).

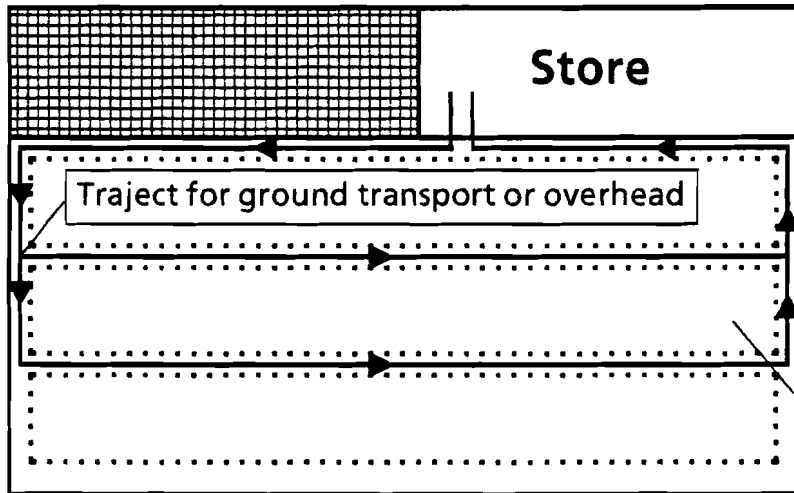
When there is a need for more grids (= more space), and the aislewidths must be smaller for the gaining of space, one is forced to use an overhead conveyor for transportation of parts to the assembly line.

The floor lay out also decides the distances that must be transported from origin to destination.

These distances are represented in the following figure.

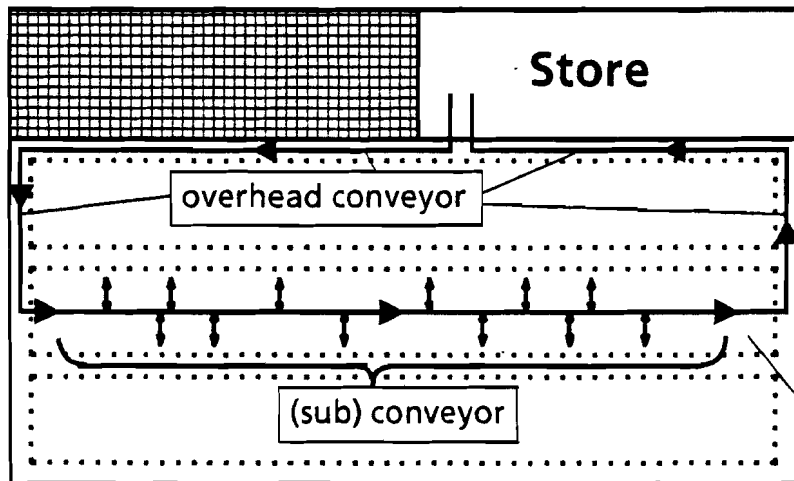


### 3 Transport-routings for Building B



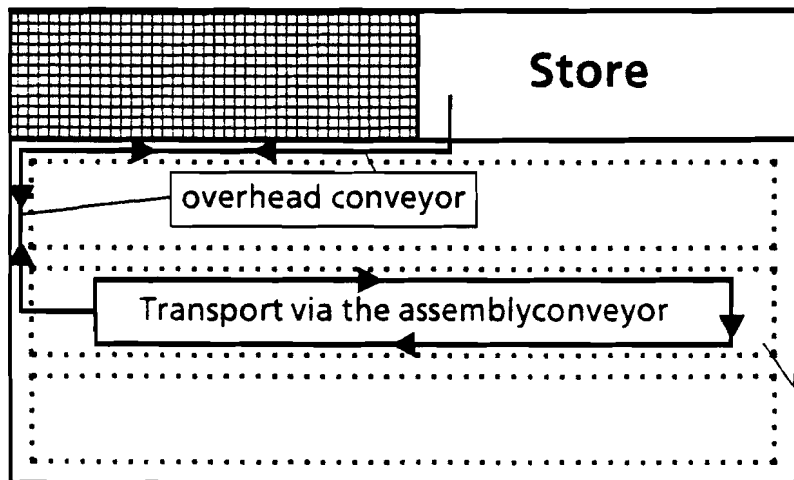
ground transport  
or  
overhead conveyor

Routing length:  
235 m.



**Combined:**  
(sub) conveyor  
and  
overhead conveyor

Routing length:  
overhead conveyor  
140 m.  
sub conveyor:  
95 m.



**Combined:**  
assembly conveyor  
and  
overhead conveyor

Routing length:  
overhead conveyor  
222 m.  
assembly conveyor  
190 m.

**Costs.**

The total costs can be divided into two parts:

1. Costs of the transport system.
2. Costs of the stock on the work floor (WIP).

1. Costs of the transportsystem.

The costs of transportation are passed on the product, so:

$$\text{Costs per productpart} = \frac{C_{\text{transport}} [\text{Dfl/day}^*]}{\text{Transports per day}^* \times \text{deliver-batchsize}}$$

\*: pick up [empty] & delivery [full]

Transportation costs.

Way of transport	Investment $I = [\text{Dfl}]$	Deprecia- tion ( $i=0.08$ ) $p = [\text{Dfl} / \text{day}]$	Manhour (Dfl 50.54) + operating costs $c = [\text{Dfl}/2\text{shfts}]$	Total costs $C_t = p + c$ $C_t = [\text{Dfl}/\text{day}^{**}]$
On the floor:				
- Manpowered	1200	0.96	808.64	809.60
- AGV	50000 (vast)* + 125000	138.91	0.00	138.91
- Forkliftrucks	N.A.	345.60	808.64	1154.24
Overhead conv.	500000	400.00	0.00	400.00
Combined:				
Assy. conv.*** + overhead conv.	95000 + 150000	76.34 + 120.50	0.00 + 0.00	196.84
Sub assy conv. + overhead conv.	500000	400.00	0.00	400.00

\*: 6 AGV's in building B

\*\* : 1 day = 2 shifts = 16 Hrs.

\*\*\*: adjustment costs.

The calculation of p goes as follows:

$$I \times (1 + i)^n = \sum_i (p \times (224 \text{ days}) \times (1 + i)^i), \text{ for } i = 1 \text{ to } n \text{ and } n = 7 \text{ years.}$$

that gives:

$$p = 0.0007938 \times I$$

The total costs ( $C_t$ ) of the conveyors are included the transport pallet costs, so

$$\text{System costs} = \text{Transportcosts} / \text{day} (= C_t).$$

For the transport on the floor applies the following:

$$\text{System costs} = \text{Needed number of vehicles} \times \text{Transportcosts} / \text{day} (C_t)$$

**Number of vehicles.**

The transport velocity of transportation determines the time that is needed for transporting the parts from origin to destination. Together with the transport frequency it determines the total needed transport time from which we can derive the required number of transport vehicles, because:

$$\frac{\sum_i(\text{distance} \times \text{frequency} / \text{transport velocity})_i}{\text{available transport time per shift}} = \text{Needed number of vehicles}$$

for  $i = 1$  to  $n$ , when  $n =$  number of assembly stations.

This makes the following system costs for the different ways of transport:

Way of transport	Costs $C_t = [\text{Dfl}/\text{day}^{**}]$	Needed number of vehicles	System costs $[\text{Dfl}/\text{day}^{**}]$
On the floor:			
- Manpowered	809.60	2	1619.20
- AGV	138.91	2	277.81
- Forklifttrucks	1154.24	1	2308.48
Overhead conv.	400.00	N.A.	400.00
Combined:			
Assy. conv.* + overhead conv.	196.84	N.A.	196.84
Sub assy conv. + overhead conv.	400.00	N.A.	400.00

**2. Costs of the stock on the workfloor (WIP).**

The value of the products is represented as follows:

$$C_{\text{VALUEWIP}} = \text{Value product} \times \text{interest \%} \times \text{deliver batchsize}^*$$

\*: assumed is that every part is delivered in approximately the same batchsize.

Together that gives:

$$C_{\text{total}} = C_{\text{transport}} + C_{\text{VALUEWIP}} = n_{\text{batch}}^1 \times \alpha + n_{\text{batch}} \times \beta$$

These costs are represented in the graphics in appendix 8 of this report. The graphic shows that there is a minimum of the costs of the stock on the workfloor for a certain batchsize.

The way of transport can not be chosen when only considering the financial side of the matter. In the following table all advantages and disadvantages are summed up to make a more complete comparison, that is needed for a well considered choice.

**Advantages and disadvantages of different ways of transport.**

Way of transport	Advantages	Disadvantages
Manpowered handpallet-truck	Very low investment. Flexible routing	Not automatic: manpower needed. Floor area occupation.
AGV	Automatic (no manpower).	Floor area occupation. High investment. Fixed routing
Forklifttruck	Low investment. Flexible routing	Not automatic: manpower needed. Floor area occupation.
Overhead conveyor	Free floor area. Layout simplicity (vertical and horizontal bends). Simple design . Low costs. Automatic (no manpower).	Limited headroom. Roof must meet certain load-bearing requirements. Fixed routing Everything must be transported in MN5, which means a higher transport frequency Not everything can be transported in MN5 boxes
Assembly conveyor	Production layout/routing = material replenishment layout/routing. Free floor area. Automatic (no manpower). Very low costs.	line capacity requirements are raised (see apendix ..). Complex controlling system required. Everything must be transported in MN5, which means a higher transport frequency Not everything can be transported in MN5 boxes
Sub conveyor	Production layout/routing = material replenishment-layout/routing. Free floor area. Automatic (no manpower). Low costs.	Complicated design (little space available). Complex controlling system required Everything must be transported in MN5, which means a higher transport frequency Not everything can be transported in MN5 boxes.

### Safety stock or minimum batchsize.

The speed of the stock control system, together with transportation time, determines the minimum batchsize or safety stock at the assembly line.

Assumptions for the determination of the minimum batch size are:

- a JIT pull system controls the parts flow output of the store (parts control).
- a transport consists of one batch each transport.
- one batch is held at the assembly line as workingstock (=WIP).
- the shortest interval time between pulls is achieved by pulling at arrival of the last pulled batch (parts control).
- the assembly line should be able to continue production (enough parts should be available).

This makes the following equation:

$$\left( \begin{array}{c} \text{Reaction time parts control system} \\ + \\ \text{transportation time} \end{array} \right) \times \text{Production speed [products/time]} = \text{minimum batch size}$$

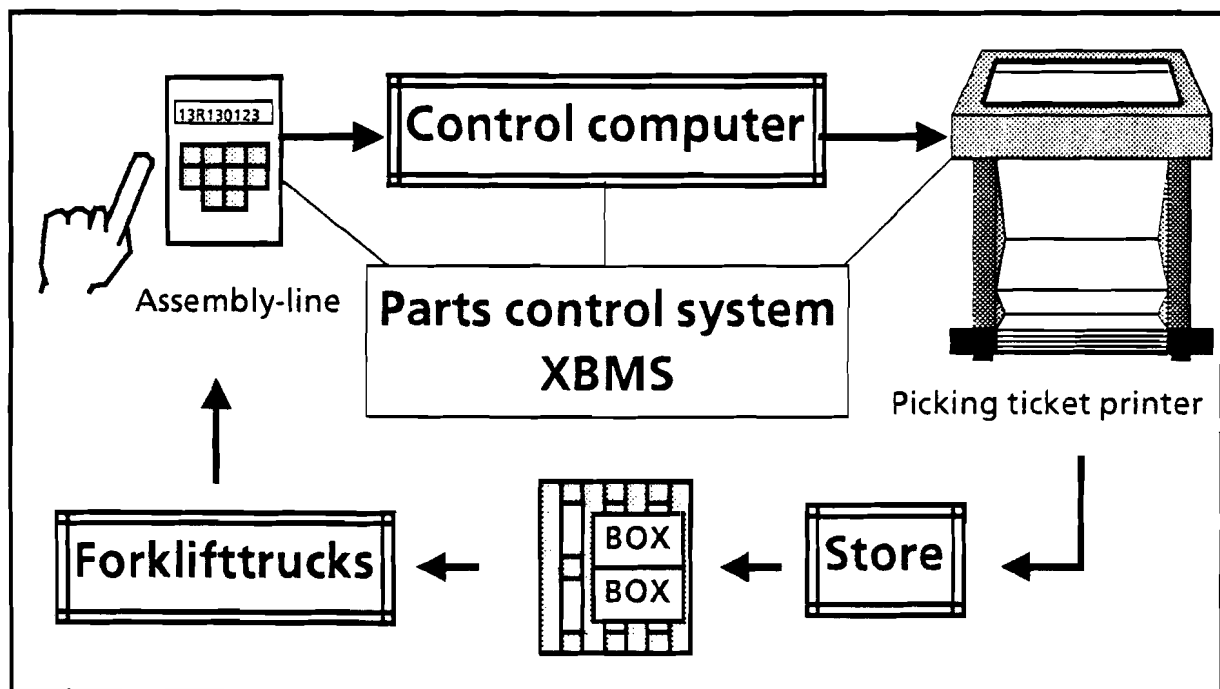
Due to the fact, that the reaction time of the control system is much larger than the transportation time, the reaction time is the leading time factor in the allowed (minimum) batch size at the assembly line.

These minimum batch sizes are represented in the graphics in appendix 10 of this report.

### Parts control.

The presently installed parts control system is the XBMS pulling system.

XBMS works as follows:



The XBMS parts control system.

This system is sufficient for a JIT pulling system, the operators at the assembly line are responsible for the requests for parts.

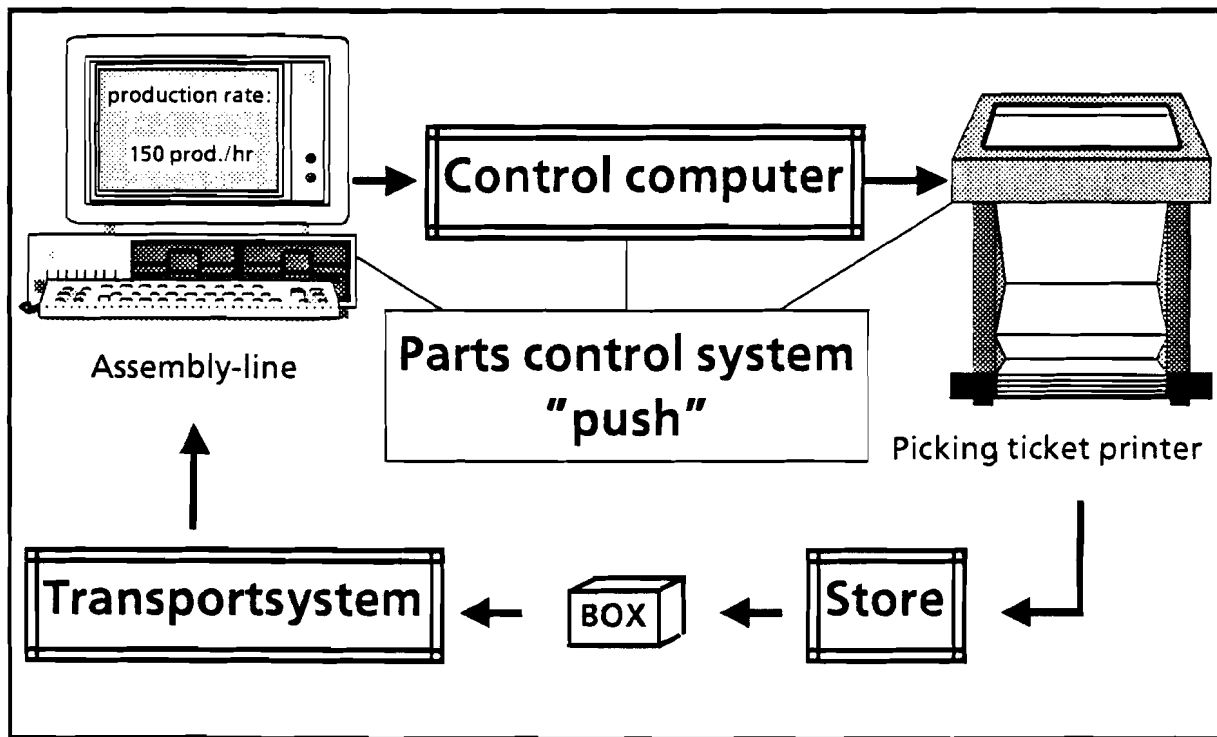
When there is a lack of space on the assembly floor it is possible to choose for smaller parts containers which occupy lesser space or are easier to store at the assembly line. When the size of a part in combination with the size of the chosen container in which the part is moved, determines that the number of parts in a container should be lower than the **calculated minimum batchsize**, then a JIT pull system no longer can be used for the control of the parts flow output of the store.

Instead of a JIT pull system one should use a push system, which plans ahead and makes part requests in advance.

To make this possible, a computer (for instance: a personal computer) should be used to make the required requests, which the computer can calculate out of the number of products that should be produced within a certain time range.

This number of products can be entered by the responsible engineer at the assembly line.

This parts control system is being represented in the following figure.



Alternative for a parts control system.

### 3. The choices for the sub-problems.

In the previous part of this report several sub-problems have been examined for alternatives. The alternatives all have their advantages and disadvantages. A decision must be made which choices must be made to go further with the next step in the designing of a material replenishment system. These decision points are:

1. Way(s) of transport;
2. Way of producing;
3. Transport containers;
4. Way of partscontrol.

The choices and the reasons for choosing an alternative are:

#### **1. Way(s) of transport (2.3.)**

choice(s): Combined transport: overhead conveyor assembly conveyor

reason(s): Low costs  
Smaller space occupation\*

#### **2. Way of producing (2.2.)**

choice: Block build producing, with the possibility to interchange 3 products at one assembly station.

reason: The increasing number of different products, that should be assembled in the future.

#### **3. Transportcontainers (2.3.)**

choice(s): MN2 and MN5

reason: The choice of transportation by an overhead and assembly conveyor.  
Smaller space occupation\* (by parts) at assembly line.

#### **4. Way of partscontrol (2.3.)**

choice(s): Combined parts control: pull and push system.

reason(s): When necessary, use of a push-partscontrol-system will be made, otherwise use of the already present pull-system will be made.

\*: Smaller space-occupation.

Lack of space is a major problem in building B, due to the increasing volumes of production. By reducing the width of the between the assembly lines and reducing the size of the parts containers, that have to be present at the workstations of the assembly lines a smaller space occupation can be achieved. Smaller aisle widths then is required than are needed for the pallet transports with forklifttrucks, can only be achieved by choosing an alternative way of transport. Smaller partscontainers can be chosen in such a way that they can be transported on a conveyor. So the combination of conveyor transport and smaller parts containers can be a solution for the lack of space in building B.

## 4. The store and handling unit at the assembly line.

### Introduction:

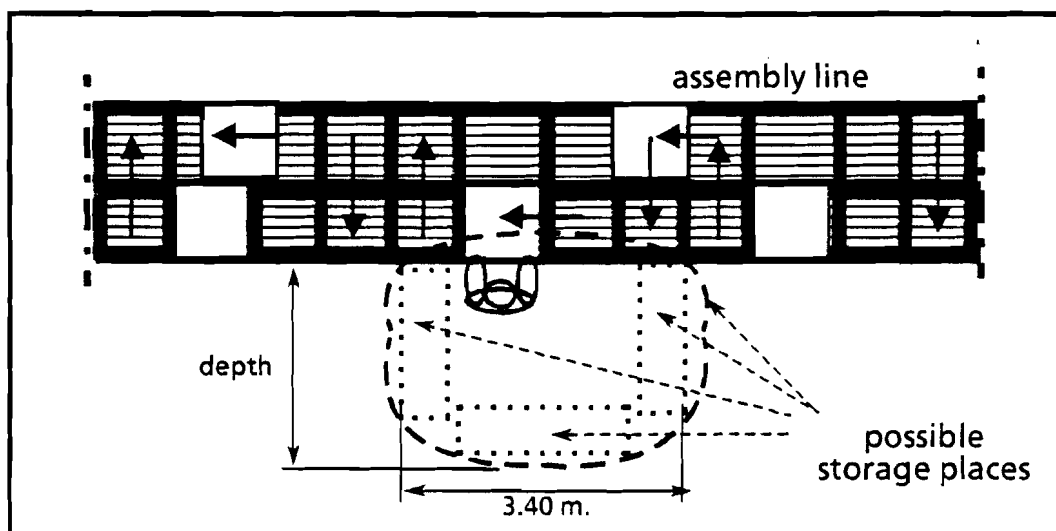
After deciding on the transport containers, the way(s) of transport, producing and parts control the only remaining sub problem for which alternatives must be determined, are the store and handling unit at the assembly line.

To make a design and a functional specification for such a unit, the following requirements must be known:

1. General design requirements.
2. Container sort(s);
3. Container quantity;
4. Ergonomical demands;
5. Automation;

### 4.1. General design requirements.

- modular built : "multi purpose" or universal design.
- Individual stores at assembly stations,
- Low floor occupation.
- The storing system must be *failsafe* in reference to the assembling of different products after the changing of products.
- The costs of each storage system (at a assembly station) should be approximately f5000,-.
- Time material handling operator < 5% of the cycle time.
- Changing time (from one product to another) approximately 5 minutes.
- System area: from the assembly line within reach of the assembly operator.



The depth of the workplace of the operator (see preceding figure) depends on the chosen layout of the building.

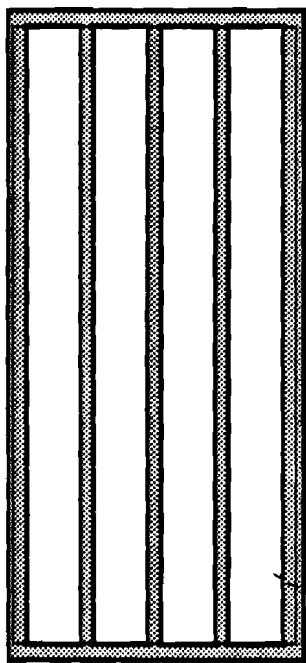
There are two possible layouts of building B (see figure on page 31):

- |   |  |
|---|--|
| - three grid layout:<br>(present situation) | depth: 3.70m.<br>gridwidth: 10m.<br>aislewidth: 3m.    |
| - four grid layout:                         | depth: 2.30m.<br>gridwidth: 7.25m.<br>aislewidth: 2m.* |

\*: Legal minimum: a man must be able to pass a forklift truck with a pallet (width 1.1m.) → minimal aisle width: 2m. (JH).



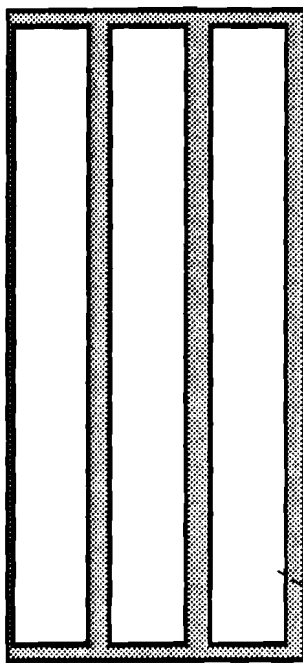
**Building B**



four grid  
lay out

grid

width: 39m.



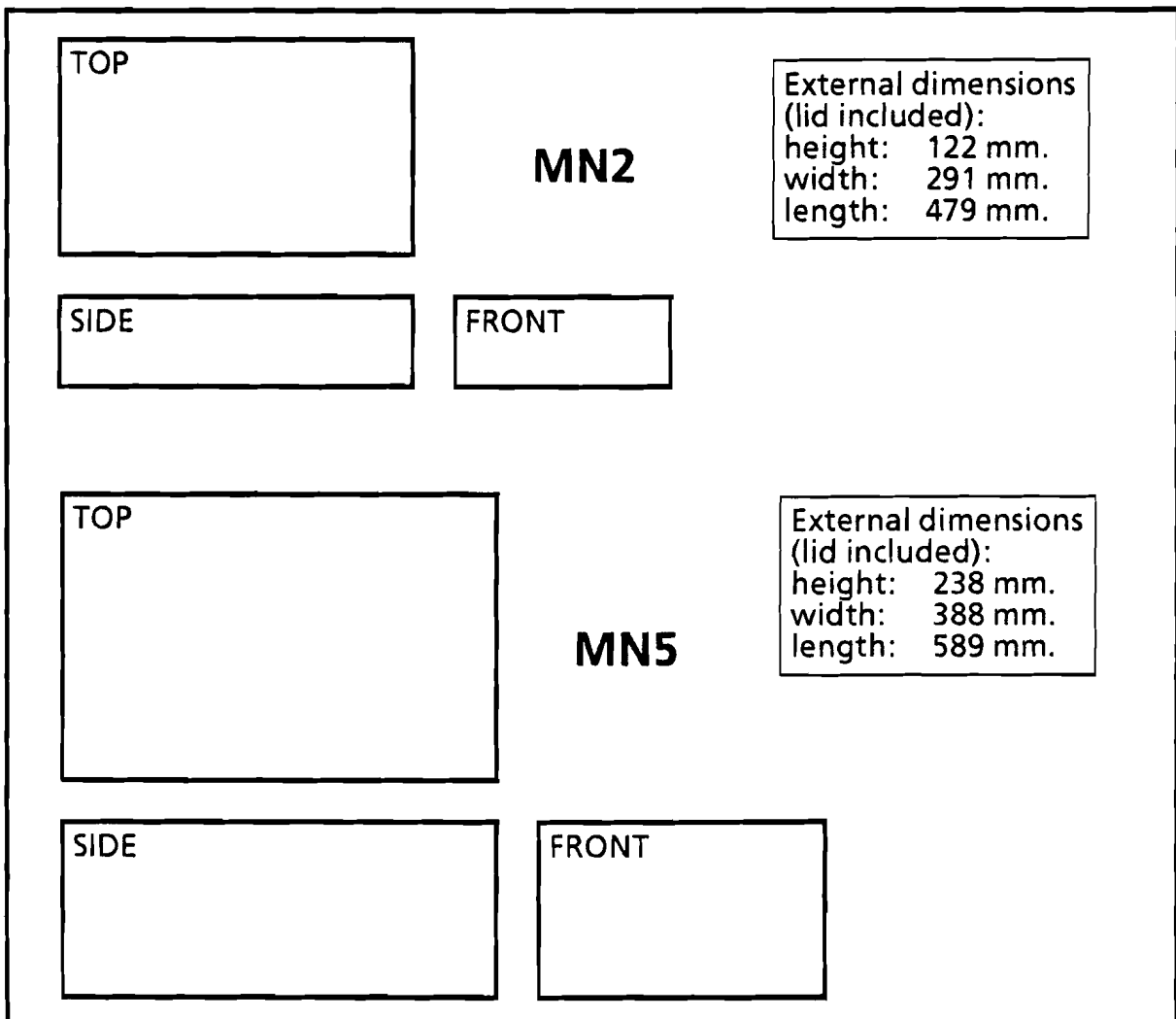
three grid  
lay out

grid

width: 39m.

**4.2. Container sort(s);**

In the previous part of this report the following part containers are selected:

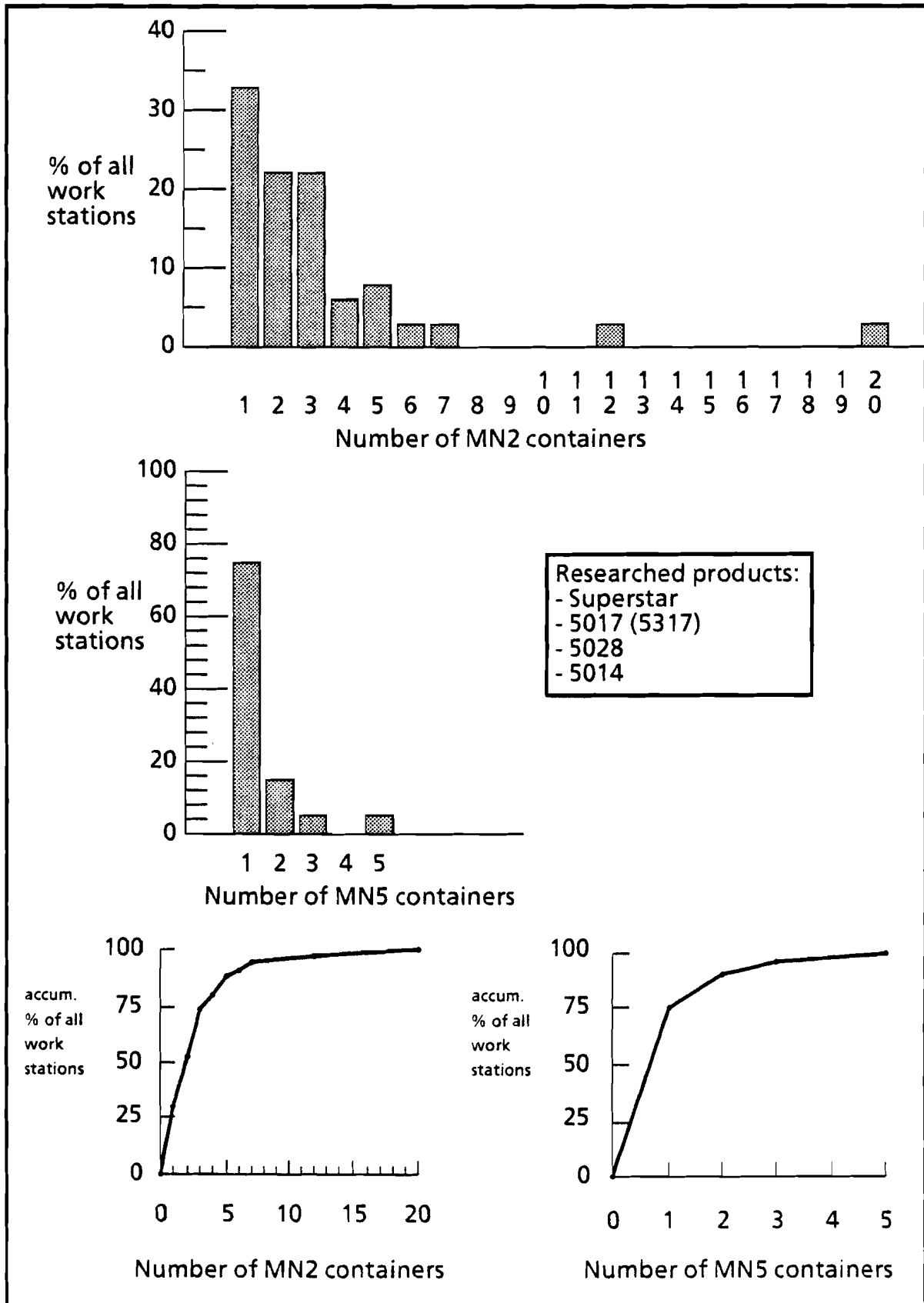


The maximum weight of the container plus contents is 15 kg. The container itself weighs 1 - 2 kgs.

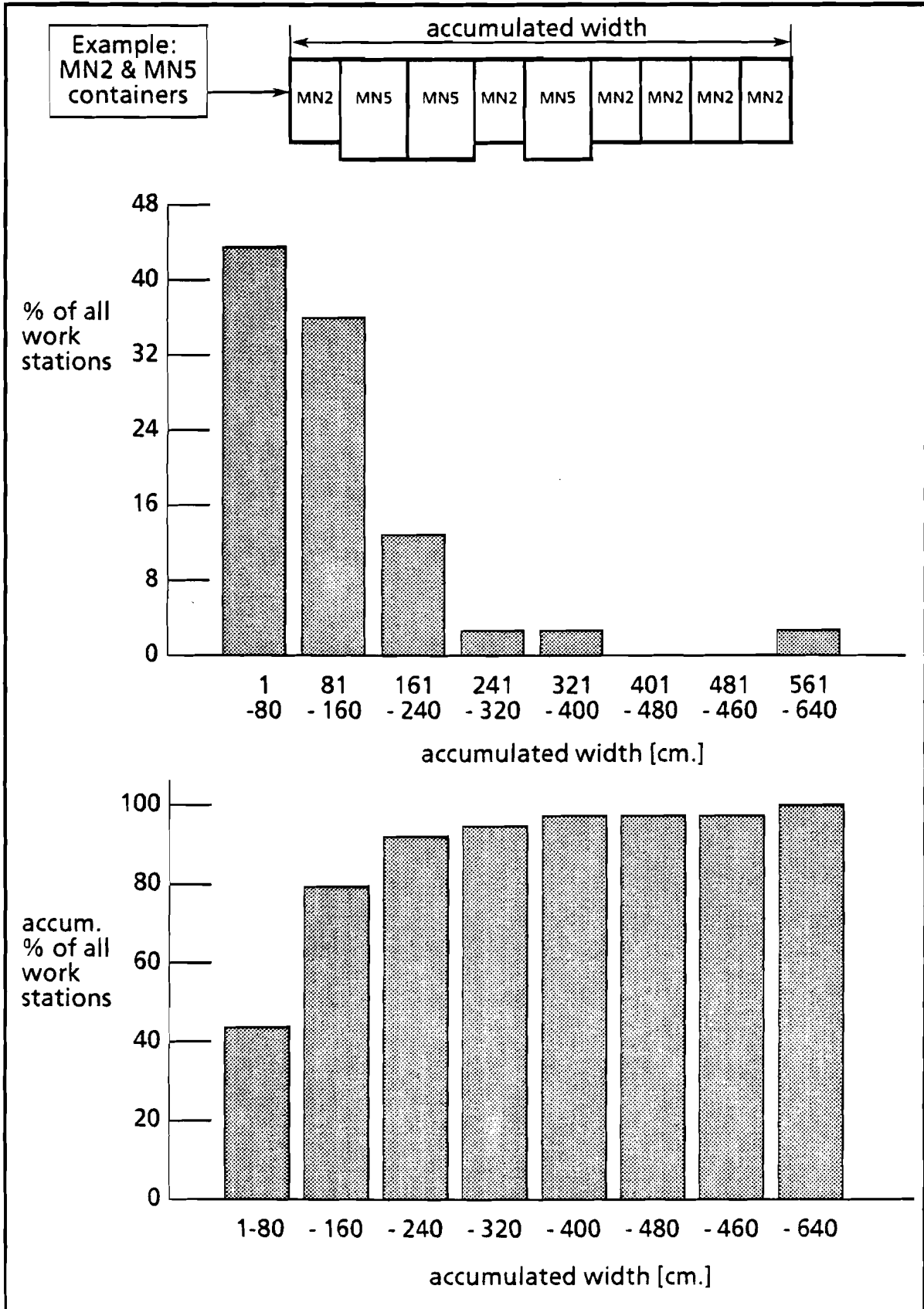
### 4.3. Container quantity; (per station)

The analyses of the parts flow of the product parts that are known gives a certain container occupation division at the assembly stations.

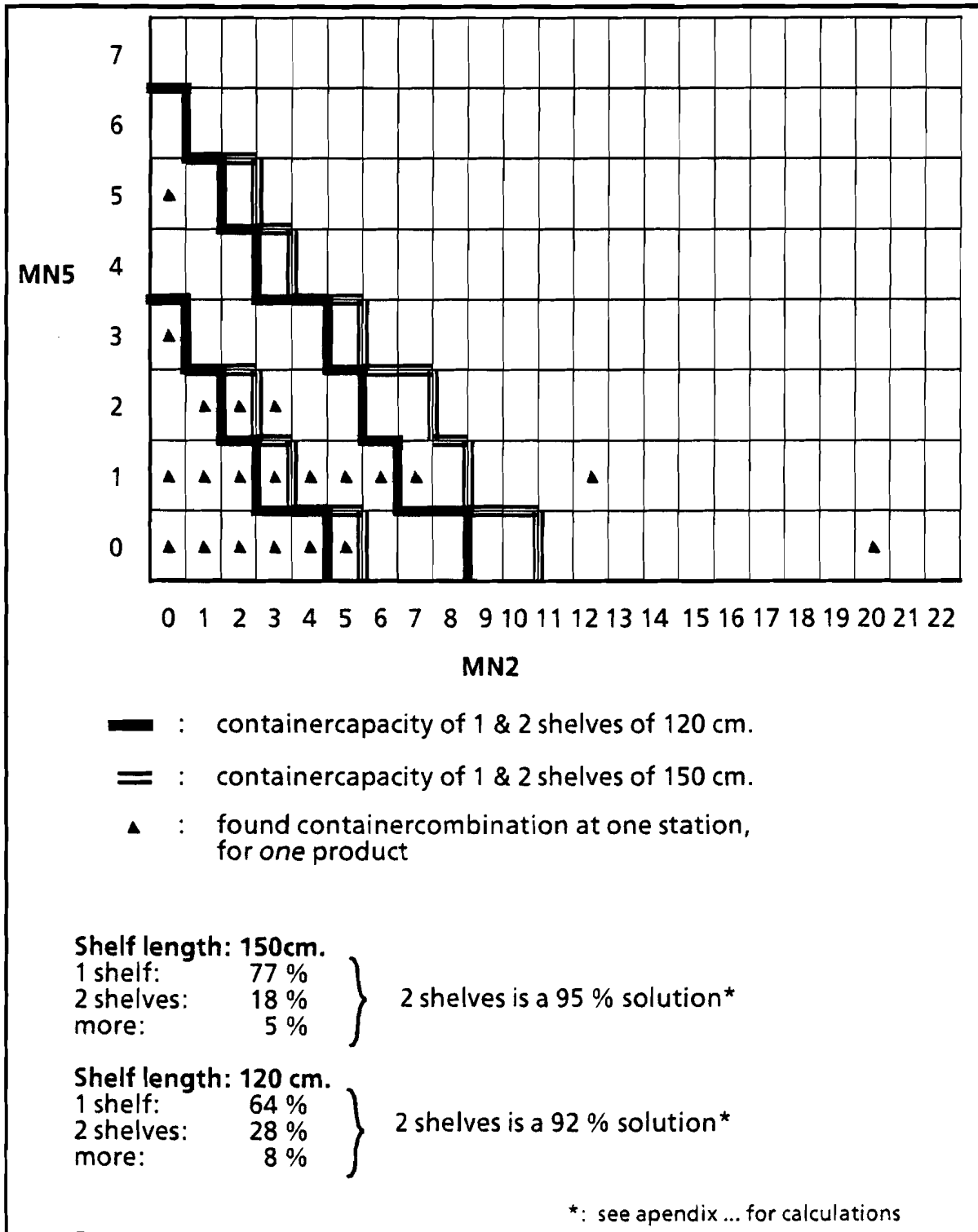
This division is represented in the following figures:



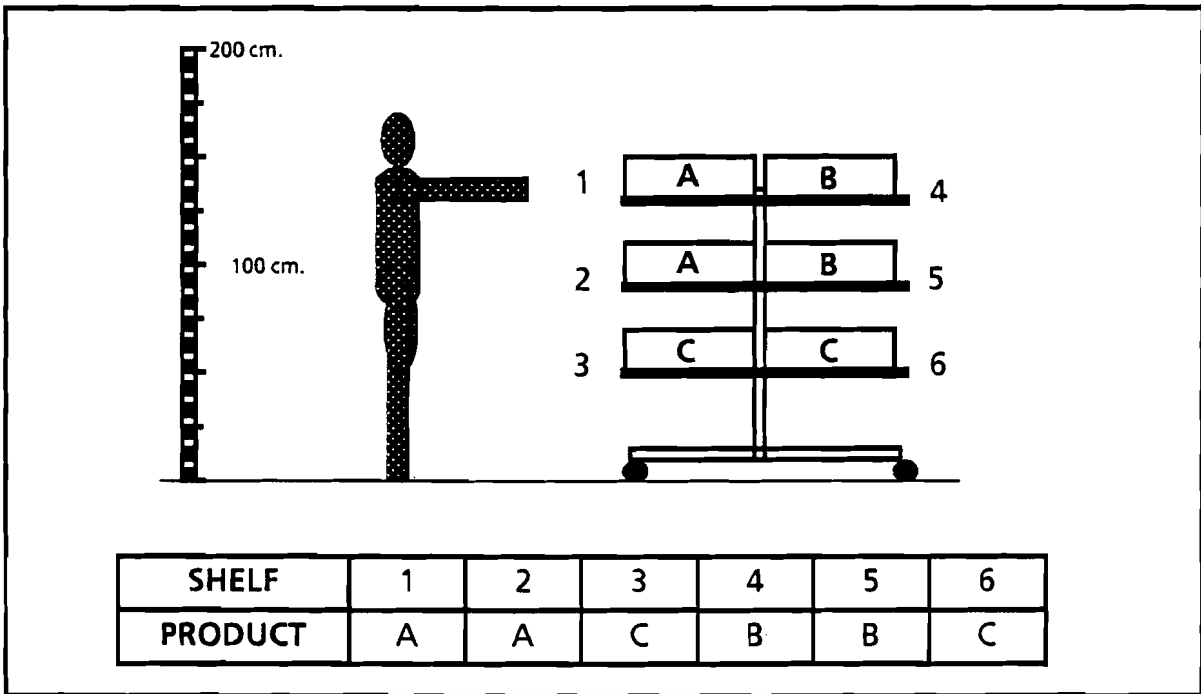
When we decide to store the container side to side, the total (accumulated) length of the containers is represented in the following figures/graphics.



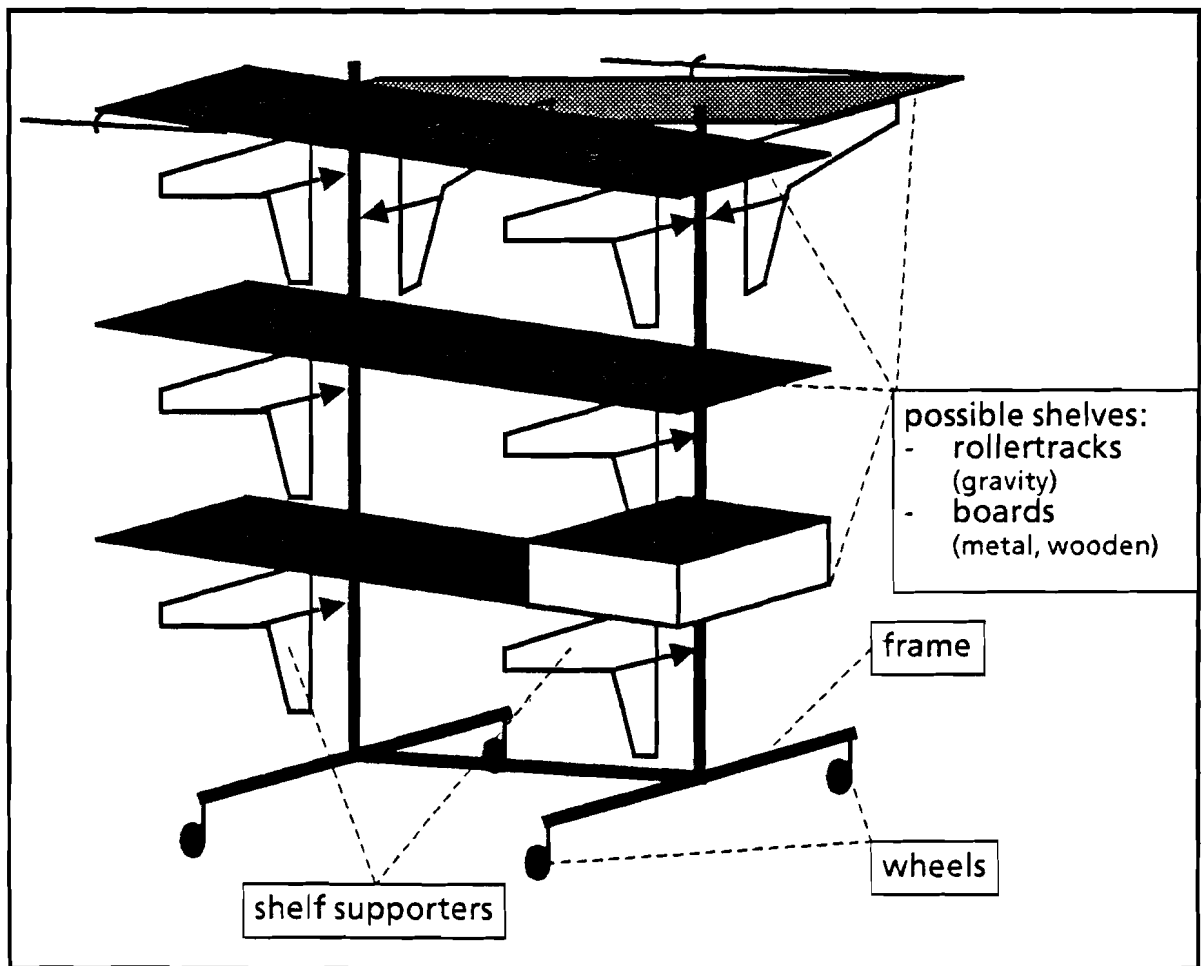
The storage of these containers should be done in such a way that the containers occupy as little space as possible. This means that the containers must be stored above each other: on shelves. The following figure gives an analysis:



Furthermore is demanded that the store at a assembly station must have enough capacity for the parts of 3 different products. This means that when one product needs two shelves, one store should consist of six shelves. (See in the following figure on page 35).

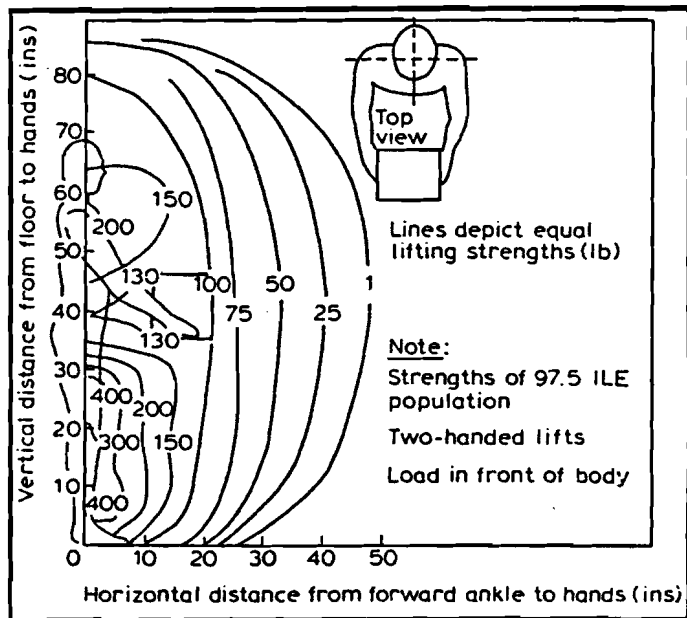


Here is a rough sketch of the modular build store



#### 4.4. Ergonomic demands.

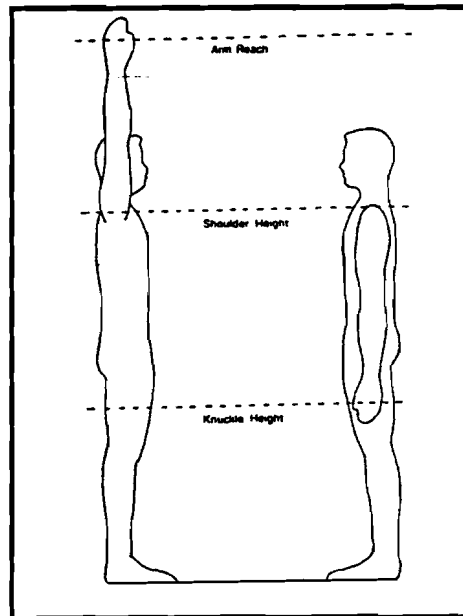
When a store is designed, that should be loaded and/or emptied by an operator, the physical aspects of the operator should be paid attention to. For loading, the operator must take containers off the assembly line with a certain frequency and store it at a certain level. The maximum weight of the containers is 15 kg. An operator needs a certain strength to lift a container. When we speak of lifting-strength we speak of a force output that can be produced with a given body posture. That is why an operator has a predicted (lifting) strength



profile for lifting objects (see the upper figure on this page).

This strength profile however, is variable when an object is lifted more than once (in a certain frequency). This effect is researched and the results are printed in the book "Manual materials handling". In this book a distinction has been made between three "sorts" of lifting, namely:

- lifting from floor to knockle height;
- lifting from knockle to shoulder height, and
- lifting from shoulder to reach height (see the lower figure on this page).



For the assembly operator the usual working height is from knockle to shoulder height with a lifting distance of approximately 50 cm. For these three sorts of lifting research has been the maximum acceptable weight of lift for different boxsizes, frequencies, vertical distances and sexes is.

See the following tables for the results of lifting from knockle to shoulder height. After examining the data in tables (see appendix 13, tables 4.4.a and 4.4.b), one can conclude that a container with a maximum weight of 15 kg gives no problem, when the time period between lifts is approximately 1 min or higher (see table females).

In "Ergonomie op de werkplek\*" tables are printed in relation to safe weights of lift (see appendix 13, tables 4.4.c and 4.4.d). According to the tables 15 kg is allowable, when the lifting commences at 75 cm above the ground.

## **4.5. Automation.**

### **Automatic assembly stations**

Preceding research showed that automatic assembly stations, that need product parts (such as a wire stringer and a automatic screwdriver) have a low parts delivery frequency. At the moment, the assembly machines are not fully automated, in this sense that the loading of the needed material (product parts) is being done by a machine operator (which attends several machines). Because it is not possible at the moment to load automatically it isn't logical to make a automatic container exchanging device.

A good alternative is to deliver the parts for the automatic assembly stations to the nearest manual assembly station. (This of course is only allowable when the delivery frequency is low and will not burden the operator of the manual station too much).

### **Manual labour vs. automation.**

Discussed in this paragraph is the need for automation. As usual the final decision is taken after considering the profits, which automation might have, when automation replaces manual labour.

Possible reasons for replacing manual labour by machines are:

- the moving of heavy objects;
- faster way of producing;
- more accurate way of producing;
- cheaper way of producing;

The objects (containers) that should be moved have a maximum weight of 15 kg., which is allowed to be lifted by an operator (see 4.4. Ergonomical demands). It is not very likely that the automated handling will be faster than the manual handling, but the automated handling however will be more accurate, due to the fact that an operator can make mistakes more easily than a machine.

So the comparing of costs of manual and automated labour determines the final choice, although one should keep in consideration that the effective assembly time of an operator will decrease when manual handling is chosen.

### **Costs comparison.**

The two methods to compare are:

1. Automatic handling: Investment (7 years,  $i = 0.08$ ),
2. Manual handling: labour costs.



#### 4.5.1. Automatic handling costs.

##### Automation possibilities:

The automation of the handling of the storing process can be divided in 4 actions:

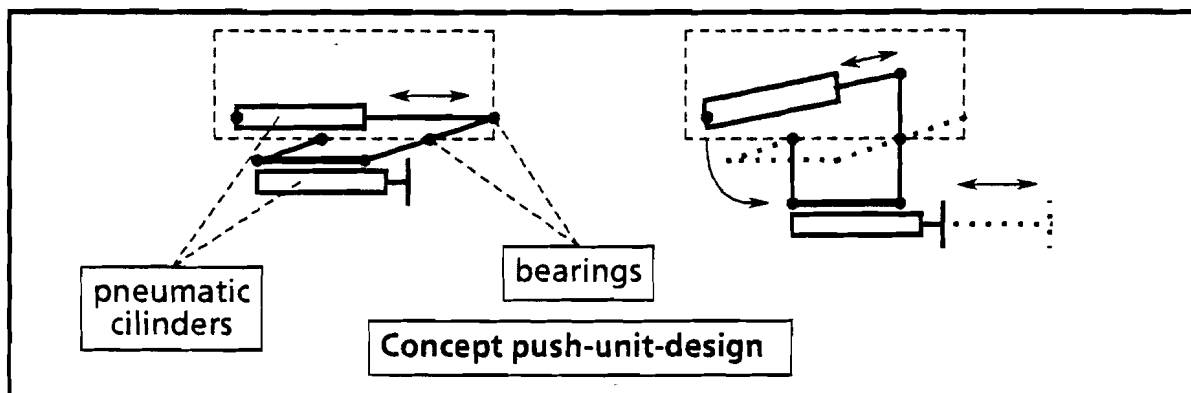
- a. Moving a container from the assembly line;
- b. Moving a container in store;
- c. Moving an empty container on assembly line.
- d. Controlling: the sensor & controlling system.

To make a cost estimate of a automatic storing device, a **concept design** must be made for all for actions (a, b, c and d). For the choises that lead to the concept design, see appendix 11.

#### **Conceptdesigns.**

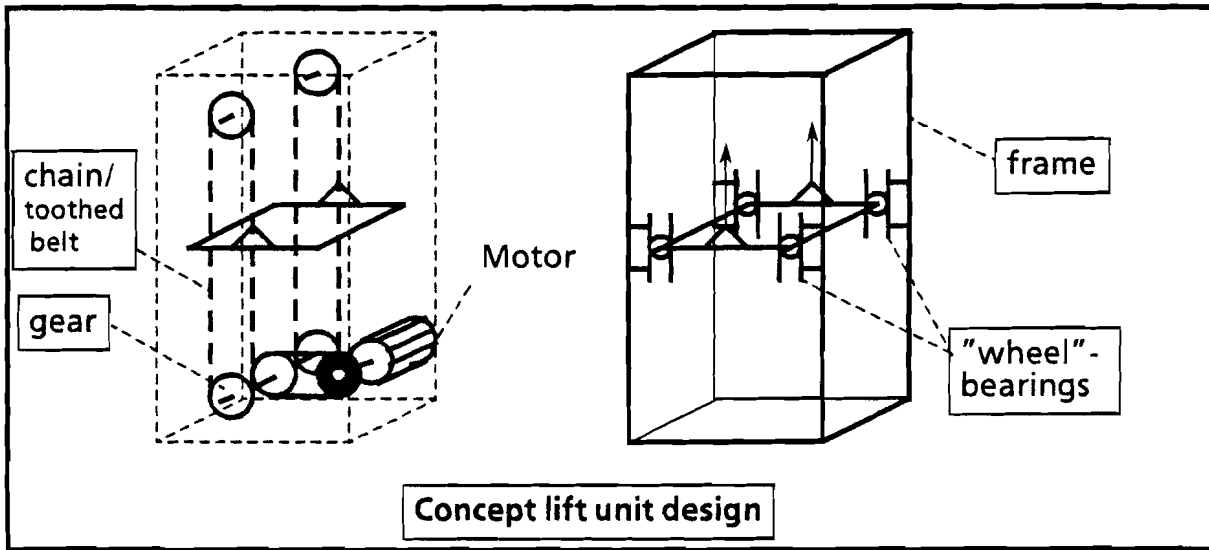
##### **a. Moving a container from the assembly line;**

When a parts container has arrived at the load and unload position, the container must be pushed of the container pallet into the lift unit.



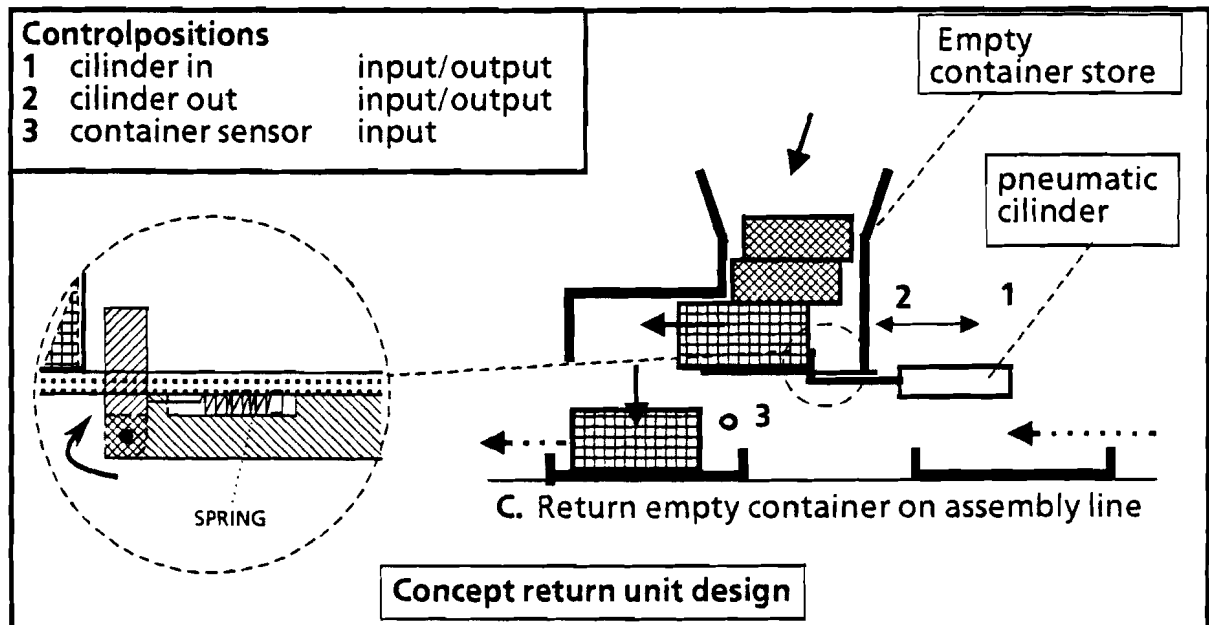
**b. Moving a container in store;**

The container must be lifted to the right level, where it should be released, so that the container can roll down the rollertrack into the store.



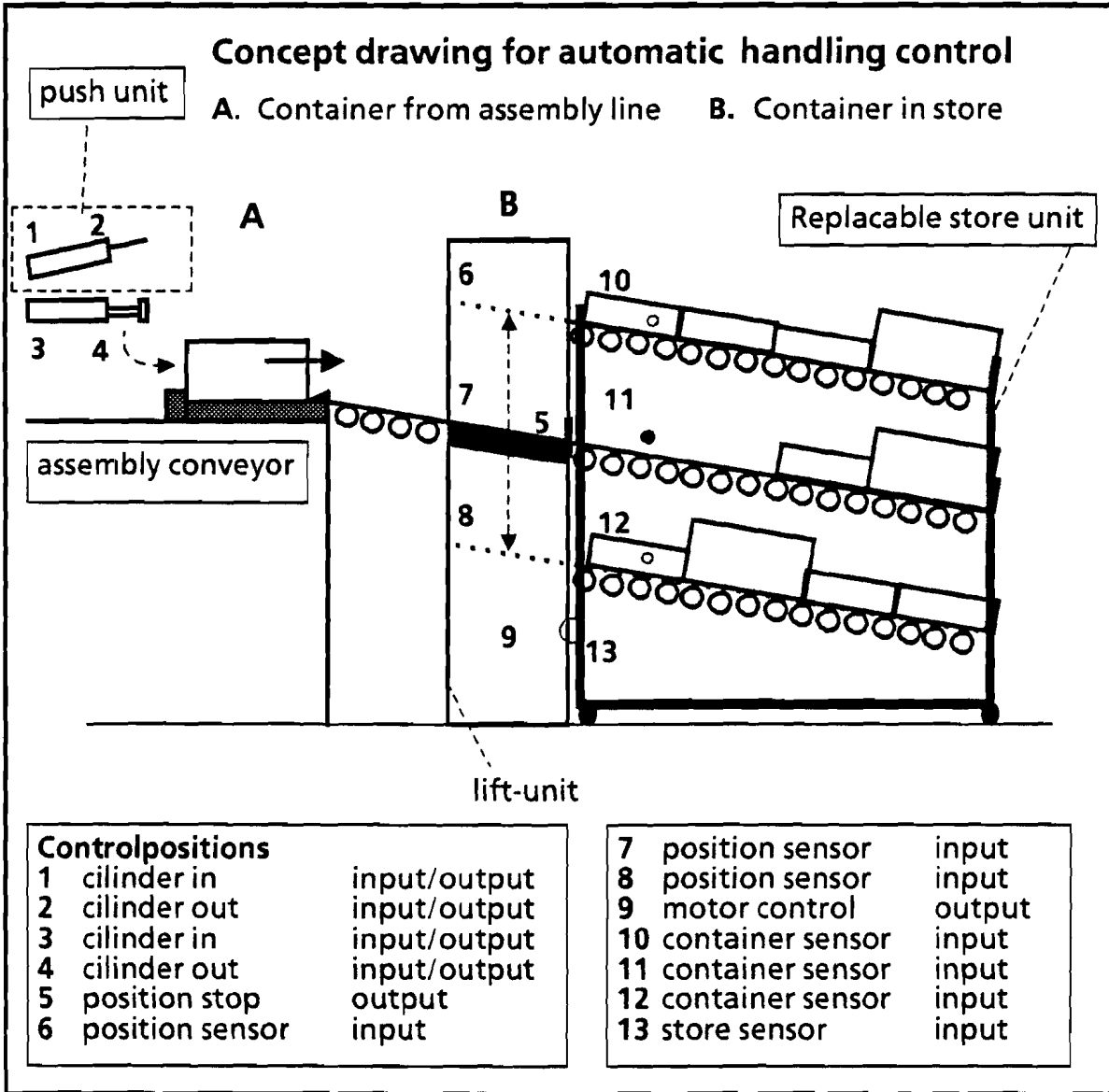
**c. Moving an empty container on assembly line.**

The assembly operator empties the containers and puts the empty containers into a store, from which they are being removed automatically and dropped on the container pallets on the assembly conveyor



**d. Controlling: the sensor & controlling system.**

The required inputs and outputs in the design for the automatic handling are represented in the following figure:



The lift unit positions on the middle level by means of controlling the lift motor (9) and checking the position sensors (6, 7 and 8).

The push unit removes the containers from the conveyor, when the conveyorsystem gives the "container present" sign (this action is controlled by pneumatics).

The container rolls down the rollertrack into the lift against the position stop (5).

The control system of the assembly conveyor knows the identity and consequently the "destination shelf" of the container. The control system checks if the store is connected with the lift with the store sensor (13) and checks if the shelf (to which the container must go) is free with the container sensors (10, 11 and 12). If not, the system must warn the operator.

The lift unit positions on the required level by means of controlling the lift motor (9) and checking the position sensors (6, 7 and 8).

When level and the container check are OK, the position stop (5) on the lift platform goes down and lets the container roll on the shelf, from which the operator takes the parts/parts containers when required.

When the conveyor pallet is emptied, it is possible to return an empty container on this pallet (see the lower figure on page 40). To check if the pallet is empty, a sensor or a feedback from the control system can make a container check. When the "pallet empty" sign is given the cylinder(s) can be activated and return a container on the pallet.

All concept designs together determine what the total investment is:

**Investment for automatic handling.**

Depreciation period: 7 years,  
interest rate:  $i=0.08$ .

	<u>Estimated Investment</u>
- Handling units: a. <u>Container from assembly line<sup>t</sup></u>	
- pneumatic cylinders	
- "overhead" frame	fl. 10 k.
b. <u>Container in store<sup>t</sup></u>	
lift unit	
- electromotor	
gears and chains incl.	
- lift cage/frame construction,	
- liftplatform, bearings incl.	fl. 20 k.
c. <u>Empty container on assyline<sup>t</sup></u>	
- pneumatic cylinder	
- empty container store	fl. 10 k.
- Control unit: d. <u>- sensor &amp; controlling system<sup>tt</sup></u>	fl. 20 k.

The costs per day are:  $p=0.0007938 \times I$  \*

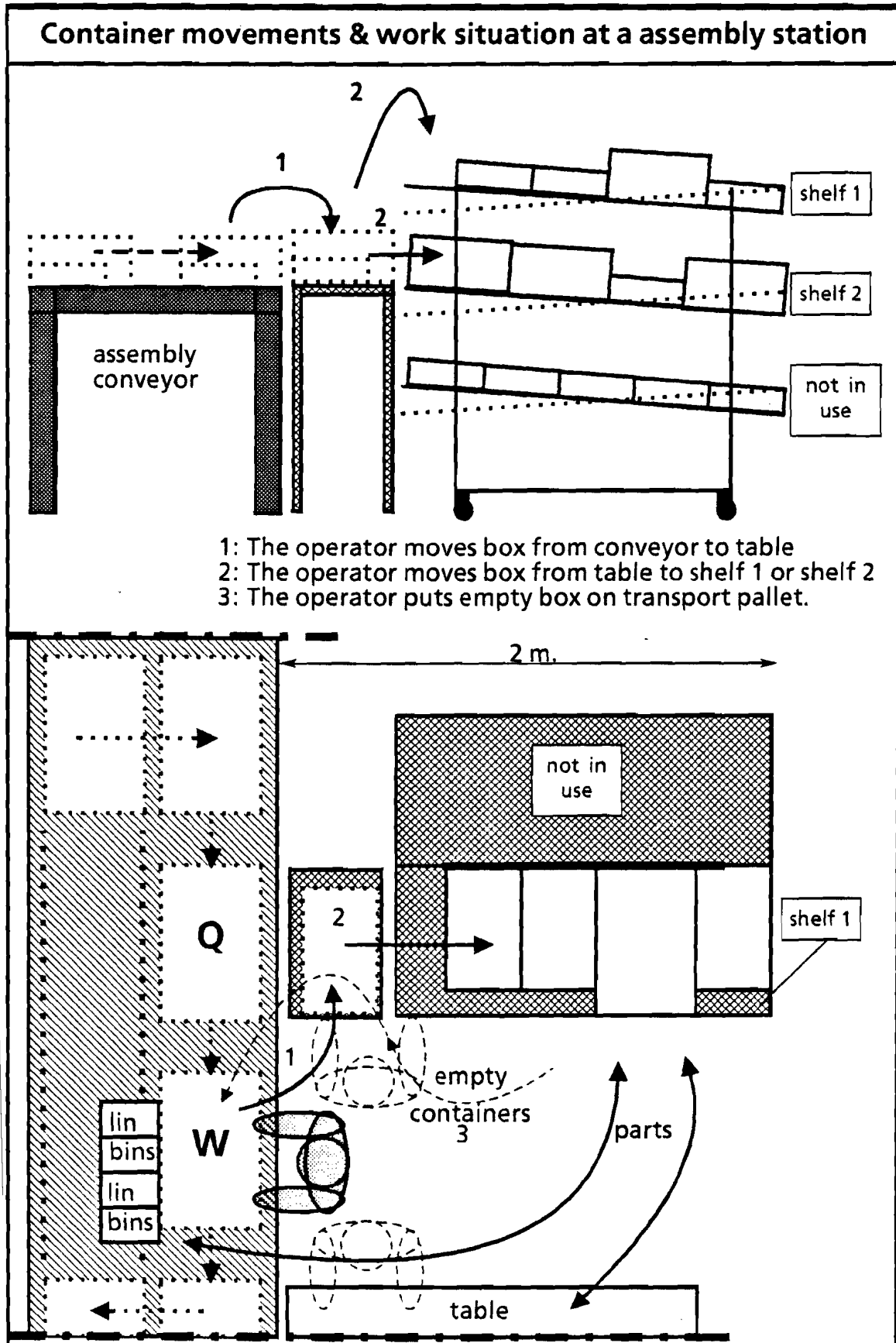
so:  $p_a = fl. 7,95$   
 $p_b = fl. 15,90$   
 $p_c = fl. 7,95$   
 $p_d = fl. 15,90$

**$p_{total} = fl. 47.70$**

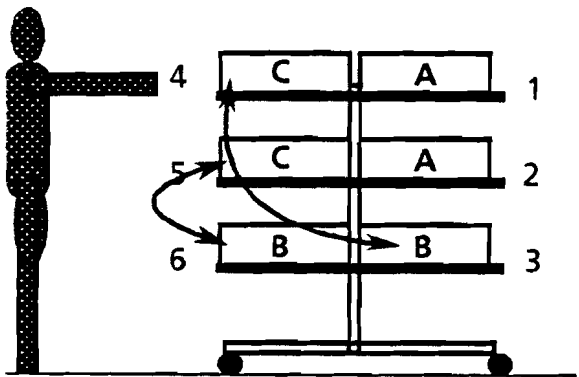
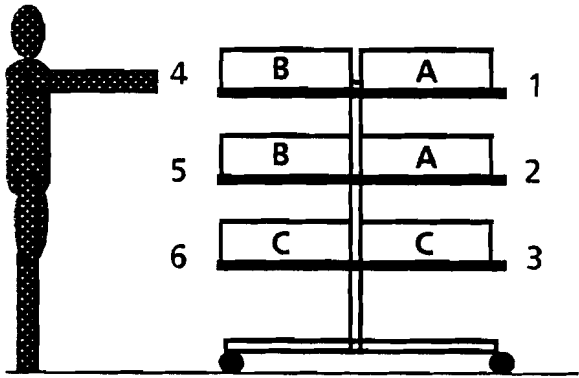
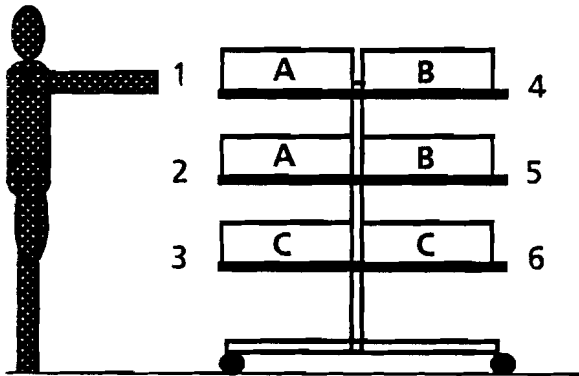
\*: see page 24.  
 †: cost estimates by L.Elbers.  
 ††: cost estimates by N. Tissink.

#### 4.5.2. Manual handling costs.

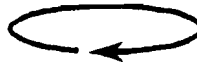
The design of the work situation and work method for manual handling are being represented in the following figures:



# THE CHANGING OF PRODUCTS in the store-rack



PRODUCT A



Turn store  
around



PRODUCT B



Exchange product containers



PRODUCT C



etcetera

The handling time per container:

<u>Action</u>	<u>Estimated time</u>
1. Take the transport container from a pallet and put is on the little table.	5 sec.
2. choose shelf (nr.1 or 2) and put container on shelf.	10 sec.
3. put empty box on transport pallet.	<u>5 sec.</u>
<b>Total</b>	<b>20 sec.</b>

The average total handling labour time per day per station, can be calculated by multiplying the number of container deliveries per day per station, with the estimated handling labour time:

$$\{\# \text{ of container deliveries}^*\} \times \text{labourtime} = 46 \times 20 = 0.2562 \text{ hr.}$$

$$\text{labourcosts} = \pm \text{fl. } 50,- / \text{ hr.} \rightarrow \text{Total labourcosts for handling: fl. } 12,81 \text{ [per day]}$$

\*: see appendix ... for calculations.

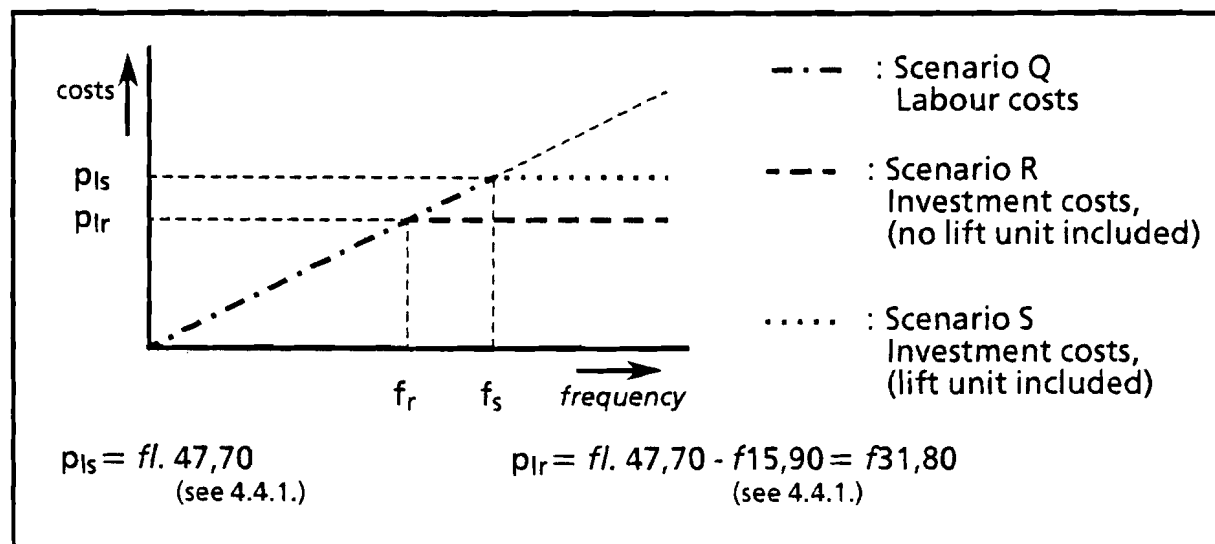
#### 4.5.3. Comparing and deciding.

In the preceding proposal the daily automation costs are higher than the manual labour costs. This makes manual labour preferable to an investment for automation in the average present situation.

This will be named **scenario Q** and its daily costs are equal to the total labour costs for handling (see 4.5.2.).

There are two possible ways to automate which depend on deliver frequency and number of different products. When the product part containers at one station fit on one shelf, there is *no need for a lift unit* (only a push unit and a return unit). This will be named **scenario R** and has dayly costs of  $C_{1r}$ .

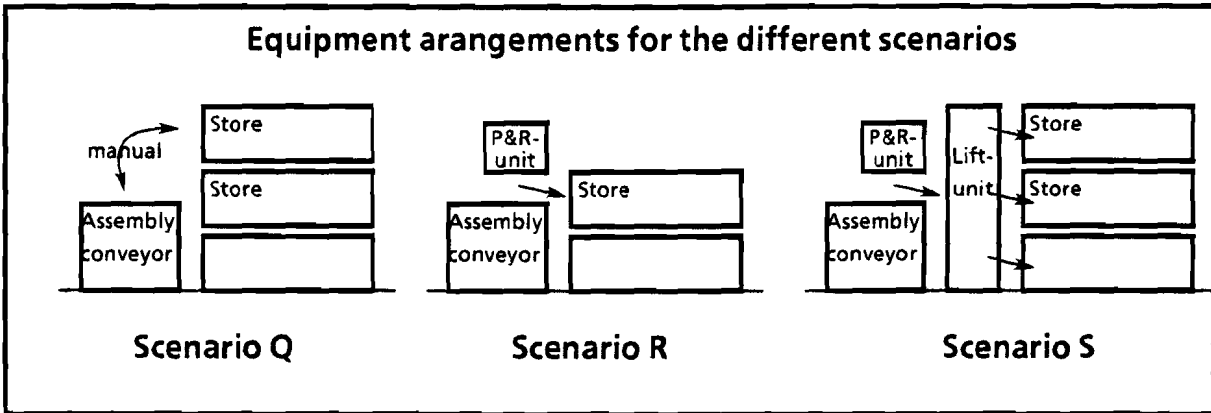
When the productparts at one station don't fit on one shelf, there is need for a lift unit (and a push unit and a return unit). This will be named **scenario S** and has daily costs of  $C_{1s}$ . This is represented in the following figure:



The automation costs of scenario R correspond with the costs which are made by **0.954 hrs** of labour. So when each container needs **20 seconds** of handling time

this means that  $f_r = 170$  containers a day\*. When a frequency is higher than  $f_r$  and all containers at one station fit on one shelf, it will be preferable to design an automated storing device (as in scenario R).

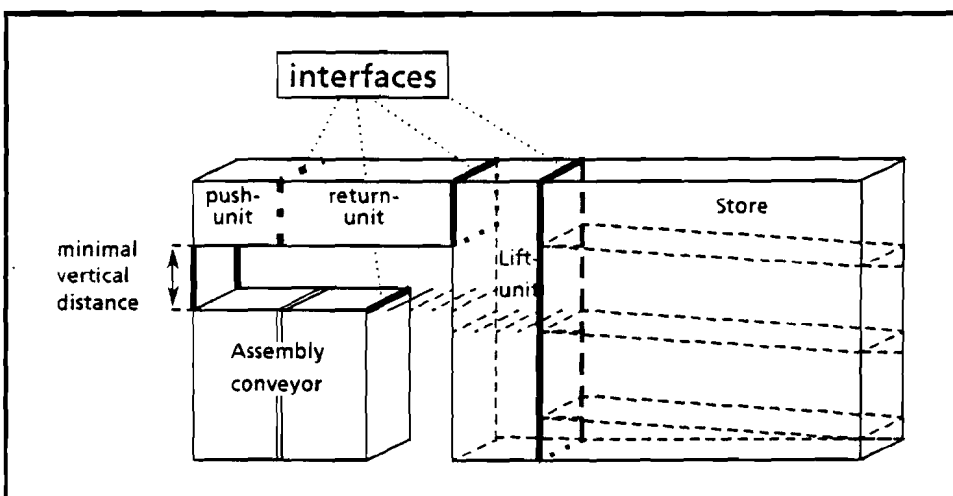
The automation costs of scenario S corresponds with the costs that are made by 0.636 hrs of labour. So when each container needs 20 seconds of handling time this means that  $f_s = 115$  containers a day\*. When a frequency is higher than  $f_s$  and not all containers at one station fit on one shelf, it will be preferable to design an automated storing device (as in scenario S).



\*: This calculation is only valid when the operator is able to use the time, (which is created by automating the handling process), for assembly.

#### 4.5.4. System area determination of the units.

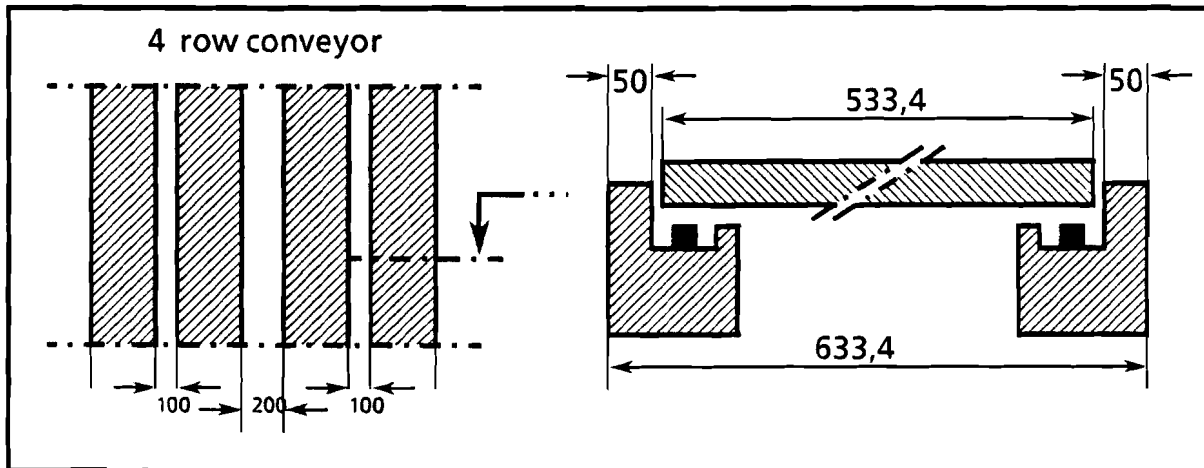
A system area of a unit is the area which is predestined for this unit. This area is separated from its surroundings by the system borders. When a border makes the connection with a system area of another unit, this border is called an interface. To develop these units independably, some agreements should be made to be sure that the different units will fit on each other.





### System area's:

The assy line unit: The height of the assembly conveyor is approximately 925 mm. (adjustable between 900 and 950 mm.).



The dimensions of a conventional conveyor pallet are: 533,4×560 mm.

### The push &

#### return unit:

The under surface should be positioned central above the side track of the assembly conveyor, and has a minimal vertical distance of ... to the assembly conveyor.

Width: maximal: the width of two conveyors + width of MN5 box =  $2 \times 733 + 450 = 1916$  mm.

Depth: minimal: depth of MN5 box =  $\pm 60$  cm.

maximum: width of a conveyor side track.

Height: relatively unlimited (preferable the same height as the lift unit: 160 cm.).

### The lift unit:

The under surface should be positioned on the floor, in the line of the side track of the assembly conveyor, in such a way that the return unit can be connected with the lift unit.

Width: minimal: the width MN5 box =  $\pm 40$  cm.

Depth: minimal: depth of MN5 box =  $\pm 60$  cm.

Height: relatively unlimited (as small as possible): 160 cm.

### Store unit:

Width: 150 cm.

Depth: minimal: depth of MN5 box (1 or 2 ×) = 60 cm or 120 cm.

Height: the same height as the lift unit or smaller (160 cm.)

**The interface agreements:**

Push & return unit

/assemblyline: The transport pallet should be designed for pushing full containers off and returning the empty ones on the conveyor pallet.

Push unit/return unit:

The push unit should be attachable to the return unit;

Return unit/liftunit:

The push unit should be attachable to the return unit;

Liftunit/assemblyline:

entrance/exit width: >65 cm.

entrance/exit height: 92.5 cm.

Lift unit/store unit:

exit/entrance width: >60 cm.

exit/entrance heights: 85 cm.

125 cm.

45 cm. (optional third / lower level).

Unit connection:

The frames of the individual units should be connectable easily . Therefore is chosen for a frame construction that consists of easy connectable profiles. The profile system that is frequently used at RANK XEROX (Venray) is the BLOCAN® profile assembly system. The advantages of this system are:

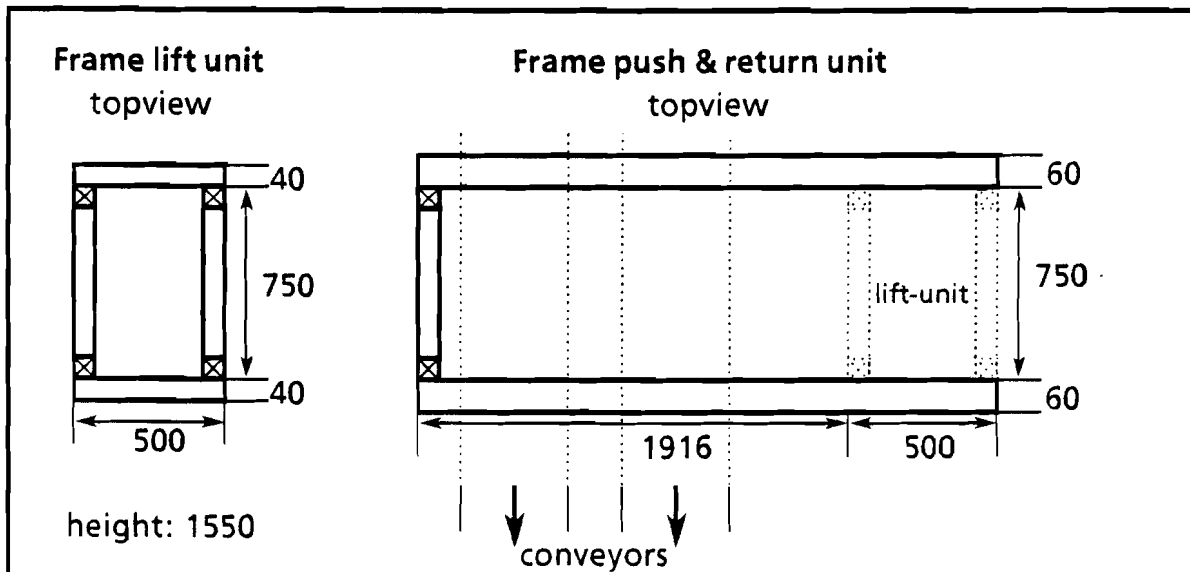
- variable use;
- assembly friendly;
- (easy) disconnectable joints;
- many sided accessories.

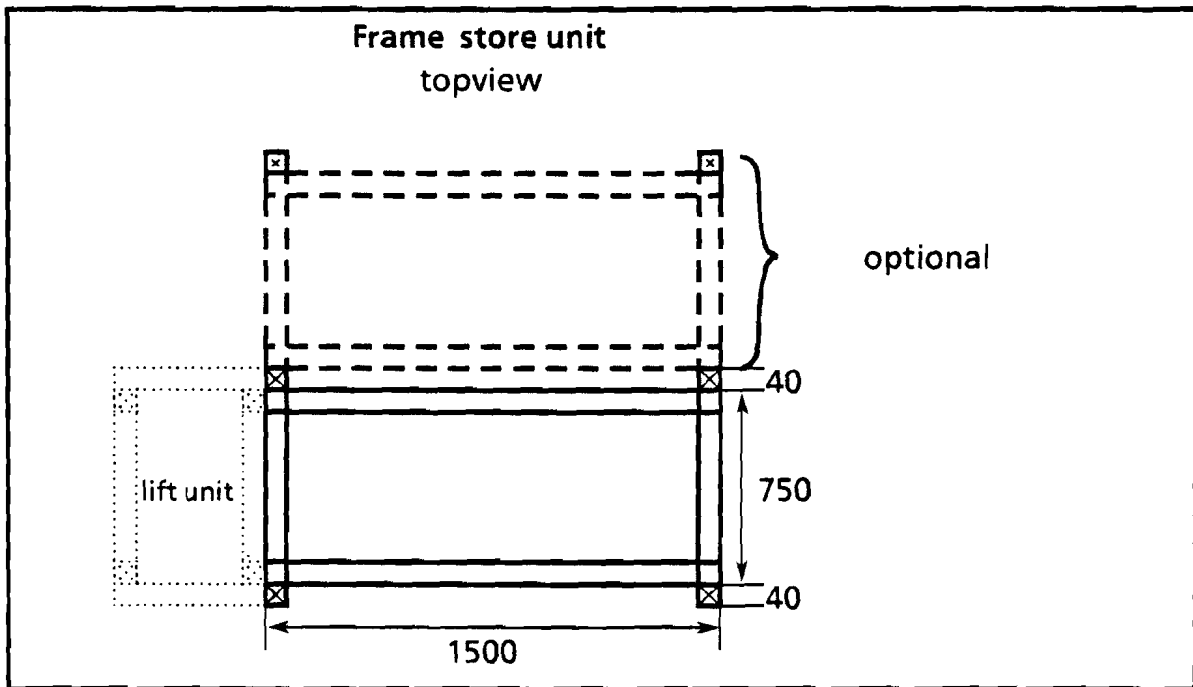
These properties come in extra handy because only few automated handling stations have to be built, because a automated handling station is only preferable at relatively high container arrival frequencies (see 4.5.3.).

In the preceding part of this paragraph it becomes clear, that before designing the individual units, the interfaces should be designed or determined first. This can be done by designing the frame(s), in which the individual units can be placed.

**Frame design.**

The measurements of the chosen profiles of which the frame is constructed are: 40×40 mm. and 60×60 mm. (see appendix 14).





**Other interfaces.**

There are also interfaces which are not determined by the frames, namely:

- The connecting rollertrack between the assembly line and the lift unit,
- The coupling device between the lift unit and the store unit,
- The container pallet.

**The connecting rollertrack assemblyline / lift unit.**

This rollertrack should 'steer' the containers into the lift unit, after they are pushed off the conveyor pallet. This means that the entrance width is larger than a MN5 container and it's exit width must be 67 cm.

So the same width as the store rollertracks will do (75 cm.).

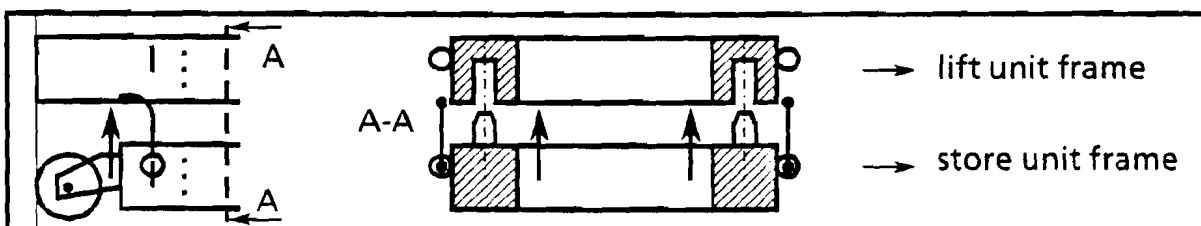
The rollertrack should be height adjustable for 100 mm. and + 100 mm.

**The coupling device lift unit / store unit.**

Because the store unit should be replacable, the lift and store unit should not be permanently fixed to each other. So there should be a coupling device, which fixes the position of the two mentioned units relatively to each other.

- This can be done by:
- positioning: pens (cilindrical, form fitted), blocks/planes (force fitted).
  - fixing: clamps, hooks, magnets

An easy solution is the combination of hooks and positioning pens. The store frame (with holes in it) is first manoeuvred againts the lift unit frame to which the pens are fixed. Then the hooks should be fixed, so that the store can not move from its place anymore. (See the following figure).

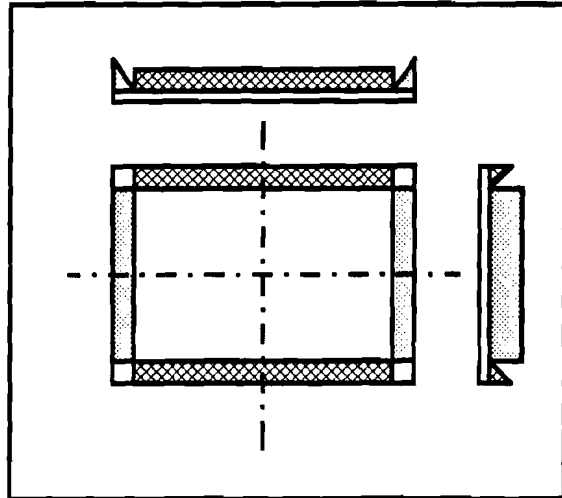


### The container pallet.

To make it possible for the push and return unit to push off and return the containers on the conveyor pallets, there are some design requirements for such container pallets, namely:

- MN2 and MN5 containers both should be transported by this pallet;
- The push unit should be able to push the containers off a pallet;
- The return unit should be able to return the container on a pallet;
- The containers may not move off the pallet during the transport.

The flat ground surface, that is as large as a MN5 box, is surrounded by sloped edges. These sloped edges help the positioning of the containers and make it possible to push off the containers when the push force is large enough.

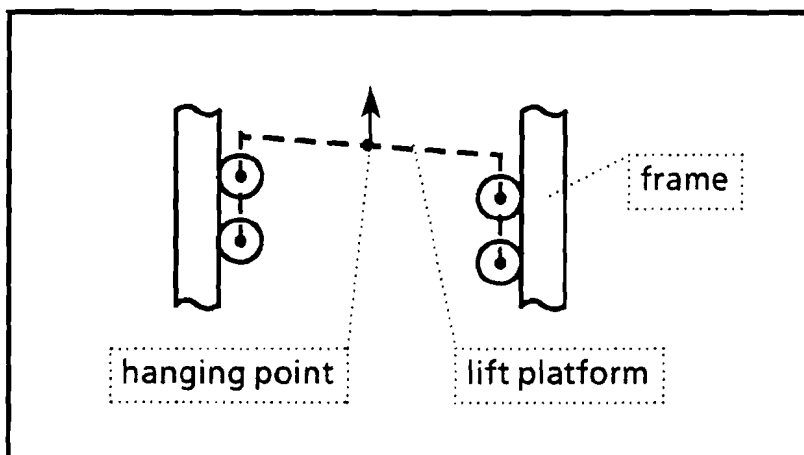


After determining the system area's, the interfaces and the sort of "building blocks" that will be used, it is possible to design the individual units.

### 4.5.5. The remaining problems of the unit design.

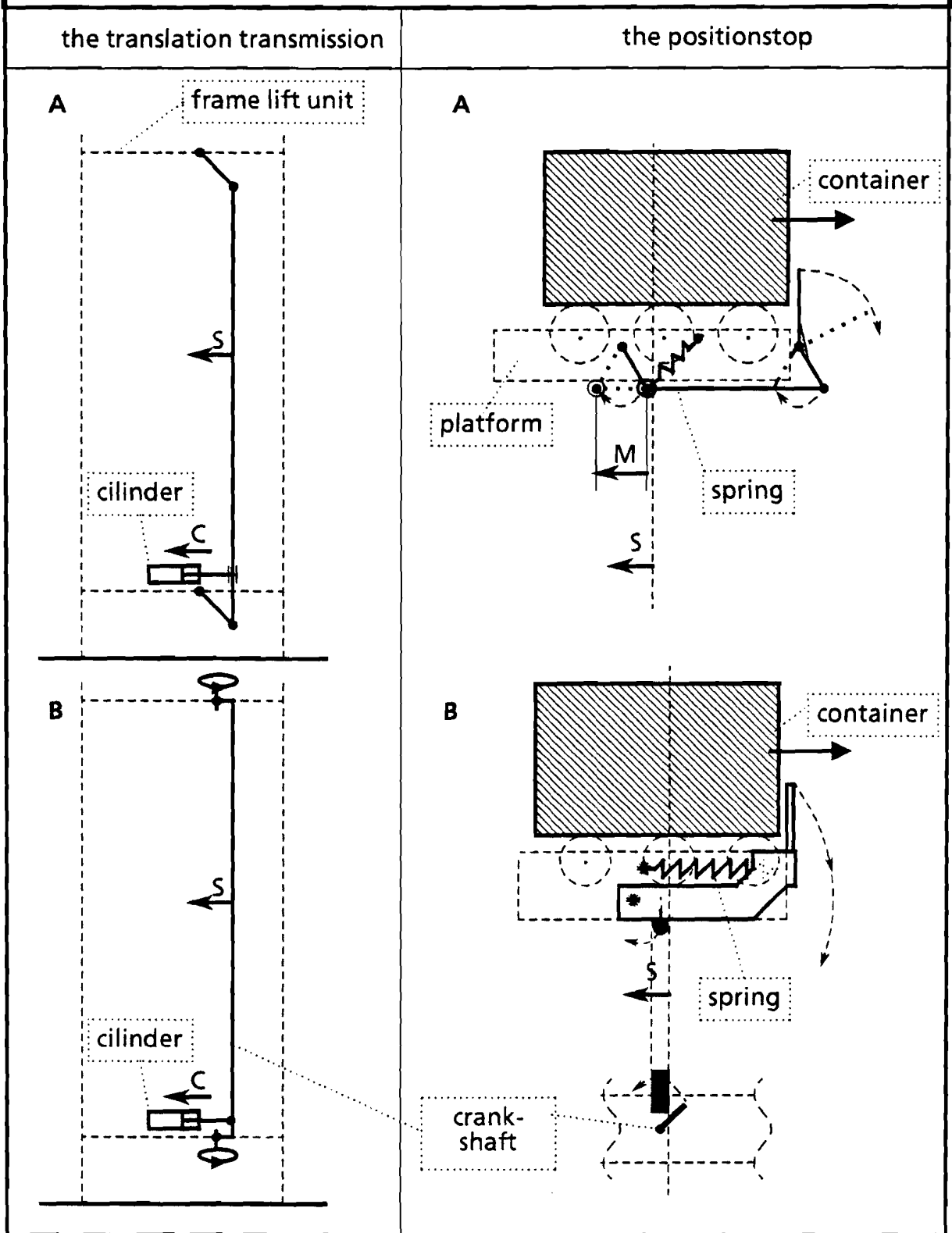
#### The lift unit.

Problem 1: The leading of the lift platform:  
To prevent the rotation round the hanging point, each of the four leading points is provided by two leading wheels.



Problem 2: The position stop at the end of the platform.  
It is not advisable to attach electric and pneumatic devices to the (moving) lift platform, because of possible cable breakage or leaking pressure tubes. The construction should also use as little space as possible. The following construction satisfies these demands (see the figure on page 51).

## Schematic representation of the positionstop mechanisms



The translation transmission A has two disadvantages:

- its translation is highly dependable of the play an precision of the joints of the mechanism.
- It is relatively complex and voluminous.

The translation transmission B:

- is relatively compact, and
- has a little translation deviation, because of torsion of the axis.

The translation leading B is chosen.

The positionstop A is more complex than positionstop B, so positionstop B is chosen.

**Problem 3:** The transmission and the generator.

The needed motorpower (generator) and the strength of the toothed belts is determined as follows:

$$m_{\text{cont.}} = \pm 15 \text{ kg.};$$

$$m_{\text{plattf.}} = \pm 10 \text{ kg.}; \quad v = 0.25 \text{ m/s};$$

$$g = 10 \text{ m/s}^2.$$

a = factor for the dynamic (acceleration) force and the friction force = 2

$$F_g = (m_{\text{cont.}} + m_{\text{plattf.}}) \times g = 250 \text{ N}$$

$$F_a = F_g \times a = 500 \text{ N}$$

The estimated minimal needed motor power:  $P = F_a \times v = 125 \text{ W}$ .

When the width of a toothed belt is 10 mm., the power that can be carried over is 0.3 kW/10 mm., which is amply sufficient for this application.

Gear diameter =  $\pm 100 \text{ mm.} \rightarrow n = \pm 48 \text{ rpm.} \equiv \omega = 5 \text{ s}^{-1}$

$$\rightarrow T = P/\omega = 25 \text{ Nm}$$

See appendix 14 for the design of the lift unit.

**The return unit.**

**Problem :** The cylinders need a stroke length of 500 mm. (which is a total cylinder length of 620 mm.) and a compact construction is required.

See appendix 14 for the design of the return unit.

**The push unit.**

**Problem :** The cylinders need a stroke length of 450 mm. (which is a total cylinder length of 570 mm.) and a compact construction is required.

The position specifications:

passive position: higher than 300 mm. above the conveyor.

active position: higher than the container pallet (height 50 mm.)

and low enough to be able to push a MN2

container (height 122 mm.)  $\rightarrow$  between 75 and 100

mm. above the conveyor.

See appendix 14 for the design of the push unit.

**Drawings**

The drawings of the provisional design of the concepts, discussed in the previous paragraphs, are put in appendix 14.

## **Conclusions and recommendations.**

### **Conclusions**

The main problem for the increasing CRU production is a lack of space. This problem can be partly solved by decreasing the space that is required for parts transport to the assembly line and storage at the assembly line.

Such a decrement can be achieved by the following proposals:

- an overhead conveyor from the main stores to the assembly line and back to the main stores (for parts containers and finished products);
- an assembly conveyor with flexible routings (for parts containers and products);
- make maximal use of small batches for the parts transport to the assembly line.

The execution of these proposals need an integrated approach to the complete material flow. Not only in the assembly area, but also in the main stores several changes must take place (for example: the change from pallet deliveries to box or container deliveries).

The advantages of the proposed system are:

- It is a flexible solution and when installed properly it can be at least as flexible as a AGV system.
- Its relative low space occupation.
- A tidy work floor.
- The system is able to transport the finished products back to the main stores as well.

The system has also some negative properties:

- Large product parts can only be transported in small batches what usually means high arrival frequencies and a high burdening of the assembly conveyor.
- When smaller aisles between the assembly grids are accomplished, it is more difficult to move heavy objects at the assembly line (for example heavy tooling / equipment).

## Recommendations

Replenishment like the proposed system, deserves recommendation, because it works for  $\pm 90\%$  of the product parts, *and* because of its "space creation", which makes it possible to increase the production in the same work area of building B (the main problem for the CRU production).

For the large product parts ( $\pm 10\%$  of all products) a dedicated solution should be developed, for example:

- a dedicated lift unit from and to the overhead conveyor at the station where these large parts are needed, or
- parts replenishment of these large parts in pallets at stations which are situated at the ends of the assembly conveyor.

A condition for this replenishment system is that the introduction of such a change of parts replenishment should happen in good consultation with the main stores department.

Automation of the exchange of containers between the assembly conveyor and the stores at the assembly line should only be done for high container arrival frequencies.

## Literature

Ergonomics of workstation design,

T.O. Kvalseth, University of Minnesota,  
Butterworth & Co (Publishers) Ltd, 1983

Manual materials handling,

M.M. Ayoub & Anil Mital, Texas Tech University & University of Cincinnati,  
Taylor & Francis 1989

Ergonomie op de werkplek,

K.Poll, NIA, GAK, /NIA 1991

Systematic Handling Analysis, R. Mutter.



# APPENDICES

## **Appendix 1          Project assignment description**

On the next page the (dutch) project assignment description is shown.

Student: J.C. van der Burg  
 Afstudeerhoogleraar: Prof. Ir. J.M. van Bragt  
 Begeleiders: Namens de TUE: Ir. A.T.J.M. Smals  
 Namens Rank Xerox: Ir. E. Mulder

**KADER VAN DE OPDRACHT**

Uitgaande van het door Rank Xerox Venray geïmplementeerde voorraadbesturings- en transportsysteem (JIT-material-replenishment-systeem) en gebaseerd op concepten die ontwikkeld zijn ten behoeve van F.A.S., is de opdracht als volgt:

**OPDRACHT**

Er moeten een of meerdere voorstellen worden aangedragen voor:

- het benutten van de operationele en te activeren functionaliteit van dit JIT-material-replenishment-systeem en
- het ontwerpen van een modulair onderdelen-toevoermechanisme,

ten behoeve van het transport van onderdelen voor de assemblage van verschillende Customer-Replaceable-Unit-modellen op een (toekomstige) mix-build assemblyline.

**TOELICHTING**

Het betreft het transport van deze onderdelen, vanaf een intern voorraad- of produktiepunt tot binnen handbereik van een operator of assembleer- of hanteermachine.

Het kunnen toeleveren van de juiste hoeveelheden CRU-onderdelen op het juiste tijdstip op de juiste plaats bij een operator of machine is een hoofdeis voor het te ontwerpen systeem.

Uitgangspunten zijn:

- Het voorraadbesturingssysteem zoals dat nu aanwezig is (ATNS= Assembly Terminal Network System en XBMS= Xerox Business Managing System);
- De produktievloer van de CRU-plant;
- De mogelijkheden van transport binnen Rank Xerox Venray.
- De geplande CRU-produktie wordt bepaald door de door Rank Xerox verwachte aantallen, die worden weergegeven in de Strategic Planning Assumptions (SPA).
- De afstudeeropdracht behoort te worden afgehandeld volgens de projektstrategie, zoals geformuleerd door prof. v. Bragt.
- De afstudeeropdracht behoort een constructief gedeelte te hebben.

**VERSLAG, ETC.**

Bij de secretaresse is verkrijgbaar:

1. Het memorandum "Afstuderen in de Produktietechnologie en -Automatisering".
2. Richtlijnen afstuderen bij onderwijsgroep "Specifieke produktiemiddelen".
3. "Wat moet waar en hoe in het verslag" door drs. P. Westendorp.

Voor akkoord:

Prof. J.M. van Bragt,

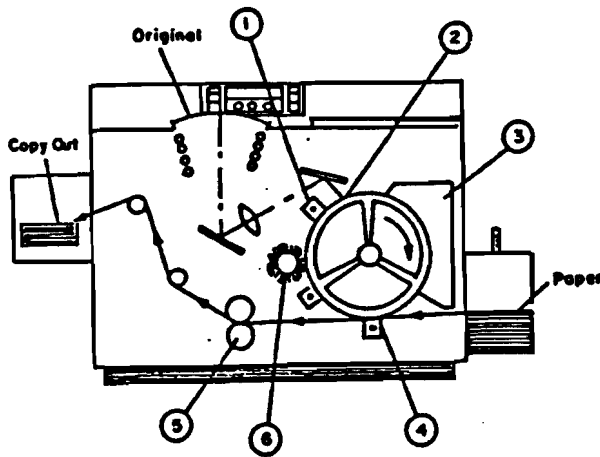
Ir. A.T.J.M. Smals,

Ir. E. Mulder,

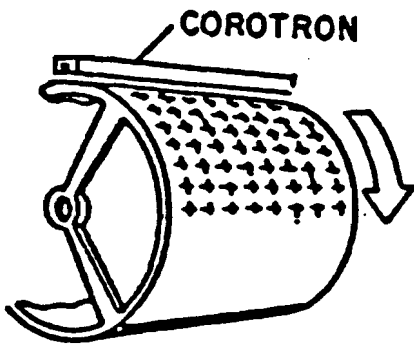
J.C. van der Burg,

## Appendix 2      The copy process

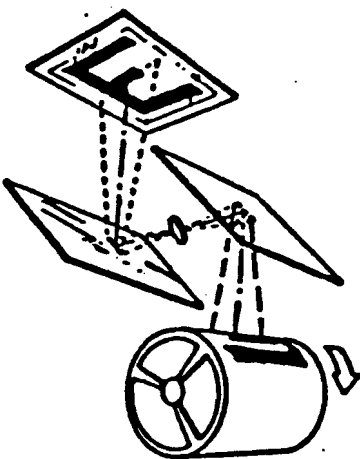
On the following pages is given the description of the copy process.



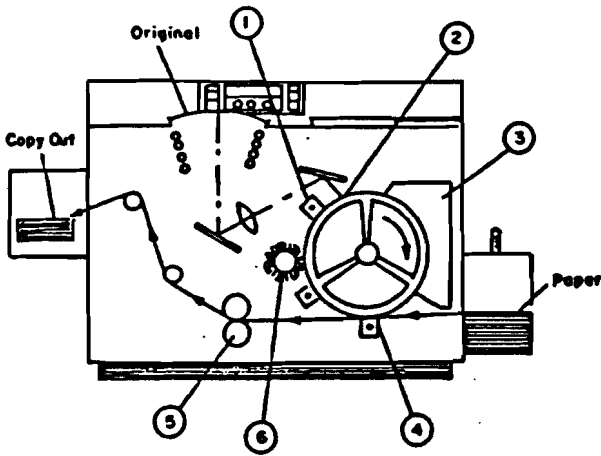
The steps of the Xerographic process.



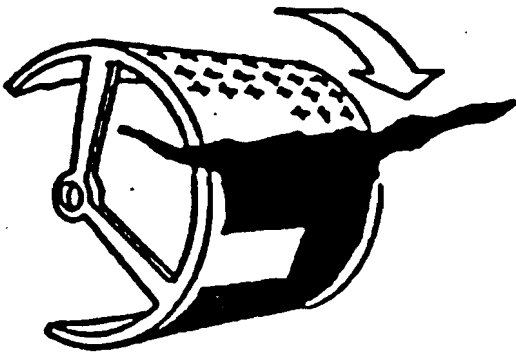
1. By rotating the drum (cilinder) along a high voltage wire (the corotron) the (with photoconductor coated) drum gets electro-staticly charged. These parts, the corotron and the drum are the mainparts of the CRU.



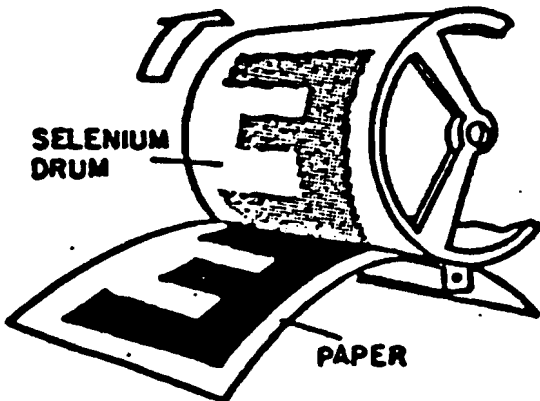
2. By projecting light on this drum the static charge disappears where the light reaches the drum and there arises a (latent) image of the original on the drum.



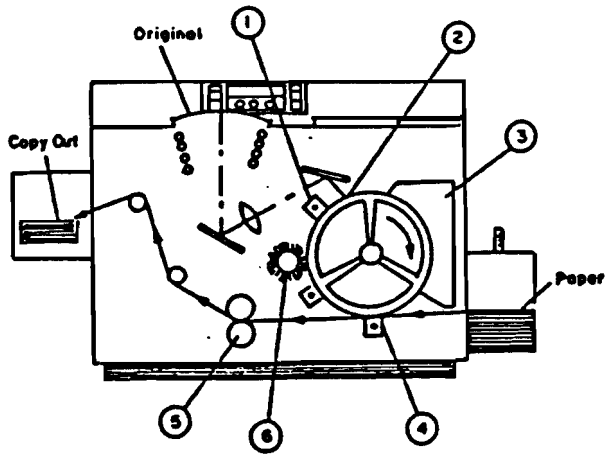
The steps of the Xerographic process.



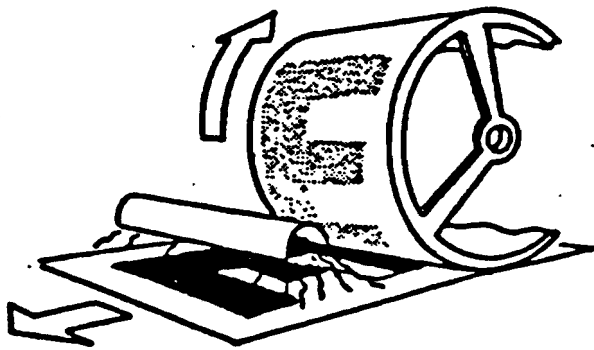
3. By bringing the toner dust (with an opposite charge) on the latent image, the toner will attach there where a static charge is present, so there appears a visible image on the drum.



4. The sheet of paper will be loaded on such a way, that when the sheet moves along the drum, the toner-image will be transferred from the drum on to the paper.

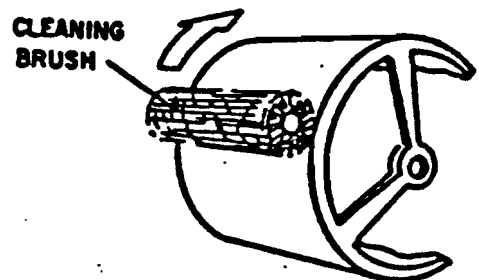
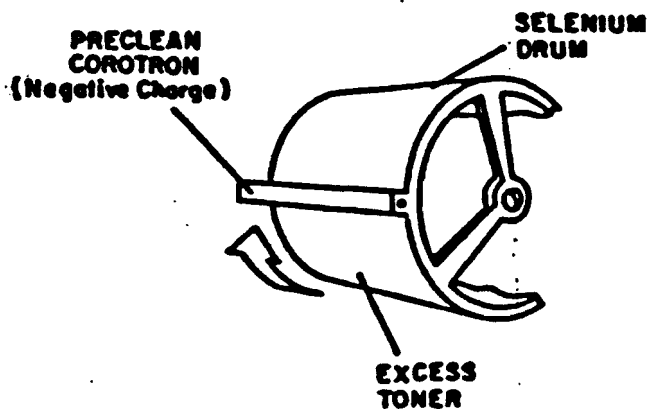


The steps of the Xerographic process.



The toner that is still loose on the paper is melted on the paper by a heat source.

6. Finally the drum rotates along a discharging corotron, which loosens toner that's still on the drum, so that the toner easily can be removed from the drum by a scraper or a brush. Now the Xerographic process can start all over again.



### **Appendix 3            The way of producing**

In this appendix the LOTUS spreadsheet (+ listing) is printed with which a mix build schedule can be composed.

# Productionschedule of the 5028 line, in 1993

Minimum length of a productionperiod: 3 days.

Product	Average dayrate	Labour st.	Average # hrs/day	cycle-time prod.sched. [days]	production periods /cyclct.	# REPETITIONS <period 1,period 4> - 2				# REPETITIONS <period 5,period 8> - 3				
						period 1	period 2	period 3	period 4	period 5	period 6	period 7	period 8	
						# of days 7	# of days 5	# of days 3	# of days 7	# of days 7	# of days 5	# of days 3	# of days 7	
						(hrs/day)	(hrs/day)	(hrs/day)	(hrs/day)	(hrs/day)	(hrs/day)	(hrs/day)	(hrs/day)	
5014	376	0.13	49	22	1	154				154				
5017	146	0.25	37	22	1		161				161			
CBOW	160	0.13	21	22	1			153				153		
LV4	345	0.13	45	22	1				141				141	
Sum hrs/day:			151											
YANKTON*	66	0.15	10	110	2			182						
5028*	1080	0.15	162	110	18	171	171		171	171	171	171	171	
Sum [hrs/day]:			172			Used cap.:	325	332	334	312	325	332	324	312
Tot. sum [hrs/day]:			323			Overcap.:	110	103	101	123	110	103	111	123
Installed man. assytm DR			2900			Cap.variation [%]:	1	3	3	-3	1	3	0	-3
Maximum capacity:			435			100%:	323							

\* 5028-- family

Product	(products /day)	(products /day)	(products /day)	(products /day)	(products /day)	(products /day)	(products /day)	(products /day)	(products /day)
5014	1182	0	0	0	1182	0	0	0	0
5017	0	642	0	0	0	642	0	0	0
CBOW	0	0	1173	0	0	0	1173	0	0
LV4	0	0	0	1084	0	0	0	0	1084
YANKTON*	0	0	1210	0	0	0	0	0	0
5028*	1142	1142	0	1142	1142	1142	1142	1142	1142

Product	(products /period)	(products /period)	(products /period)	(products /period)	(products /period)	(products /period)	(products /period)	(products /period)	(products /period)
5014	8272	0	0	0	8272	0	0	0	0
5017	0	3212	0	0	0	3212	0	0	0
CBOW	0	0	3520	0	0	0	3520	0	0
LV4	0	0	0	7590	0	0	0	0	7590
YANKTON*	0	0	3630	0	0	0	0	0	0
5028*	7996	5712	0	7996	7996	5712	3427	7996	7996



A:A1: {Page 1/1 SWISS24} 'Productionschedule of the 5028 line, in 1993  
A:E4: {Bold} 'Minimum length of a productionperiod: 3 days.  
A:G7: {LTB} '# REPETITIONS <period 1,period 4> =  
A:J7: {RTB} +F17  
A:K7: {LTB} '# REPETITIONS <period 5,period 8> =  
A:N7: {RTB} +E17/E12-F17  
A:G8: {LTB} 'period 1  
A:H8: {LTB} 'period 2  
A:I8: {LTB} 'period 3  
A:J8: {LTB} 'period 4  
A:K8: {LTB} 'period 5  
A:L8: {LTB} 'period 6  
A:M8: {LTB} 'period 7  
A:N8: {LRTB} 'period 8  
A:A9: {Page LRT} 'Product  
A:B9: {LRT} 'Average  
A:C9: {LRT} [W10] 'Labour  
A:D9: {LRT} 'Average  
A:E9: {LT} 'cycle-time  
A:F9: {LT} 'production  
A:G9: {L} '# of days  
A:H9: {L} '# of days  
A:I9: {L} '# of days  
A:J9: {L} '# of days  
A:K9: {L} '# of days  
A:L9: {L} '# of days  
A:M9: {L} '# of days  
A:N9: {LR} '# of days  
A:B10: {LR} 'dayrate  
A:C10: {LR} [W10] 'st.  
A:D10: {LR} '# hrs/day  
A:E10: {L} 'prod.sched.  
A:F10: {L} 'periods  
A:G10: {L} 7  
A:H10: {L} 5  
A:I10: {L} 3  
A:J10: {L} 7  
A:K10: {L} +\$G\$10  
A:L10: {L} +\$H\$10  
A:M10: {L} +\$I\$10  
A:N10: {LR} +\$J\$10  
A:E11: {LB} '[days]  
A:F11: {L} ' /cyclet.  
A:G11: {LTB} '(hrs/day)  
A:H11: {LTB} '(hrs/day)  
A:I11: {LTB} '(hrs/day)  
A:J11: {LTB} '(hrs/day)  
A:K11: {LTB} '(hrs/day)  
A:L11: {LTB} '(hrs/day)  
A:M11: {LTB} '(hrs/day)  
A:N11: {LRTB} '(hrs/day)  
A:A12: {Page LRTB} '5014  
A:B12: {LRTB} 376  
A:C12: {LRTB} [W10] 0.13  
A:D12: {LRTB} (F0) +C12\*B12  
A:E12: {LRTB} @SUM(G10..J10)

A:F12: {LRTB} (F0) 1  
A:G12: {LRTB} (F0) +\$E12\*\$D12/(G\$10\*\$F12)  
A:K12: {LRTB} (F0) +\$E12\*\$D12/K\$10  
A:A13: {Page LRTB} '5017  
A:B13: {LRTB} 146  
A:C13: {LRTB} [W10] 0.25  
A:D13: {LRTB} (F0) +C13\*B13  
A:E13: {LRTB} +E\$12  
A:F13: {LRTB} (F0) 1  
A:H13: {LRTB} (F0) +\$E13\*\$D13/(H\$10\*\$F13)  
A:L13: {LRTB} (F0) +\$E13\*\$D13/L\$10  
A:A14: {Page LRTB} 'CBOW  
A:B14: {LRTB} 160  
A:C14: {LRTB} [W10] 0.13  
A:D14: {LRTB} (F0) +C14\*B14  
A:E14: {LRTB} +E\$12  
A:F14: {LRTB} (F0) 1  
A:I14: {LRTB} (F0) +\$E14\*\$D14/(I\$10\*\$F14)  
A:M14: {LRTB} (F0) +\$E14\*\$D14/M\$10  
A:A15: {Page LRTB} 'LV4  
A:B15: {LRTB} 345  
A:C15: {LRTB} [W10] 0.13  
A:D15: {LRTB} (F0) +C15\*B15  
A:E15: {LRTB} +E\$12  
A:F15: {LRTB} (F0) 1  
A:J15: {LRTB} (F0) +\$E15\*\$D15/(J\$10\*\$F15)  
A:N15: {LRTB} (F0) +\$E15\*\$D15/N\$10  
A:B16: {LRTB} ' Sum hrs/day:  
A:D16: {LRTB} (F0) @SUM(D12..D15)  
A:A17: {Page LRTB} 'YANKTON\*  
A:B17: {LRTB} 66  
A:C17: {LRTB} [W10] 0.15  
A:D17: {LRTB} (F0) +C17\*B17  
A:E17: {LRTB} 5\*E\$12  
A:F17: {LRTB} (F0) 2  
A:I17: {LRTB} (F0) +\$E\$17\*\$D\$17/(\$I\$10\*\$F\$17)  
A:A18: {Page LRTB} '5028\*  
A:B18: {LRTB} 1080  
A:C18: {LRTB} [W10] 0.15  
A:D18: {LRTB} (F0) +C18\*B18  
A:E18: {LRTB} +E\$17  
A:F18: {LRTB} (F0) +E18/E12\*4-\$F\$17  
A:G18: {LRTB} (F0) +\$E\$18\*\$D\$18/(\$E\$18-\$F\$17\*\$I\$10)  
A:H18: {LRTB} (F0) +\$E\$18\*\$D\$18/(\$E\$18-\$F\$17\*\$I\$10)  
A:J18: {LRTB} (F0) +\$E\$18\*\$D\$18/(\$E\$18-\$F\$17\*\$I\$10)  
A:K18: {LRTB} (F0) +\$E\$18\*\$D\$18/(\$E\$18-\$F\$17\*\$I\$10)  
A:L18: {LRTB} (F0) +\$E\$18\*\$D\$18/(\$E\$18-\$F\$17\*\$I\$10)  
A:M18: {LRTB} (F0) +\$E\$18\*\$D\$18/(\$E\$18-\$F\$17\*\$I\$10)  
A:N18: {LRTB} (F0) +\$E\$18\*\$D\$18/(\$E\$18-\$F\$17\*\$I\$10)  
A:B19: {LRTB} ' Sum [hrs/day]:  
A:D19: {LRTB} (F0) @SUM(D17..D18)  
A:F19: {LRTB} (F0) 'Used cap.:  
A:G19: {LRTB} (F0) @SUM(G12..G18)  
A:H19: {LRTB} (F0) @SUM(H12..H18)  
A:I19: {LRTB} (F0) @SUM(I12..I18)  
A:J19: {LRTB} (F0) @SUM(J12..J18)

A:K19: {LRTB} (F0) @SUM(K12..K18)  
A:L19: {LRTB} (F0) @SUM(L12..L18)  
A:M19: {LRTB} (F0) @SUM(M12..M18)  
A:N19: {LRTB} (F0) @SUM(N12..N18)  
A:B20: {LB} 'Tot. sum [hrs/day]:  
A:D20: {B} (F0) +D16+D19  
A:F20: {RTB} ' Overcap.:  
A:G20: {LRTB} (F0) +\$D\$22-G19  
A:H20: {LRTB} (F0) +\$D\$22-H19  
A:I20: {LRTB} (F0) +\$D\$22-I19  
A:J20: {LRTB} (F0) +\$D\$22-J19  
A:K20: {LRTB} (F0) +\$D\$22-K19  
A:L20: {LRTB} (F0) +\$D\$22-L19  
A:M20: {LRTB} (F0) +\$D\$22-M19  
A:N20: {LRTB} (F0) +\$D\$22-N19  
A:B21: {LB} 'Installed man. assytim DR:  
A:D21: {B} 2900  
A:E21: {LT} ' Cap.variation [%]:  
A:G21: {LRTB} (F0) -100+G\$19/\$D\$20\*100  
A:H21: {LRTB} (F0) -100+H\$19/\$D\$20\*100  
A:I21: {LRTB} (F0) -100+I\$19/\$D\$20\*100  
A:J21: {LRTB} (F0) -100+J\$19/\$D\$20\*100  
A:K21: {LRTB} (F0) -100+K\$19/\$D\$20\*100  
A:L21: {LRTB} (F0) -100+L\$19/\$D\$20\*100  
A:M21: {LRTB} (F0) -100+M\$19/\$D\$20\*100  
A:N21: {LRTB} (F0) -100+N\$19/\$D\$20\*100  
A:B22: {LB} 'Maximum capacity:  
A:D22: {B} 0.15\*D21  
A:E22: {LB} ' 100%=  
A:F22: {RB} (F0) +D20  
A:A23: {Page} '\* 5028-family  
A:F24: {LT} 'Product  
A:G24: {LT} '(products  
A:H24: {LT} '(products  
A:I24: {LT} '(products  
A:J24: {LRT} '(products  
A:K24: {LT} '(products  
A:L24: {LT} '(products  
A:M24: {LT} '(products  
A:N24: {LRT} '(products  
A:G25: {L} ' /day)  
A:H25: {L} ' /day)  
A:I25: {L} ' /day)  
A:J25: {LR} ' /day)  
A:K25: {L} ' /day)  
A:L25: {L} ' /day)  
A:M25: {L} ' /day)  
A:N25: {LR} ' /day)  
A:F26: {LRTB} '5014  
A:G26: {LRTB} (F0) +G12/\$C12  
A:H26: {LRTB} (F0) +H12/\$C12  
A:I26: {LRTB} (F0) +I12/\$C12  
A:J26: {LRTB} (F0) +J12/\$C12  
A:K26: {LRTB} (F0) +K12/\$C12  
A:L26: {LRTB} (F0) +L12/\$C12

A:M26: {LRTB} (F0) +M12/\$C12

A:N26: {LRTB} (F0) +N12/\$C12

A:F27: {LRTB} '5017

A:G27: {LRTB} (F0) +G13/\$C13

A:H27: {LRTB} (F0) +H13/\$C13

A:I27: {LRTB} (F0) +I13/\$C13

A:J27: {LRTB} (F0) +J13/\$C13

A:K27: {LRTB} (F0) +K13/\$C13

A:L27: {LRTB} (F0) +L13/\$C13

A:M27: {LRTB} (F0) +M13/\$C13

A:N27: {LRTB} (F0) +N13/\$C13

A:F28: {LRTB} 'CBOW

A:G28: {LRTB} (F0) +G14/\$C14

A:H28: {LRTB} (F0) +H14/\$C14

A:I28: {LRTB} (F0) +I14/\$C14

A:J28: {LRTB} (F0) +J14/\$C14

A:K28: {LRTB} (F0) +K14/\$C14

A:L28: {LRTB} (F0) +L14/\$C14

A:M28: {LRTB} (F0) +M14/\$C14

A:N28: {LRTB} (F0) +N14/\$C14

A:F29: {LRTB} 'LV4

A:G29: {LRTB} (F0) +G15/\$C15

A:H29: {LRTB} (F0) +H15/\$C15

A:I29: {LRTB} (F0) +I15/\$C15

A:J29: {LRTB} (F0) +J15/\$C15

A:K29: {LRTB} (F0) +K15/\$C15

A:L29: {LRTB} (F0) +L15/\$C15

A:M29: {LRTB} (F0) +M15/\$C15

A:N29: {LRTB} (F0) +N15/\$C15

A:F31: {LRTB} 'YANKTON\*

A:G31: {LRTB} (F0) +G17/\$C17

A:H31: {LRTB} (F0) +H17/\$C17

A:I31: {LRTB} (F0) +I17/\$C17

A:J31: {LRTB} (F0) +J17/\$C17

A:K31: {LRTB} (F0) +K17/\$C17

A:L31: {LRTB} (F0) +L17/\$C17

A:M31: {LRTB} (F0) +M17/\$C17

A:N31: {LRTB} (F0) +N17/\$C17

A:F32: {LRTB} '5028\*

A:G32: {LRTB} (F0) +G18/\$C18

A:H32: {LRTB} (F0) +H18/\$C18

A:I32: {LRTB} (F0) +I18/\$C18

A:J32: {LRTB} (F0) +J18/\$C18

A:K32: {LRTB} (F0) +K18/\$C18

A:L32: {LRTB} (F0) +L18/\$C18

A:M32: {LRTB} (F0) +M18/\$C18

A:N32: {LRTB} (F0) +N18/\$C18

A:F34: {LT} 'Product

A:G34: {LT} '(products

A:H34: {LT} '(products

A:I34: {LT} '(products

A:J34: {LRT} '(products

A:K34: {LT} '(products

A:L34: {LT} '(products

A:M34: {LT} '(products  
A:N34: {LRT} '(products  
A:G35: {L} ' /period)

A:H35: {L} ' /period)  
A:I35: {L} ' /period)  
A:J35: {LR} ' /period)  
A:K35: {L} ' /period)  
A:L35: {L} ' /period)  
A:M35: {L} ' /period)  
A:N35: {LR} ' /period)  
A:F36: {LRTB} '5014  
A:G36: {LRTB} (F0) +G26\*G\$10  
A:H36: {LRTB} (F0) +H26\*H\$10  
A:I36: {LRTB} (F0) +I26\*I\$10  
A:J36: {LRTB} (F0) +J26\*J\$10  
A:K36: {LRTB} (F0) +K26\*K\$10  
A:L36: {LRTB} (F0) +L26\*L\$10  
A:M36: {LRTB} (F0) +M26\*M\$10  
A:N36: {LRTB} (F0) +N26\*N\$10  
A:F37: {LRTB} '5017  
A:G37: {LRTB} (F0) +G27\*G\$10  
A:H37: {LRTB} (F0) +H27\*H\$10  
A:I37: {LRTB} (F0) +I27\*I\$10  
A:J37: {LRTB} (F0) +J27\*J\$10  
A:K37: {LRTB} (F0) +K27\*K\$10  
A:L37: {LRTB} (F0) +L27\*L\$10  
A:M37: {LRTB} (F0) +M27\*M\$10  
A:N37: {LRTB} (F0) +N27\*N\$10  
A:F38: {LRTB} 'CBOW  
A:G38: {LRTB} (F0) +G28\*G\$10  
A:H38: {LRTB} (F0) +H28\*H\$10  
A:I38: {LRTB} (F0) +I28\*I\$10  
A:J38: {LRTB} (F0) +J28\*J\$10  
A:K38: {LRTB} (F0) +K28\*K\$10  
A:L38: {LRTB} (F0) +L28\*L\$10  
A:M38: {LRTB} (F0) +M28\*M\$10  
A:N38: {LRTB} (F0) +N28\*N\$10  
A:F39: {LRTB} 'LV4  
A:G39: {LRTB} (F0) +G29\*G\$10  
A:H39: {LRTB} (F0) +H29\*H\$10  
A:I39: {LRTB} (F0) +I29\*I\$10  
A:J39: {LRTB} (F0) +J29\*J\$10  
A:K39: {LRTB} (F0) +K29\*K\$10  
A:L39: {LRTB} (F0) +L29\*L\$10  
A:M39: {LRTB} (F0) +M29\*M\$10  
A:N39: {LRTB} (F0) +N29\*N\$10  
A:F41: {LRTB} 'YANKTON\*  
A:G41: {LRTB} (F0) +G31\*G\$10  
A:H41: {LRTB} (F0) +H31\*H\$10  
A:I41: {LRTB} (F0) +I31\*I\$10  
A:J41: {LRTB} (F0) +J31\*J\$10  
A:K41: {LRTB} (F0) +K31\*K\$10  
A:L41: {LRTB} (F0) +L31\*L\$10  
A:M41: {LRTB} (F0) +M31\*M\$10

A:N41: {LRTB} (F0) +N31\*N\$10  
A:F42: {LRTB} '5028\*  
A:G42: {LRTB} (F0) +G32\*G\$10  
A:H42: {LRTB} (F0) +H32\*H\$10  
A:I42: {LRTB} (F0) +I32\*I\$10

A:J42: {LRTB} (F0) +J32\*J\$10  
A:K42: {LRTB} (F0) +K32\*K\$10  
A:L42: {LRTB} (F0) +L32\*L\$10  
A:M42: {LRTB} (F0) +M32\*M\$10  
A:N42: {LRTB} (F0) +N32\*N\$10

## Appendix 4

In this appendix the LOTUS spreadsheet (+ listing) is printed in which the properties of the parts are registered and combined as described in paragraph 2.1.3. .

### Read instruction for the LOTUS spreadsheets.

1. In the upper tableframe are given the productname and its production number.
2. Under the line 'AGV addresses' are given the assembly station numbers of the product. Under each assembly station number is given the (calculated) quantity of container sorts for that are destined for that station.
3. Under the headlines '1JB = Special materials; 1SB = PMS; 2P = STORE' are given the (calculated) quantities of containersorts (calculated for all parts).
4. In the biggest (and also lowest) tableframe on the worksheet are given the partnumbers, description quantity per product and the pack codes, from which the needed data (see2. and 3.) is calculated.

PAGE	PRODUCT
A4.2	5028
A4.3	5014
A4.4	5017
A4.5	Superstar
A4.6 - A4.13	5014 (combined with a production schedule), listing included.

AGV-ADDRESSES

5028	CUMMULATIVE	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV
AA [# DAY]	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CC* [# DAY]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HH* [# DAY]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
** D [# DAY]	64.06	6.17	0.22	0.26	0.08	0.83	0.20	0.24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
** K [# DAY]	62.17	33.33	12.80	2.88	0.00	1.67	0.31	0.00	0.00	0.00	0.00	0.00	1.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00
# AA places	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
# CC* places	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
# HH* places	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
# ** D places	30	6	3	3	1	4	1	4	0	0	1	0	0	0	0	0	0	0	0	0
# ** K places	7	1	1	2	0	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0

AGV-ADDRESSES

5028	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV
AA [# DAY]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CC* [# DAY]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HH* [# DAY]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
** D [# DAY]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
** K [# DAY]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
# AA places	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
# CC* places	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
# HH* places	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
# ** D places	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
# ** K places	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

CODE TRANSPORT-UNIT TO ASSEMBLY LINE  
 AA\* BOX-FILLET  
 CC\* FULL HEIGHT WOODEN FOR INTERNAL USE  
 HH\* BOX-FILLET  
 \*\* D HALF HEIGHT WOODEN FOR INTERNAL USE  
 \*\* K GROUND PALLET  
 \*\* D MN 2 TOYE TM

5028	1 JB = Spec of Materials	1 SB = PMSI SP = STORE
AA [# DAY]	0.00	0.00
CC* [# DAY]	0.00	0.01
HH* [# DAY]	0.00	0.12
** D [# DAY]	0.00	2.88
** K [# DAY]	0	67.86385
		32.5734
# AA places	0	4
# CC* places	1	1
# HH* places	0	4
# ** D places	0	38
# ** K places	0	8

Partnumber	Description	PMAGP	QTY	XPRK	XWV	XCON	XIPQ	AGV	# of AA - places	Qty AA	# of CC - places	Qty CC*	# of HH - places	Qty HH*	# of D - places	Qty ** D	# of K - places	Qty ** K	
002E016423	COVER	1SB	1	00000	HK	56	K	3000	0	0	0	0	0	0	0	0	0	1	0.333333
016E006040	PRECHARGE INSERT	2P	1	00000	HD	14000	D	700	3000	0	0	0	0	0	1	0.001429	0	0	
071E000350	HOTSTAMP FOL 120MMX3	2P	6	00010	HD	42700	D	2138	3000	0	0	0	0	0	1	4.7E-08	0	0	
071E000360	HOTSTAMP FOL 60MMX3	2P	6	00010	HD	73200	D	3660	3000	0	0	0	0	0	1	2.7E-08	0	0	
091E046300	TOP COPY CART	2P	1	00000	HD	200000	D	10000	3000	0	0	0	0	0	1	0.0001	0	0	
091E046310	COPY CART ARROW	2P	2	00000	HD	300000	D	15000	3000	0	0	0	0	0	1	0.000133	0	0	
091E051200	LABEL FX	2P	0	00000	HD	60000	D	3000	3000	0	0	0	0	0	0	0	0	0	
091E051220	P/R J2	2P	0	00000	HD	60000	D	3000	3000	0	0	0	0	0	0	0	0	0	
091E051890	LABEL BAR CODE	2P	2	00000	HD	2304000	D	38000	3000	0	0	0	0	0	1	0.000056	0	0	
001E011332	PHOTO REC FRAME	1SB	1	00000	HK	200	K	10	14	0	0	0	0	0	0	0	0	1	0.1
001E011342	DRIVE ROLL FRAME	1SB	1	00000	HK	200	K	10	15	0	0	0	0	0	0	0	0	0	1
001E017690	MIL-FRAME	1SB	1	00000	HK	100	K	5	3010	0	0	0	0	0	0	0	0	0	1
002E003550	HANDLE	2P	1	00000	HD	10000	D	500	3020	0	0	0	0	0	1	0.0022	0	0	
002E009682	BUTTON	2P	1	00000	HD	60000	D	4000	3020	0	0	0	0	0	1	0.00025	0	0	
003E00102	COPY PAPER A3/90GRAMS	2P	0	01200	HK	100	K	5	10	0	0	0	0	0	0	0	0	1	0.0024
006E090127	CHEYENNE TONER	2P	0	00200	HH	192	X	98	10	0	0	0	1	0.00001	0	0	0	0	
006E090167	TONER 1065	1JB	0	00200	CC	198	--	0	1.3	0	0	1	0.00001	0	0	0	0	0	
007E007230	PULLEY 28T HD	2P	1	00000	HD	18000	D	750	12	0	0	0	0	0	1	0.001333	0	0	
008E017360	WIRE SPRING	2P	1	00000	HD	120000	D	6000	3010	0	0	0	0	0	1	0.000167	0	0	
010E000371	EDGE ERASE SLIDE	1SB	1	00000	HK	650	K	650	3020	0	0	0	0	0	0	0	0	1	0.001538
010E001470	GRID PLUNGER	2P	1	00000	HD	30000	D	1500	18	0	0	0	0	0	1	0.000667	0	0	
010E006651	DRIVE BUSHING	2P	1	00000	HD	20000	D	1000	12	0	0	0	0	0	1	0.001	0	0	
010E001481	DRIVE BUSHING FRONT	2P	1	00000	HD	20000	D	1000	12	0	0	0	0	0	1	0.001	0	0	
010E002254	DRIVE ROLL LIF	2P	1	00000	HH	1000	X	50	12	0	0	0	1	0.000982	0	0	0	0	
010E000281	TENSION ROLL LIF	2P	1	00000	HH	1000	X	50	14	0	0	0	1	0.000982	0	0	0	0	
010E000403	INDICATOR ASSY HT	2P	1	00000	HD	4800	D	240	3040	0	0	0	0	0	1	0.004167	0	0	
020E007980	SCREW-PLAST CROSS	2P	8	00000	HD	180000	D	9000	3080	0	0	0	0	0	1	0.000889	0	0	
030E000141	CLEANER BLADE	2P	1	00000	HD	10000	D	500	3040	0	0	0	0	0	1	0.002	0	0	
033E000730	CLEANER BLADE-WING	2P	1	00000	HD	320000	D	16000	3040	0	0	0	0	0	1	0.000663	0	0	
033E000840	27MM WRNG BLADE	2P	1	00000	HD	240000	D	12000	3040	0	0	0	0	0	1	0.000833	0	0	
036E006881	FLAP SEAL	2P	1	00000	HD	120000	D	6000	3070	0	0	0	0	0	1	0.000167	0	0	
036E010931	HINGE PLUG	2P	1	00000	HD	30000	D	1500	13	0	0	0	0	0	1	0.000467	0	0	
036E011091	SEAL-HV CONTACT	2P	1	00000	HD	60000	D	3000	3020	0	0	0	0	0	1	0.003333	0	0	
036E002041	SEAL-CLEANER	2P	1	00000	HK	2200	K	110	3080	0	0	0	0	0	0	0	0	1	0.000901
036E002051	SEAL-FIBER TRAP	2P	1	00000	HK	16000	K	760	3080	0	0	0	0	0	0	0	0	0	
036E003211	HINGE SEAL	2P	1	00000	HD	34000	D	1700	15	0	0	0	0	0	1	0.003333	0	0	
036E003221	MIDFRAME SEAL	2P	1	00000	HD	38000	D	1900	3070	0	0	0	0	0	1	0.000566	0	0	
036E003230	GRID PLUG SEAL	2P	1	00000	HD	200000	D	10000	15	0	0	0	0	0	1	0.0001	0	0	
036E003330	GRID CONTACT SEAL	2P	1	00000	HK	6000	K	60	15	0	0	0	0	0	0	0	0	1	0.0126
042E000310	END SEAL	2P	2	00000	HD	20000	D	1000	3080	0	0	0	0	0	0	0	0	0	
042E000323	CLEANER HOLDER	1SB	1	00000	HK	840	K	60	3040	0	0	0	0	0	0	0	0	1	0.016667
050E011071	GRID SCOROTRON DAG	2P	1	00000	HD	40000	D	2000	13	0	0	0	0	0	1	0.0008	0	0	
055E011851	AIR FILTER	2P	1	00000	HK														



AGV-ADDRESSES

	CUMULATIVE	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV
AA (#/DAY)	0.38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CC* (#/DAY)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HH* (#/DAY)	0.94	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.43	0.28	0.00	0.28	0.00	0.00	0.00
**D (#/DAY)	11.03	0.06	0.06	0.07	0.03	0.18	0.06	0.06	0.06	0.25	1.00	0.25	0.00	0.10	0.00	0.00	0.00	0.00	0.00
**K (#/DAY)	8.96	0.00	0.00	0.82	0.00	0.18	0.00	8.02	2.50	0.00	0.00	0.00	0.73	0.00	0.00	0.00	0.00	0.00	0.00
# AA places	2	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0
# CC* places	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
# HH* places	5	0	0	0	0	0	0	0	0	1	1	1	0	3	0	0	0	0	0
# **D places	29	3	2	2	1	3	2	1	1	1	2	1	0	1	0	0	0	0	0
# **K places	9	0	0	2	0	1	0	2	1	0	0	0	3	0	0	0	0	0	0

AGV-ADDRESSES

	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV
AA (#/DAY)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CC* (#/DAY)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HH* (#/DAY)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
**D (#/DAY)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
**K (#/DAY)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
# AA places	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
# CC* places	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
# HH* places	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
# **D places	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
# **K places	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

CODE TRANSPORT-UNIT TO ASSEMBLY LINE  
 AA\* BOX-PALLET  
 (FULL HIGHT, WOODEN, FOR INTERNAL USE)  
 CC\* BOX-PALLET  
 (HALF HIGHT, WOODEN, FOR INTERNAL USE)  
 HH\* GROUND PALLET  
 \*\*D MN 2 / TOTE TN

5014	1JB = Special Materials	1SB = PMS	2P = STORE
AA (#/DAY)	0.00	0.00	0.38
CC* (#/DAY)	0.00	0.00	0.00
HH* (#/DAY)	0.00	0.00	0.94
**D (#/DAY)	0.00	0.00	2.04
**K (#/DAY)	0.00	0.00	8.96
# AA places	0	0	2
# CC* places	0	0	0
# HH* places	0	0	5
# **D places	0	0	18
# **K places	0	0	9

Partnumber	Description	PMGP	QTY	XRPK	XRV	XCON	XRPQ	AGV	# of AA-places	Qty AA	# of CC-places	Qty CC*	# of HH-places	Qty HH*	# of D-places	Qty **D	# of K-places	Qty **K
002E031460	HSG XERO MOD	1SB	0.00000	HK	72	K	4	2	0	0	0	0	0	0	0	0	0	0
002K028120	CVR ASSY FRNT	2P	1.00000	HH	400	K	60	11	0	0	0	0	1	0.0028	0	0	0	0
002K031410	COVER ASSEMBLY	2P	1.00000	HK	144	K	20	0	0	0	0	0	0	0	0	0	1	0.05
008E017540	SHAFT DRUM	2P	1.00000	HD	3200	D	100	10	0	0	0	0	0	1	0.01	0	0	0
007E014220	GEAR PADDLE	2P	1.00000	HD	78800	D	1200	5	0	0	0	0	0	1	0.000833	0	0	0
007E014230	GEAR RDLR	2P	1.00000	HD	96000	D	1800	5	0	0	0	0	0	1	0.000667	0	0	0
008R062200	DUSTING POUCH	2P	0.00000	HD	6400	D	100	8	0	0	0	0	0	1	0.00033	0	0	0
008R062000	DUSTING POUCH	2P	0.00000	HD	6400	D	100	10	0	0	0	0	0	1	0.00033	0	0	0
015E012690	PLATE GRIDDED	2P	1.00000	HD	1280000	D	2000	7	0	0	0	0	0	1	0.0006	0	0	0
015E012720	SUPPORT BRKT	2P	1.00000	HD	25600	D	400	11	0	0	0	0	0	1	0.0025	0	0	0
019E016010	FINGER DRUM	2P	1.00000	HD	25600	D	400	9	0	0	0	0	0	1	0.0025	0	0	0
020K003140	DRUM ASSY	2P	1.00000	HH	240	X	20	10	0	0	0	0	1	0.004292	0	0	0	0
020K003770	WHEEL ASSY	11L	3.00000	HD	512000	D	8000	2	0	0	0	0	0	1	0.00375	0	0	0
027E001670	NUT SPEED	2P	1.00000	HD	640000	D	10000	5	0	0	0	0	0	1	0.0001	0	0	0
031E001750	PADDLE	2P	1.00000	HK	2800	K	560	8	0	0	0	0	0	0	0	0	1	0.001788
033K000700	BLADE ASSY	2P	1.00000	HK	5400	K	40	8	0	0	0	0	0	0	0	0	1	0.025
035E011190	SEAL BLADE 1B	2P	1.00000	HD	192000	D	3000	3	0	0	0	0	0	1	0.000333	0	0	0
035E011190	SEAL BLADE O B	2P	1.00000	HD	160000	D	2500	3	0	0	0	0	0	1	0.0004	0	0	0
035E011210	SEAL DRUM O B	2P	1.00000	HD	256000	D	4000	6	0	0	0	0	0	1	0.00025	0	0	0
035E011230	SEAL DRUM 1 B	2P	1.00000	HD	192000	D	3000	6	0	0	0	0	0	1	0.000333	0	0	0
035E000590	SEAL PADDLE	2P	1.00000	HD	256000	D	4000	4	0	0	0	0	0	1	0.00025	0	0	0
038K002560	SEAL ASSY TNR	2P	1.00000	HK	1000	K	200	3	0	0	0	0	0	0	0	0	1	0.006
091E045470	LABEL	2P	0.00000	HK	20	K	4	12	0	0	0	0	0	0	0	0	0	0
091E061890	LABEL BAR CODE	2P	1.00000	HK	120000	K	6000	12	0	0	0	0	0	0	0	0	1	0.000167
091E061880	LABEL BAR CODE	2P	1.00000	HK	120000	K	6000	7	0	0	0	0	0	0	0	0	1	0.000167
096K008280	ASSEMBLY WRAPPING	2P	1.00000	HK	750	K	180	12	0	0	0	0	0	0	0	0	1	0.006667
121K003780	MAG RUBBER	2P	1.00000	HD	256000	D	4000	2	0	0	0	0	0	1	0.00025	0	0	0
063E000340	TAPE 75MM - 1 ROLL - 1025	2P	0.00100	HK	36	K	4	3	0	0	0	0	0	0	0	0	1	0.00025
088K020470	50125014 COMMON CRJ 1L	2P	0.00000					0	0	0	0	0	0	0	0	0	0	0
096K020472	UNIQUE Y-1 RX CRU	11L	0.00000					0	0	0	0	0	0	0	0	0	0	0
802P053888	BOX 5012/14 13R22	2P	1.00000	HH	600		0	13	0	0	0	0	0	1	0.001667	0	0	0
804E003690	TOP PAD 116X90CM 16-	2P	0.00000	HH	200		0	0	0	0	0	0	0	0	0	0	0	0
032P001483	SEAL WHEEL	2P	3.00000	HD	1280000	D	20000	1	0	0	0	0	0	0	0	0	1	0.00015
032E081780	RIMMER SUPPORT	2P	3.00000	HD	1280000	D	20000	1	0	0	0	0	0	0	0	0	1	0.00015
032E081790	SUPPORT OUTER	2P	3.00000	HD	1280000	D	20000	1	0	0	0	0	0	0	0	0	1	0.00015
074K001620	MINAT PALLET	2P	0.01180	HK	11		0	13	0	0	0	0	0	1	0.000892	0	0	0
095E024280	BAG METALIZED 22	2P	1.00000	HK	10000	K	2000	12	0	0	0	0	0	0	0	0	1	0.0005
095E027230	METALIZED POLY ROLL	2P	0.00000	HH	6000		0	0	0	0	0	0	0	0	0	0	0	0
501K001600	END CAP ASSY 1012/50	2P	1.00000	AA	275		0	13	1	0.000364	0	0	0	0	0	0	0	0
802P010779	HOT MELT TYPE 242 25	2P	0.00000	CC*	0	X	0	0	0	0	0	0	0	0	0	0	0	0
802P010836	ADHESIVE INST 6HT	2P	0.00000					0	0	0	0	0	0	0	0	0	0	0
804E003470	WRAPP 500MM - ROLL A	2P	0.00020	AA	12000	X	1000	13	1	1.7E-08	0	0	0	0	0	0	0	0
804E003590	TOP PAD 116X90CM 16-	2P	0.01000	HH	200		0	13	0	0	0	0	0	1	0.00005	0	0	0
028K031440	MOBILE ASSY	11L	1.00000	HD	64000	D	1000	13	0									



AGW-ADDRESSES		AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV
AA (# DAY)	0.00	2060	2060	2070	1000	2110	2120	2130	2140	2600	2510	2520	2530	2540	2650	2660	2670	2680	2580
CC* (# DAY)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HH* (# DAY)	2.88	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
** D (# DAY)	9.23	0.97	0.00	0.00	0.18	1.08	4.60	0.03	0.00	0.00	0.68	0.00	0.09	0.25	0.00	0.02	0.00	0.00	0.00
** K (# DAY)	64.60	0.60	0.00	0.00	0.30	0.00	0.00	0.00	0.00	0.00	0.48	0.00	0.00	0.00	2.00	0.00	0.00	0.00	5.67

AGV-ADDRESSES		AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV
AA (# DAY)	0.00	2600	2600	2610	2620	2700	2710	2720	2730	2800	z	z	z	z	z	z	z	z	z
CC* (# DAY)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	z	z	z	z	z	z	z	z	z
HH* (# DAY)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.88	z	z	z	z	z	z	z	z	z
** D (# DAY)	0.16	1.03	0.00	0.00	0.04	0.08	0.03	0.13	0.00	0.00	z	z	z	z	z	z	z	z	z
** K (# DAY)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	64.60	0.00	z	z	z	z	z	z	z	z	z

SUPERS TAR	JOB = Special Materials	1SB = PMS	2P = STORE
AA (# DAY)	0.00	0.00	0.00
CC* (# DAY)	0.00	0.00	0.00
HH* (# DAY)	0.00	0.00	2.88
** D (# DAY)	0.00	0.00	9.52
** K (# DAY)	0.00	0.00	64.80

CODE	TRANSPORT - UNIT TO ASSEMBLY LINE
AA*	BOX-PALLET
	(FULL HIGHT. WOODEN FOR INTERNAL USE)
CC*	BOX-PALLET
	(HALF HIGHT. WOODEN FOR INTERNAL USE)
HH*	GROUND PALLET
** D	MN 2 / TOTE TN
** K	MN 5 - BOX

SUPERS TAR	JOB = Special Materials	1SB = PMS	2P = STORE
AA (# DAY)	0.00	0.00	0.00
CC* (# DAY)	0.00	0.00	0.00
HH* (# DAY)	0.00	0.00	2.88
** D (# DAY)	0.00	0.00	9.52
** K (# DAY)	0.00	0.00	64.80

Partnumber	Description	PMGP	QTY	XRPK	XMV	XCON	XIPO	AGV	# of AA - places	Qty AA	# of CC - places	Qty CC*	# of HH - places	Qty HH*	# of D - places	Qty ** D	# of K - places	Qty ** K
233EP00124	PADDLE SHAFT	2P	1	HD	256000	D	4000	1000	0	0	0	0	0	0	1	0.00026	0	0
233EP00123	PADDLE	2P	1	HK	6800	K	330	1000	0	0	0	0	0	0	0	0	1	0.0003
233EP00127	GEAR IDLER	2P	1	HD	61200	D	800	1000	0	0	0	0	0	0	1	0.00126	0	0
233EP00140	HSG XEROX	1SB	1	HH	90	Q	90	1000	0	0	0	0	0	0	0	0	0	0
233EP00125	FEL T PADDLE	2P	1	HD	2660000	D	40000	1000	0	0	0	0	0	0	1	0.00026	0	0
233EP00126	GEAR PADDLE	2P	1	HD	234000	D	3500	1000	0	0	0	0	0	0	1	0.000286	0	0
233E000128	P STOP (**)	2P	1	HD	2560000	D	400000	1000	0	0	0	0	0	0	1	2.5E-06	0	0
233E000121	SPRING SHATT	2P	1	HD	640000	D	10000	2500	0	0	0	0	0	0	1	0.0001	0	0
233E000128	P STOP (**)	2P	1	HD	2560000	D	400000	2620	0	0	0	0	0	0	1	2.5E-06	0	0
233EP00119	LINK A	2P	1	HD	38400	D	600	2520	0	0	0	0	0	0	1	0.001867	0	0
233E000120	LINK B	2P	1	HD	18000	D	260	2520	0	0	0	0	0	0	1	0.004	0	0
233EP00141	COVER OPC	2P	1	HK	4180	K	209	2520	0	0	0	0	0	0	1	0.004	0	1
233E000129	SEAL PADDLE	2P	1	HD	64000	D	1000	2520	0	0	0	0	0	0	1	0.001	0	0
233E000130	SEAL CLEAN	2P	4	HD	2560000	D	40000	2840	0	0	0	0	0	0	1	0.0001	0	0
033R005430	SEAL ASSY TONER	2P	0	HD	1	D	60	2540	0	0	0	0	0	0	0	0	0	0
233E000132	SEAL DRUM O/B	2P	1	HD	160000	D	3500	2540	0	0	0	0	0	0	1	0.0004	0	0
233E000133	IMAG RUBBER	2P	1	HD	32000	D	800	2560	0	0	0	0	0	0	1	0.002	0	0
233E000131	SEAL DRUM I/B	2P	1	HD	160000	D	3500	2540	0	0	0	0	0	0	1	0.0004	0	0
033E000140	SCREW M3 (*1)	2P	6	HD	76800	D	12000	2560	0	0	0	0	0	0	1	0.0006	0	0
033K095280	BLADE DOCTOR ASSY	2P	1	HK	800	K	50	2560	0	0	0	0	0	0	0	0	1	0.02
233A500721	BLADE ASSY	2P	1	HD	2040000	D	32000	2570	0	0	0	0	0	0	1	0.00031	0	0
033E000140	SCREW TAPPING (*1)	2P	2	HD	76800	D	12000	2570	0	0	0	0	0	0	1	0.000187	0	0
233A500137	DRUM ASSY	2P	1	HK	400	K	15	2580	0	0	0	0	0	0	0	0	1	0.06667
233A500109	CS ASSY	2P	1	HD	6272	D	98	2600	0	0	0	0	0	0	1	0.010204	0	0
023E008180	SCREW M3 (*1)	2P	1	HD	76800	D	12000	2600	0	0	0	0	0	0	1	0.00083	0	0
233A500117	SHAFT OB ASSY	2P	1	HD	80000	D	1260	2580	0	0	0	0	0	0	1	0.0008	0	0
233A500114	SHAFT B ASSY	2P	1	HD	80000	D	1260	2690	0	0	0	0	0	0	1	0.0008	0	0
033E008180	SCREW M3 (*2)	2P	2	HD	76800	D	12000	18	0	0	0	0	0	0	1	0.000167	0	0
233E007129	PH T CONNECT	2P	2	HD	768000	D	12000	2700	0	0	0	0	0	0	1	0.000187	0	0
233E000703	SPRING O/B	2P	1	HD	640000	D	10000	2700	0	0	0	0	0	0	1	0.0001	0	0
233E000703	SPRING I/B	2P	1	HD	640000	D	10000	2700	0	0	0	0	0	0	1	0.000126	0	0
033E004000	LABEL MAIN CARTRIDGE	2P	1	HD	128000	D	2000	2710	0	0	0	0	0	0	1	0.0005	0	0
233EP00139	COVER CARTRIDGE	1SB	1	AA	110	K	110	2710	0	0	0	0	0	0	0	0	0	0
033E008040	SCREW M3 (*2)	2P	2	HD	76800	D	12000	2720	0	0	0	0	0	0	1	0.000167	0	0
033E008730	LABEL NO 3	2P	1	HD	1280000	D	20000	2730	0	0	0	0	0	0	1	0.00006	0	0
233E000752	TAPE LEVER	2P	1	HD	768000	D	1200	2730	0	0	0	0	0	0	1	0.000833	0	0
233A500718	SEAL LEVER	2P	1	HD	180000	D	2800	2730	0	0	0	0	0	0	1	0.0004	0	0
033E037190	BOX CRU (V-US)	2P	1	HK	640	K	2	2800	0	0	0	0	0	0	0	0	1	0.5
033E008360	PROBOTOM	2P	1	HH	82	-	0	2800	0	0	0	0	1	0.018231	0	0	0	0
033E008360	BAG	2P	1	HK	64000	K	1000	2800	0	0	0	0	0	0	0	0	1	0.001
033A095050	WICK ASSY	2P	1	HK	3840	K	182	2800	0	0	0	0	0	0	0	0	1	0.005496
0007000000	BAG WICK	2P	1	HD	1280000	D	2000	23	0	0	0	0	0	0	1	0.0006	0	0
033E008370	PKD TOR	2P	1	HK	104	-	0	2800	0	0	0	0	0	0	1	0.0006	0	0
00095270	INS TRUCTDN (V)	2P	1	HK	1000	K	50	2800	0	0	0	0	0	0	1	0.0006	0	0.02
0007000000	BAG TC	2P	1	HD	1280000	D	2000	23	0	0	0	0	0	0	1	0.0006	0	0
0007000000	T/C ASSY	2P	1	HK	1020	K	50	2800	0	0	0	0	0	0	0	0	1	0.02
233EP00728	GEAR AGITATOR	2P	1	HD	8640	D	135	2060	0	0	0	0	0	0	1	0.007407	0	0
233EP00763	HSG DEVE LOWER	1SB	1	HH	200	R	200	2060	0	0	0	0	0	0	0	0	0	0
233EP00732	HSG DEVE UPPER	1SB	1	HH	3200	K	180	2060	0	0	0	0	0	0	0	0	0	0
233EP00723	BUSH AGITATOR	2P	1	HD	384000	D	6000	2060	0	0	0	0	0	0	1	0.000167	0	0
233A500719	AGITATOR ASSY SUB	2P	1	HK	4000	K	200	2060	0	0	0	0	0	0	1	0.000167	0	1
233EP00705	SEAL INNER	2P	1	HD	512000	D	8000	2060	0	0	0	0	0	0	1	0.000126	0	0
233EP00707	RING FEL	2P	1	HD	384000	D	6000	2060	0	0	0	0	0	0	1	0.000167	0	0
233A5																		

product (family)	period 1 products/day	period 1 [days]	period 2 [days]	period 3 [days]	period 4 [days]	period 5 [days]	period 6 [days]	period 7 [days]	period 8 [days]
5014	1182	1182					1182		
5017	642		642					642	
CBGW	1173			1173					1173
LV4	1084				1084				1084
YANKTON	1210			1210					
8028	1142	1142	1142		1142	1142	1142	1142	1142
5014	1182								

AGV-ADRESSES

5014	CUMULATIVE	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV
AA (#/DAY)	4.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CC* (#/DAY)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HH* (#/DAY)	11.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
**D (#/DAY)	436.92	0.83	0.74	0.87	0.30	1.89	0.89	0.89	0.04	2.98	11.96	2.98	0.00	1.13	0.00	0.00	0.00	0.00	0.00	0.00
**K (#/DAY)	401.33	0.00	236.50	6.21	0.00	2.11	0.00	68.30	28.58	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

5014	AGV-ADRESSES	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV
AA places	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CC* places	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HH* places	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**D places	30	3	2	2	1	3	2	1	1	2	1	0	1	0	1	0	0	0	0	0
**K places	10	0	1	2	0	1	0	2	1	0	0	0	0	0	0	0	0	0	0	0

5014	AGV-ADRESSES	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV
AA (#/DAY)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CC* (#/DAY)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HH* (#/DAY)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
**D (#/DAY)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
**K (#/DAY)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

5014	1JB - Special Materials	1SB - PMS	2P - STORE
AA (#/DAY)	0.00	0.00	4.30
CC* (#/DAY)	0.00	0.00	0.00
HH* (#/DAY)	0.00	0.00	11.11
**D (#/DAY)	0.00	0.00	241.4
**K (#/DAY)	0.00	0.00	401.33

5014	AGV-ADRESSES	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV	AGV
AA places	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CC* places	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HH* places	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**D places	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**K places	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

CODE	TRANSPORT-UNIT TO ASSEMBLYLINE
AA*	BOX-PALLET (FULL HEIGHT, WOODEN, FOR INTERNAL USE)
CC*	BOX-PALLET (HALF HEIGHT, WOODEN, FOR INTERNAL USE)
HH*	GROUND PALLET
**D	MIN 27 TOTE TIN

Partnumber	Description	PMAGP	QTY	NRPK	XMG	XCON	XIPQ	AGV	# of AA-places	Qty AA	# of CC-places	Qty CC*	# of HH-places	Qty HH*	# of D-places	Qty **D	# of K-places	Qty **K			
002E031440	HSG XERO MOD	2P	1.00000	HK	72	K	4	2	0	0	0	0	0	0	0	0	0	1	0.25		
002K028120	CVR ASSY FRNT	2P	1.00000	HH	403	K	80	11	0	0	0	0	0	1	0.0028	0	0	0	0		
002K031410	COVER ASSEMBLY	2P	1.00000	HK	144	K	20	7	0	0	0	0	0	0	0	0	0	0	1	0.08	
002E017550	SHAFT DRUM	2P	1.00000	HD	3250	D	100	10	0	0	0	0	0	0	0	0	0	0	0	0	
002E014220	GEAR PADDLE	2P	1.00000	HD	79800	D	1300	83	0	0	0	0	0	0	0	0	0	0	1	0.00083	
002E014230	GEAR IDLER	2P	1.00000	HD	96000	D	1800	8	0	0	0	0	0	0	0	0	0	0	1	0.00087	
002K000200	DUSTING POUCH	2P	0.00000	HD	6400	D	100	8	0	0	0	0	0	0	0	0	0	0	0	0	
002K000200	DUSTING POUCH	2P	0.00000	HD	6400	D	100	10	0	0	0	0	0	0	0	0	0	0	1	0.00003	
01SE012660	PLATE GRID CP	2P	1.00000	HD	128000	D	2000	7	0	0	0	0	0	0	0	0	0	0	0	0	
01SE012720	SUPPORT BRKT	2P	1.00000	HD	28900	D	400	11	0	0	0	0	0	0	0	0	0	0	0	0	
01SE012010	FINGER DRUM	2P	1.00000	HD	26600	D	400	9	0	0	0	0	0	0	0	0	0	0	1	0.0025	
02K003140	DRUM ASSY	2P	1.00000	HH	240	X	20	10	0	0	0	0	0	1	0.00492	0	0	0	0	0	
02K003270	WHEEL ASSY	1L	3.00000	HD	612000	D	8000	2	0	0	0	0	0	0	0	1	0.000376	0	0	0	
022E001870	NUT SPEED	2P	1.00000	HD	640000	D	10000	8	0	0	0	0	0	0	0	0	0	0	1	0.0001	
002E001760	PADDLE	2P	1.00000	HK	2800	K	80	8	0	0	0	0	0	0	0	0	0	0	0	1	0.001786
002K000700	BLADE ASSY	2P	1.00000	HK	6400	K	40	8	0	0	0	0	0	0	0	0	0	0	0	1	0.028
002E011190	SEAL BLADE 1B	2P	1.00000	HD	198000	D	3000	3	0	0	0	0	0	0	0	0	0	0	1	0.000333	
002E011190	SEAL BLADE 0B	2P	1.00000	HD	180000	D	2800	3	0	0	0	0	0	0	0	0	0	0	1	0.0004	
002E011210	SEAL DRUM 0B	2P	1.00000	HD	288000	D	4200	8	0	0	0	0	0	0	0	0	0	0	1	0.00036	
002E011220	SEAL DRUM 1B	2P	1.00000	HD	192000	D	3000	8	0	0	0	0	0	0	0	0	0	0	1	0.000333	
002E000890	SEAL PADDLE	2P	1.00000	HD	288000	D	4800	4	0	0	0	0	0	0	0	0	0	0	0	1	0.00026
002K002640	SEAL ASSY TNR	2P	1.00000	HK	1000	K	200	3	0	0	0	0	0	0	0	0	0	0	0	1	0.008
002E048470	LABEL	2P	0.00000	HK	20	K	4	12	0	0	0	0	0	0	0	0	0	0	0	0	0
002E048480	LABEL BAR CODE	2P	1.00000	HK	120000	K	6000	12	0	0	0	0	0	0	0	0	0	0	0	1	0.000167
002E048490	LABEL BAR CODE	2P	1.00000	HK	120000	K	6000	7	0	0	0	0	0	0	0	0	0	0	0	1	0.000167
002K000260	ASSEMBLY WRAPPING	2P	1.00000	HK	780	K	180	12	0	0	0	0	0	0	0	0	0	0	0	1	0.000867
12K0003780	MAG RUBBER	2P	1.00000	HD	288000	D	4000	2	0	0	0	0	0	0	0	0	0	0	1	0.00026	
002E000340	TAPE 75MM-1 ROLL-10P		0.00000	HK	36	K	4	3	0	0	0	0	0	0	0	0	0	0	0	1	0.00026
002K000360	80121014 COMBINATION CR	1L	0.00000		0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
002K000372	UNIQUE Y-TRX CRU	1L	0.00000		0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
502P063558	BOX 801214 13R22	2P	1.00000	HH	600	X	0	13	0	0	0	0	0	0	0	0	0	0	0	0	0
504E000890	TOP PAD 116X90CM 18P	2P	0.00000	HH	200	X	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
002P001483	STAR WHEEL	2P	3.00000	HD	1280000	D	20000	1	0	0	0	0	0	0	0	0	0	0	0	1	0.00018
002E051790	INNER SUPPORT	2P	3.00000	HD	12800																

Product family	period 1 Products/day	period 2 (days)	period 3 (days)	period 4 (days)	period 5 (days)	period 6 (days)	period 7 (days)	period 8 (days)
S01s	1182	1182				1182		
S01T	642		642					
CROW	1173			1173				
LWA	1084				1084			1084
VANKTON	1290							
AGV	1142	1142	1142	1142	1142	1142	1142	1142
S01s	1182							

Bot 4	AGV-ADDRESSES																	
	CUMULATIVE	AGV 1	AGV 2	AGV 3	AGV 4	AGV 5	AGV 6	AGV 7	AGV 8	AGV 9	AGV 10	AGV 11	AGV 12	AGV 13	AGV 14	AGV 15	AGV 16	AGV 17
AA (#/DAY)	4.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.30	0.00	0.00	0.00	0.00
CC (#/DAY)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HH (#/DAY)	11.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.07	2.96	0.00	3.08	0.00	0.00	0.00	0.00
**D (#/DAY)	428.92	0.63	0.74	0.87	0.30	1.89	0.89	0.68	0.04	2.96	11.96	2.96	0.00	1.19	0.00	0.00	0.00	0.00
**K (#/DAY)	401.33	0.00	286.50	6.21	0.00	2.11	0.00	68.30	28.66	0.00	0.00	0.00	8.67	0.00	0.00	0.00	0.00	0.00
# AA places	3	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0
# CC places	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
# HH places	6	0	0	0	0	0	0	0	0	0	1	1	0	3	0	0	0	0
# **D places	30	3	2	2	1	3	2	1	1	1	2	1	0	1	0	0	0	0
# **K places	10	0	1	2	0	1	0	2	1	0	0	0	3	0	0	0	0	0

Bot 4	AGV-ADDRESSES																
	AGV 18	AGV 19	AGV 20	AGV 21	AGV 22	AGV 23	AGV 24	AGV 25	AGV 26	AGV 27	AGV 28	AGV 29	AGV 30	AGV 31	AGV 32	AGV 33	AGV 34
AA (#/DAY)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CC (#/DAY)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HH (#/DAY)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
**D (#/DAY)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
**K (#/DAY)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
# AA places	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
# CC places	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
# HH places	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
# **D places	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
# **K places	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

CODE	TRANSPORT-UNIT TO ASSEMBLYLINE
AA	BOX-PALLET
CC	FULL HEIGHT, WOODEN, FOR INTERNAL USE
HH	BOX-PALLET
HH	HALF HEIGHT, WOODEN, FOR INTERNAL USE
**D	GROUND PALLET
**K	MIN 27 TOTE TIN

Bot 4	150 = Special Materials			150 = PMS			2P = STORE			
	AA (#/DAY)	CC (#/DAY)	HH (#/DAY)	**D (#/DAY)	**K (#/DAY)	# AA places	# CC places	# HH places	# **D places	# **K places
AA (#/DAY)	0.00	0.00	4.30							
CC (#/DAY)	0.00	0.00	0.00							
HH (#/DAY)	0.00	0.00	11.11							
**D (#/DAY)	0.00	0.00	341.4							
**K (#/DAY)	0.00	0.00	401.33							
# AA places	0	0	2							
# CC places	0	0	0							
# HH places	0	0	6							
# **D places	0	0	19							
# **K places	0	0	10							

Partnumber	Description	PMGP	QTY	IRPK	XMV	ICON	XIPO	AGV	# of AA-places	Qty AA	# of CC-places	Qty CC	# of HH-places	Qty HH	# of D-places	Qty **D	# of K-places	Qty **K
003E01460	HS G ZERO MOD	2P	1.0000	HK	72	K	2	0	0	0	0	0	0	0	0	0	0	0.26
003R01210	CYR ASSY FRNT	2P	1.0000	HK	40	K	11	0	0	0	0	0	0	0	0	0	0	0
003R01310	COVER ASSEMBLY	2P	1.0000	HK	144	K	7	0	0	0	0	0	0	0	0	0	0	0.06
003R01750	SPRKT DRUM	2P	1.0000	HD	320	K	10	0	0	0	0	0	0	0	0	0	0	0
003R01760	SPRKT DRUM	2P	1.0000	HD	7680	J	1200	0	0	0	0	0	0	0	0	0	0	0
007E01420	GEAR OILER	2P	1.0000	HD	9400	J	1800	0	0	0	0	0	0	0	0	0	0	0
008R02000	DUSTING POUCH	2P	0.0000	HD	6400	D	100	0	0	0	0	0	0	0	0	0	0	0
003R02000	DUSTING POUCH	2P	0.0000	HD	6400	D	100	0	0	0	0	0	0	0	0	0	0	0
015E01350	PLATE GRID ED	2P	1.0000	HD	128000	D	2000	7	0	0	0	0	0	0	0	0	0	0
015E01270	SUPPORT BRKT	2P	1.0000	HD	29600	D	400	11	0	0	0	0	0	0	0	0	0	0
015R01010	FINGER DRUM	2P	1.0000	HD	28600	D	400	9	0	0	0	0	0	0	0	0	0	0
003R00310	DRUM ASSY	2P	1.0000	HK	20	K	20	10	0	0	0	0	0	0	0	0	0	0
003R00370	WHEEL ASSY	1L	3.0000	HD	512000	D	8000	2	0	0	0	0	0	0	0	0	0	0
002E00180	NUT SPEED	2P	1.0000	HK	640000	D	10000	5	0	0	0	0	0	0	0	0	0	0
003E00170	PADDLE	2P	1.0000	HK	2800	K	640	5	0	0	0	0	0	0	0	0	0	0.001794
003K00070	BLADE ASSY	2P	1.0000	HK	6400	K	40	8	0	0	0	0	0	0	0	0	0	0.026
035E01180	SEAL BLADE TB	2P	1.0000	HD	192000	J	3000	3	0	0	0	0	0	0	0	0	0	0.000333
035E01190	SEAL BLADE O B	2P	1.0000	HD	140000	J	2800	3	0	0	0	0	0	0	0	0	0	0.0004
035E01120	SEAL DRUM O B	2P	1.0000	HD	280000	J	4000	6	0	0	0	0	0	0	0	0	0	0.00028
035E01120	SEAL DRUM TB	2P	1.0000	HD	180000	J	3000	6	0	0	0	0	0	0	0	0	0	0.000333
035E00090	SEAL PROBLE	2P	1.0000	HD	280000	J	4000	4	0	0	0	0	0	0	0	0	0	0.00028
003E00260	SEAL ASSY TNR	2P	1.0000	HK	1000	K	200	3	0	0	0	0	0	0	0	0	0	0.0003
003E00470	LABEL	2P	0.0000	HK	20	K	4	12	0	0	0	0	0	0	0	0	0	0
003E00160	LABEL BAR CODE	2P	1.0000	HK	120000	K	6000	0	0	0	0	0	0	0	0	0	0	0.000167
003E00160	LABEL BAR CODE	2P	1.0000	HK	120000	K	6000	7	0	0	0	0	0	0	0	0	0	0.000167
003E00060	ASSEMBLY WRAPPING	2P	1.0000	HK	780	K	180	12	0	0	0	0	0	0	0	0	0	0.005647
12W000700	MAG RUBBER	2P	1.0000	HD	288000	D	4000	2	0	0	0	0	0	0	0	0	0	0.00025
003E00040	TAPE 78MM-1 ROLL-10	2P	0.0000	HK	36	K	4	3	0	0	0	0	0	0	0	0	0	0.00025
003R00200	5012/5014 COMMON CR U	1L	0.0000		0		0	0	0	0	0	0	0	0	0	0	0	0
003R00200	UNIQUE Y-1 RX CRU	1L	0.0000		0		0	0	0	0	0	0	0	0	0	0	0	0
502P01350	BOX 50214 13R2	2P	1.0000	HH	600		0	13	0	0	0	0	0	0	0	0	0	0
504E00060	TOP PAD 116X30CM 16-	2P	0.0000	HH	200		0	0	0	0	0	0	0	0	0	0	0	0
002P01480	ST NR WHEEL	2P	3.0000	HD	1200000	D	20000	1	0	0	0	0	0	0	0	0	0	0.00018
035E01780	INNER SUPPORT	2P	3.0000	HD	1200000	D	20000	1	0	0	0	0	0	0	0	0	0	0.00018
035E01780	SUPPORT OUTER	2P	3.0000	HD	1200000	D	20000	1	0	0	0	0	0	0	0	0	0	0.00018
074R01520	MINI PALLET	2P	0.0100	HK	13		0	13	0	0	0	0	0	0	0	0	0	0.000082
003E02620	BAG METALIZED 22	2P	1.0000	HK	10000	K	2000	12	0	0	0	0	0	0	0	0	0	0.00008
003E02230	METALIZED POLY ROLL	2P	0.0000	HH	6000		0	0	0	0	0	0	0	0	0	0	0	0
003R001400	END CAP ASSY 101280	2P	1.0000	AA	276		0	13	1	0.000036	0	0	0					

A:A10: [W13] '5014  
A:B10: [W20] 1182  
A:C15: 'AGV-ADRESSES  
A:A16: [W13] +\$A\$10  
A:B16: [W20] 'CUMMULATIVE  
A:C16: 'AGV  
A:C17: 1  
A:A18: (F2) [W13] 'AA [# /DAY]  
A:B18: (F2) [W20] @SUM(C18..S18)+@SUM(B33..R33)  
A:C18: (F2) @DSUM(\$I\$62..\$K\$142,2,C16..C17)\*\$B\$10  
A:A19: (F2) [W13] 'CC \* [# /DAY]  
A:B19: (F2) [W20] @SUM(C19..S19)+@SUM(B34..R34)  
A:C19: (F2) @DSUM(\$I\$62..\$M\$142,4,C16..C17)\*\$B\$10  
A:A20: (F2) [W13] 'HH \* [# /DAY]  
A:B20: (F2) [W20] @SUM(C20..S20)+@SUM(B35..R35)  
A:C20: (F2) @DSUM(\$I\$62..\$O\$142,6,C16..C17)\*\$B\$10  
A:A21: (F2) [W13] '\*\* D [# /DAY]  
A:B21: (F2) [W20] @SUM(C22..S21)+@SUM(B37..R36)  
A:C21: (F2) @DSUM(\$I\$62..\$Q\$142,8,C16..C17)\*\$B\$10  
A:A22: (F2) [W13] '\*\* K [# /DAY]  
A:B22: (F2) [W20] @SUM(C23..S22)+@SUM(B38..R37)  
A:C22: (F2) @DSUM(\$I\$62..\$S\$142,10,C16..C17)\*\$B\$10  
A:A24: (F2) [W13] '# AA places  
A:B24: (F0) [W20] @SUM(C24..S24)+@SUM(B39..R39)  
A:C24: (F0) @DSUM(\$I\$62..\$J\$142,1,C16..C17)  
A:A25: (F2) [W13] '# CC \* places  
A:B25: (F0) [W20] @SUM(C25..S25)+@SUM(B40..R40)  
A:C25: (F0) @DSUM(\$I\$62..\$L\$142,3,C16..C17)  
A:A26: (F2) [W13] '# HH \* places  
A:B26: (F0) [W20] @SUM(C26..S26)+@SUM(B41..R41)  
A:C26: (F0) @DSUM(\$I\$62..\$N\$142,5,C16..C17)  
A:A27: (F2) [W13] '# \*\* D places  
A:B27: (F0) [W20] @SUM(C28..S27)+@SUM(B43..R42)  
A:C27: (F0) @DSUM(\$I\$62..\$P\$142,7,C16..C17)  
A:A28: (F2) [W13] '# \*\* K places  
A:B28: (F0) [W20] @SUM(C29..S28)+@SUM(B44..R43)  
A:C28: (F0) @DSUM(\$I\$62..\$R\$142,9,C16..C17)

A:N45: [W9] 'CODE  
A:O45: [W9] 'TRANSPORT-UNIT TO ASSEMBLYLINE  
A:N46: [W9] 'AA \*  
A:O46: [W9] 'BOX-PALLET  
A:W46: [W9] 'PMGP  
A:X46: 'XRPK  
A:Y46: 'PMGP  
A:Z46: 'XRPK  
A:AA46: 'PMGP  
A:AB46: 'XRPK  
A:AC46: 'PMGP  
A:AD46: 'XCON  
A:AE46: 'PMGP  
A:AF46: 'XCON  
A:A47: [W13] +V47  
A:B47: [W20] '1JB= Special Materials  
A:C47: '1SB= PMS  
A:D47: '2P= STORE  
A:N47: [W9] '  
A:O47: [W9] '(FULL HIGHT, WOODEN, FOR INTERNAL USE)  
A:V47: (F2) [W10] +\$A\$10  
A:W47: (F2) [W9] '1SB  
A:X47: 'AA  
A:Y47: (F2) '1SB  
A:Z47: (F2) 'CC  
A:AA47: (F2) '1SB  
A:AB47: (F2) 'HH  
A:AC47: (F2) '1SB  
A:AD47: (F2) 'D  
A:AE47: (F2) '1SB  
A:AF47: (F2) 'K  
A:A48: (F2) [W13] 'AA [# /DAY]  
A:B48: (F2) [W20] +W56  
A:C48: (F2) +W48  
A:D48: (F2) +W52  
A:N48: [W9] 'CC \*  
A:O48: [W9] 'BOX-PALLET  
A:W48: (F2) [W9] @DSUM(\$C\$62..\$Q\$142,8,W\$46..X\$47)\*\$B\$10  
A:X48: (F0) @DSUM(\$C\$62..\$Q\$142,7,W\$46..X\$47)  
A:Y48: (F2) @DSUM(\$C\$62..\$Q\$142,10,Y\$46..Z\$47)\*\$B\$10  
A:Z48: (F0) @DSUM(\$C\$62..\$Q\$142,9,Y\$46..Z\$47)  
A:AA48: (F2) @DSUM(\$C\$62..\$Q\$142,12,AA\$46..AB\$47)\*\$B\$10  
A:AB48: (F0) @DSUM(\$C\$62..\$Q\$142,11,AA\$46..AB\$47)  
A:AC48: (F2) @DSUM(\$C\$62..\$Q\$142,14,AC\$46..AD\$47)\*\$B\$10  
A:AD48: (F0) @DSUM(\$C\$62..\$Q\$142,13,AC\$46..AD\$47)  
A:AE48: (F2) @DSUM(\$C\$62..\$S\$142,16,AE\$46..AF\$47)\*\$B\$10  
A:AF48: (F0) @DSUM(\$C\$62..\$S\$142,15,AE\$46..AF\$47)  
A:A49: (F2) [W13] 'CC \* [# /DAY]  
A:B49: (F2) [W20] +Y56  
A:C49: (F2) +Y48  
A:D49: (F2) +Y52  
A:N49: [W9] '  
A:O49: [W9] '(HALF HIGHT, WOODEN, FOR INTERNAL USE)  
A:A50: (F2) [W13] 'HH \* [# /DAY]  
A:B50: (F2) [W20] +AA56  
A:C50: (F2) +AA48

A:D50: (F2) +AA52  
A:N50: [W9] 'HH \*  
A:O50: [W9] 'GROUNDPALLET  
A:W50: [W9] 'PMGP  
A:X50: 'XRPK  
A:Y50: 'PMGP  
A:Z50: 'XRPK  
A:AA50: 'PMGP  
A:AB50: 'XRPK  
A:AC50: 'PMGP  
A:AD50: 'XCON  
A:AE50: 'PMGP  
A:AF50: 'XCON  
A:A51: (F2) [W13] '\*\* D [# / DAY]  
A:B51: (F2) [W20] +AC56  
A:C51: (F2) +AC48  
A:D51: (F2) +AC52  
A:N51: [W9] '\* \* D  
A:O51: [W9] 'MN 2 / TOTE TIN  
A:V51: (F2) [W10] +\$\$10  
A:W51: (F2) [W9] '2P  
A:X51: 'AA  
A:Y51: (F2) '2P  
A:Z51: (F2) 'CC  
A:AA51: (F2) '2P  
A:AB51: (F2) 'HH  
A:AC51: (F2) '2P  
A:AD51: (F2) 'D  
A:AE51: (F2) '2P  
A:AF51: (F2) 'K  
A:A52: (F2) [W13] '\*\* K [# / DAY]  
A:B52: (F2) [W20] +AE56  
A:C52: (F2) +AE48  
A:D52: (F2) +AE52  
A:W52: (F2) [W9] @DSUM(\$C\$62..\$Q\$142,8,W\$50..X\$51)\*\$B\$10  
A:X52: (F0) @DSUM(\$C\$62..\$Q\$142,7,W\$50..X\$51)  
A:Y52: (F2) @DSUM(\$C\$62..\$Q\$142,10,Y\$50..Z\$51)\*\$B\$10  
A:Z52: (F0) @DSUM(\$C\$62..\$Q\$142,9,Y\$50..Z\$51)  
A:AA52: (F2) @DSUM(\$C\$62..\$Q\$142,12,AA\$50..AB\$51)\*\$B\$10  
A:AB52: (F0) @DSUM(\$C\$62..\$Q\$142,11,AA\$50..AB\$51)  
A:AC52: (F2) @DSUM(\$C\$62..\$Q\$142,14,AC\$50..AD\$51)\*\$B\$10  
A:AD52: (F0) @DSUM(\$C\$62..\$Q\$142,13,AC\$50..AD\$51)  
A:AE52: (F2) @DSUM(\$C\$62..\$S\$142,16,AE\$50..AF\$51)\*\$B\$10  
A:AF52: (F0) @DSUM(\$C\$62..\$S\$142,15,AE\$50..AF\$51)  
A:A54: (F2) [W13] '# AA places  
A:B54: (F0) [W20] +X56  
A:C54: (F0) +X48  
A:D54: (F0) +X52  
A:W54: [W9] 'PMGP  
A:X54: 'XRPK  
A:Y54: 'PMGP  
A:Z54: 'XRPK  
A:AA54: 'PMGP  
A:AB54: 'XRPK  
A:AC54: 'PMGP  
A:AD54: 'XCON



A:AE54: 'PMGP  
A:AF54: 'XCON  
A:A55: (F2) [W13] '# CC \* places  
A:B55: (F0) [W20] +Z56  
A:C55: (F0) +Z48  
A:D55: (F0) +Z52  
A:V55: (F2) [W10] +\$A\$10  
A:W55: (F2) [W9] '1JB  
A:X55: 'AA  
A:Y55: (F2) '1JB  
A:Z55: (F2) 'CC  
A:AA55: (F2) '1JB  
A:AB55: (F2) 'HH  
A:AC55: (F2) '1JB  
A:AD55: (F2) 'D  
A:AE55: (F2) '1JB  
A:AF55: (F2) 'K  
A:A56: (F2) [W13] '# HH \* places  
A:B56: (F0) [W20] +AB56  
A:C56: (F0) +AB48  
A:D56: (F0) +AB52  
A:W56: (F2) [W9] @DSUM(\$C\$62..\$Q\$142,8,W\$54..X\$55)\*\$B\$10  
A:X56: (F0) @DSUM(\$C\$62..\$Q\$142,7,W\$54..X\$55)  
A:Y56: (F2) @DSUM(\$C\$62..\$Q\$142,10,Y\$54..Z\$55)\*\$B\$10  
A:Z56: (F0) @DSUM(\$C\$62..\$Q\$142,9,Y\$54..Z\$55)  
A:AA56: (F2) @DSUM(\$C\$62..\$Q\$142,12,AA\$54..AB\$55)\*\$B\$10  
A:AB56: (F0) @DSUM(\$C\$62..\$Q\$142,11,AA\$54..AB\$55)  
A:AC56: (F2) @DSUM(\$C\$62..\$Q\$142,14,AC\$54..AD\$55)\*\$B\$10  
A:AD56: (F0) @DSUM(\$C\$62..\$Q\$142,13,AC\$54..AD\$55)  
A:AE56: (F2) @DSUM(\$C\$62..\$S\$142,16,AE\$54..AF\$55)\*\$B\$10  
A:AF56: (F0) @DSUM(\$C\$62..\$Q\$142,13,AE\$54..AF\$55)  
A:A57: (F2) [W13] '# \*\* D places  
A:B57: (F0) [W20] +AD56  
A:C57: (F0) +AD48  
A:D57: (F0) +AD52  
A:A58: (F2) [W13] '# \*\* K places  
A:B58: (F0) [W20] +AF56  
A:C58: (F0) +AF48  
A:D58: (F0) +AF52  
A:J61: [W9] '# of  
A:K61: [W9] 'Qty  
A:L61: [W9] '# of  
A:M61: [W9] 'Qty  
A:N61: [W9] '# of  
A:O61: [W9] 'Qty  
A:P61: '# of  
A:Q61: 'Qty  
A:R61: '# of  
A:S61: 'Qty  
A:A62: [W13] 'Partnumber  
A:B62: [W20] 'Description  
A:C62: 'PMGP  
A:D62: 'QTY  
A:E62: 'XRPK  
A:F62: 'XMV

A:G62: 'XCON

A:H62: 'XIPQ  
A:I62: 'AGV  
A:J62: [W9] 'AA-places  
A:K62: [W9] 'AA  
A:L62: [W9] 'CC-places  
A:M62: [W9] 'CC \*  
A:N62: [W9] 'HH-places  
A:O62: [W9] 'HH \*  
A:P62: 'D-places  
A:Q62: '\*\* D  
A:R62: 'K-places  
A:S62: '\*\* K  
A:A63: [W13] '002E031460  
A:B63: [W20] 'HSG XERO MOD  
A:C63: '2P  
A:D63: (F5) 1  
A:E63: 'HK  
A:F63: (F0) 72  
A:G63: 'K  
A:H63: (F0) 4  
A:I63: 2  
A:J63: [W9] @IF(\$K63=0,0,1)  
A:K63: [W9] @IF(\$E63="AA", \$D63/\$F63,0)  
A:L63: [W9] @IF(\$M63=0,0,1)  
A:M63: [W9] @IF(\$E63="CC", \$D63/\$F63,0)  
A:N63: [W9] @IF(O63=0,0,1)  
A:O63: [W9] @IF(\$E63="HH", \$D63/\$F63,0)  
A:P63: @IF(Q63=0,0,1)  
A:Q63: @IF(\$E63="HD", \$D63/\$H63,0)  
A:R63: @IF(S63=0,0,1)  
A:S63: @IF(\$E63="HK", \$D63/\$H63,0)  
A:V63: [W10] 1  
A:A64: [W13] '002K028120  
A:B64: [W20] 'CVR ASSY FRNT  
A:C64: '2P  
A:D64: (F5) 1  
A:E64: 'HH  
A:F64: (F0) 400  
A:G64: 'K  
A:H64: (F0) 80  
A:I64: 11  
A:J64: [W9] @IF(\$K64=0,0,1)  
A:K64: [W9] @IF(\$E64="AA", \$D64/\$F64,0)  
A:L64: [W9] @IF(\$M64=0,0,1)  
A:M64: [W9] @IF(\$E64="CC", \$D64/\$F64,0)  
A:N64: [W9] @IF(O64=0,0,1)  
A:O64: [W9] @IF(\$E64="HH", \$D64/\$F64,0)  
A:P64: @IF(Q64=0,0,1)  
A:Q64: @IF(\$E64="HD", \$D64/\$H64,0)  
A:R64: @IF(S64=0,0,1)  
A:S64: @IF(\$E64="HK", \$D64/\$H64,0)  
A:V64: [W10] 1  
A:A65: [W13] '002K031410

A:B65: [W20] 'COVER ASSEMBLY  
A:C65: '2P  
A:D65: (F5) 1

A:E65: 'HK  
A:F65: (F0) 144  
A:G65: 'K  
A:H65: (F0) 20  
A:I65: 7  
A:J65: [W9] @IF(\$K65=0,0,1)  
A:K65: [W9] @IF(\$E65="AA", \$D65/\$F65,0)  
A:L65: [W9] @IF(\$M65=0,0,1)  
A:M65: [W9] @IF(\$E65="CC", \$D65/\$F65,0)  
A:N65: [W9] @IF(O65=0,0,1)  
A:O65: [W9] @IF(\$E65="HH", \$D65/\$F65,0)  
A:P65: @IF(Q65=0,0,1)  
A:Q65: @IF(\$E65="HD", \$D65/\$H65,0)  
A:R65: @IF(S65=0,0,1)  
A:S65: @IF(\$E65="HK", \$D65/\$H65,0)  
A:V65: [W10] 1  
A:A66: [W13] '006E017560  
A:B66: [W20] 'SHAFT DRUM  
A:C66: '2P  
A:D66: (F5) 1  
A:E66: 'HD  
A:F66: (F0) 3200  
A:G66: 'D  
A:H66: (F0) 100  
A:I66: 10  
A:J66: [W9] @IF(\$K66=0,0,1)  
A:K66: [W9] @IF(\$E66="AA", \$D66/\$F66,0)  
A:L66: [W9] @IF(\$M66=0,0,1)  
A:M66: [W9] @IF(\$E66="CC", \$D66/\$F66,0)  
A:N66: [W9] @IF(O66=0,0,1)  
A:O66: [W9] @IF(\$E66="HH", \$D66/\$F66,0)  
A:P66: @IF(Q66=0,0,1)  
A:Q66: @IF(\$E66="HD", \$D66/\$H66,0)  
A:R66: @IF(S66=0,0,1)  
A:S66: @IF(\$E66="HK", \$D66/\$H66,0)  
A:V66: [W10] 1

## Appendix 5 Average number of container deliveries

In this appendix the average number of container deliveries is calculated, based on the assembly lay outs for the 5017 CRU, the Superstar CRU, the 5028 CRU and the 5014 CRU.

- Arrival pattern of containers with a dayrate of 100.  
(Voluminous PMS parts not included)

Superstar:	MN2	9.23;58*	Average: 73.83/68* = 1.0857
	MN5	14.6;9*	
	Box	50;1*	

5017:	MN2	11.09;37*	Average: 62.76/39* = 1.6092
	MN5	1.67;1*	
	Box	50;1*	

5028:	MN2	1.89;7*	Average: 64.1/10* = 0.6410
	MN5	4.52;3*	

5014:	MN2	2.08;30*	<u>Average: 36.03/40* = 0.9008</u>
	MN5	33.95;10*	

Average arrival  
per container  
per 100 products = 1.06

- Average number of product parts (= containers) per station = 3.625
- Dayrate per station = 1200

**Number of container deliveries** =  $(1.06/100) \times 3.625 \times 1200 = 46.11$   
(per day per station)

\*: [ containers per 100 products ; product parts ].

## Appendix 6

### Simulation of part replenishment on the assembly conveyor.

The main purpose of the assembly conveyor is to transport the product pallets from one assembly station to the next. When a production schedule does not fully occupy the assembly conveyor, it is possible, with an additional controlling system, to transport other pallets to the stations. These pallets can transport the parts containers to the different assembly stations.

It is difficult to calculate how much the assembly process will be disturbed by the additional parts pallets on the assembly conveyor, and here's where simulation comes in handy.

The simulation of the several assembly conveyors is programmed with the program WITNESS version 4.0. by P. Coenen and N. Tissink. The conveyor which are simulated are the Van der Lande conveyors, which are already present or on order.

The input needed for such simulations are:

- The assembly conveyor layout;
- The station cycle times;
- The station routings;
- Belt speed;
- Side conveyor speed;
- Transfer speed;
- Transfer lifting / lowering time;
- number of assembly pallets;
- The routing and volumes of part replenishment.

This last information is deduced from the calculations of the product parts in the LOTUS sheets, which are represented in appendix 6.

The outcome of these simulations is that it gives no significant disturbance to the assembly process, when the not voluminous parts are transported on the assembly conveyor. These not voluminous parts consist of  $\pm 90\%$  of the number of parts of a product.

The voluminous parts are the PMS and packaging products. These products have such a high deliver frequency, when transported on a conveyor container, that they were left out for practical reasons. A specific solution should be found for these products.

One solution is to transport these products on wooden boxpallets to the head of the assembly conveyor, where these voluminous parts then can be directly mounted on the assembly conveyor pallet.

## Appendix 7

### The number of vehicles

On the next page of this appendix is shown that when the replenish routing is known, it is possible to calculate the needed capacity of vehicles, for forklift trucks, AGV and manual replenishment.

This is not applicable for conveyors. An overhead conveyor with the transport velocity of 24 m per minute, divided in parts of 1 meter length, can transport 1440 objects per hour (theoretical: 1 object per 1 meter). This is more than sufficient for the required replenishment.

The assembly conveyor capacity can be determined with a simulation (see appendix 6).

5028	V(transport) [m/s]:	1.7	1.7	2 shifts, bring full & pick up empty
forklift	positioning time [sec]:	60	reactiontime XBMS:	
	number of tote tins per transport:	4		

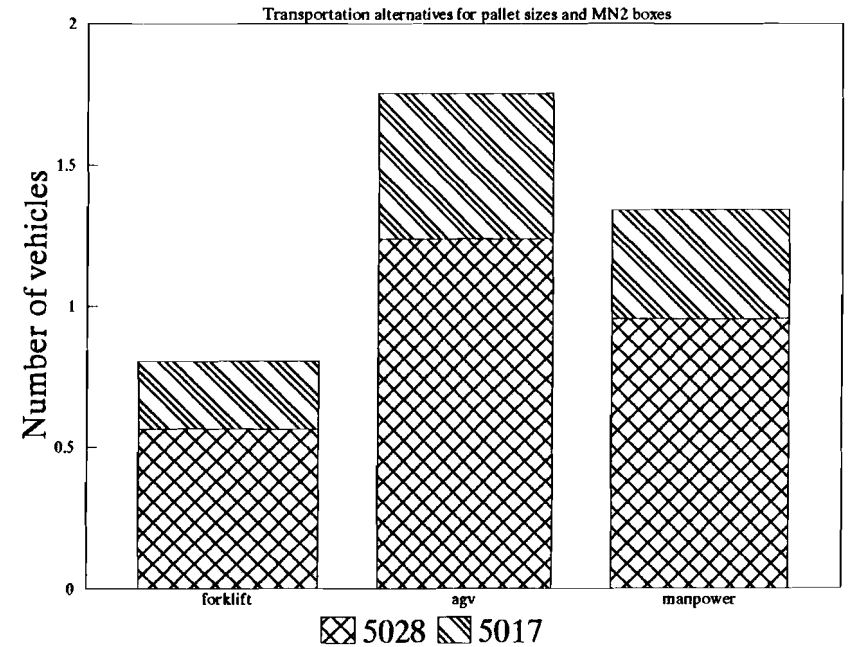
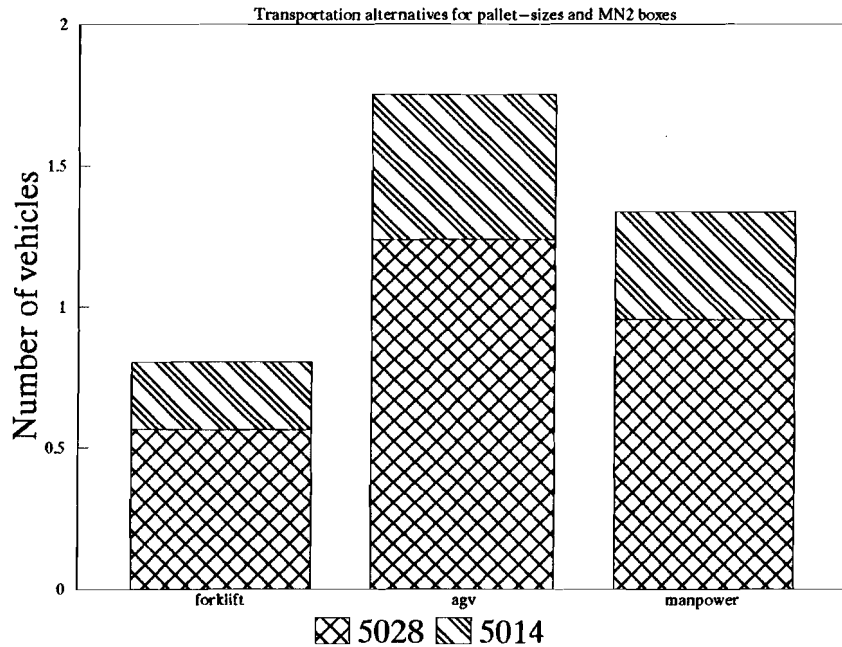
	FORKLIFT	AGV	manpower	Assy conv.	Overhead c.
V(transport) [m/s]:	1.7	0.71	0.82	2.4	0.45
positioning time per transport [sec]:	60	110	60	110	20
number of tote tins per transport:	4	4	4	1	1

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Frequency:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Distance from store:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
D*F:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Needed transporttime:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
Frequency:	20.18001	12.03858	3.255798	0.2284	3.161743	2.951897	0.523417	0	0.253778	0.148936	16.95758	2.525693	0.344619	8.906816	6.706078	5.392778	0
Distance from store:	235	235	235	235	235	235	235	235	235	235	0	235	235	235	235	235	0
D*F:	4742.303	2829.067	765.1125	53.674	743.0095	693.6958	123.0029	0	59.63778	34.99992	0	593.5379	80.98539	2093.102	1575.928	1267.303	0
Needed transporttime:	4000.39	2386.472	645.4141	45.27694	626.769	585.1702	103.7597	0	50.30771	29.52434	1017.455	500.6815	68.31559	1765.645	1329.381	1069.039	0
	108	110	115	124	141	156	169	182	176	154	10	177	180	186	193	124	0

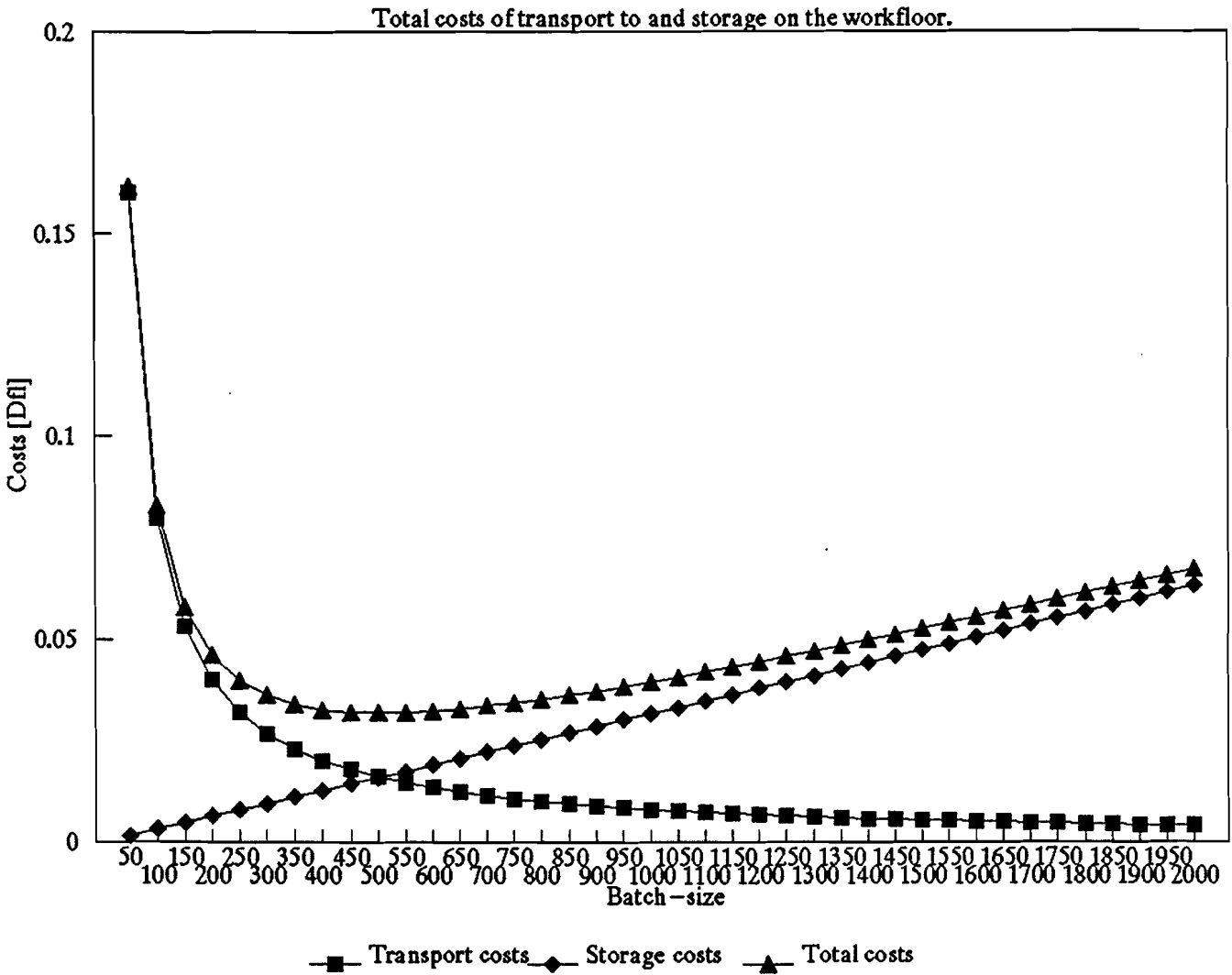
		5028					
Accumulated transporttime [sec]:	14223.6	14223.6	31243.17	24106.47	20698.95	49397.87	
available time per vehicle [min/shift]:	421	421	421	421	421	421	
needed vehicles:	0.563088	0.563088	1.236864	0.954334	0.819436	1.955577	
average transporttime [sec.]:	170.1874	170.1874	373.8289	288.4373	192.2963	458.9134	
		hefrtruck	agv	manpower	Assembly c	Overhead	

	forklift	agv	manpower	Assembly c	Overhead
5028	0.563088	1.236864	0.954334	0.819436	1.955577
5014	0.241315	0.515648	0.381407	0.350112	0.636068
	forklift	agv	manpower	Assembly c	Overhead
5028	0.563088	1.236864	0.954334	0.819436	1.955577
5017	0.239945	0.516502	0.386475	0.744188	1.531475



**Appendix 8            Costs: Transport vs. WIP**

In the following figure is shown, that an (average) batchsize can be determined with which the costs (due to transport and Work In Progress) are minimized.



transportcost per single transport:	8
average costs for keeping a (end)product in store per year:	8
year-rate:	253000



## Appendix 9 Store capacity calculation

In this appendix the store capacity is calculated based on the assembly lay outs for the 5017 CRU, the Superstar CRU, the 5028 CRU and the 5014 CRU.

### Container combinations at the 5017 assembly line

MN2	12	20	0	0	0	3			
MN5	1	0	0	0	0	1			

### Container combinations the at Superstar assembly line

MN2	7	0	0	5	5	1	0	0	0	5	0	3
MN5	1	0	0	1	0	0	0	0	0	1	0	0
MN2	3	2	0	2	0	2	2	0	0	3	1	0
MN5	0	0	1	0	1	0	0	0	0	0	0	5

### Container combinations at the 5028 assembly line

MN2	6	3	3	1	4	1	4	0	1	0
MN5	1	1	2	0	1	1	0	0	0	1

### Container combinations at the 5014 assembly line

MN2	3	2	2	1	3	2	1	1	1	2	1	0	1
MN5	0	1	2	0	1	0	2	1	0	0	0	3	0

There are 39 container combinations, which need a container store. (See also table A22)

One container combination is  $1/39 \times 100\% = 2.56\%$  of all neede stores.  
shelf length: 150 cm.

What does fit on two shelves? Everything  $< 300$  cm.

→ Everything but combinations:  $12 \times \text{MN2} + 1 \times \text{MN5} \rightarrow 2.56\%$   
 $20 \times \text{MN2} + 0 \times \text{MN5} \rightarrow \underline{2.56\%}$   
 5.12%

Everything that does fit on 2 shelves of 150 cm =  $100\% - 5.12\% = 94.88\%$

shelf length: 120 cm.

What does fit on two shelves? Everything  $< 240$  cm.

→ Everything but combinations:  $12 \times \text{MN2} + 1 \times \text{MN5} \rightarrow 2.56\%$   
 $20 \times \text{MN2} + 0 \times \text{MN5} \rightarrow 2.56\%$   
 $12 \times \text{MN2} + 1 \times \text{MN5} \rightarrow \underline{2.56\%}$   
 7.68%

Everything that does fit on 2 shelves of 120 cm =  $100\% - 7.68\% = 92.32\%$

Number of MN2 containers	Number of MN5 containers	Accumulated length [cm.]	Number of assy stations
0	0	0	(12)
1	0	30	7
0	1	40	2
2	0	60	6
1	1	70	2
3	0	90	4
2	1	100	1
1	2	110	1
0	3	120	1
4	0	120	1
3	1	130	3
2	2	140	1
5	0	150	1
4	1	160	1
3	2	170	1
5	1	190	2
0	5	200	1
6	1	220	1
7	1	250	1
12	1	400	1
20	0	600	1
		Totaal:	39

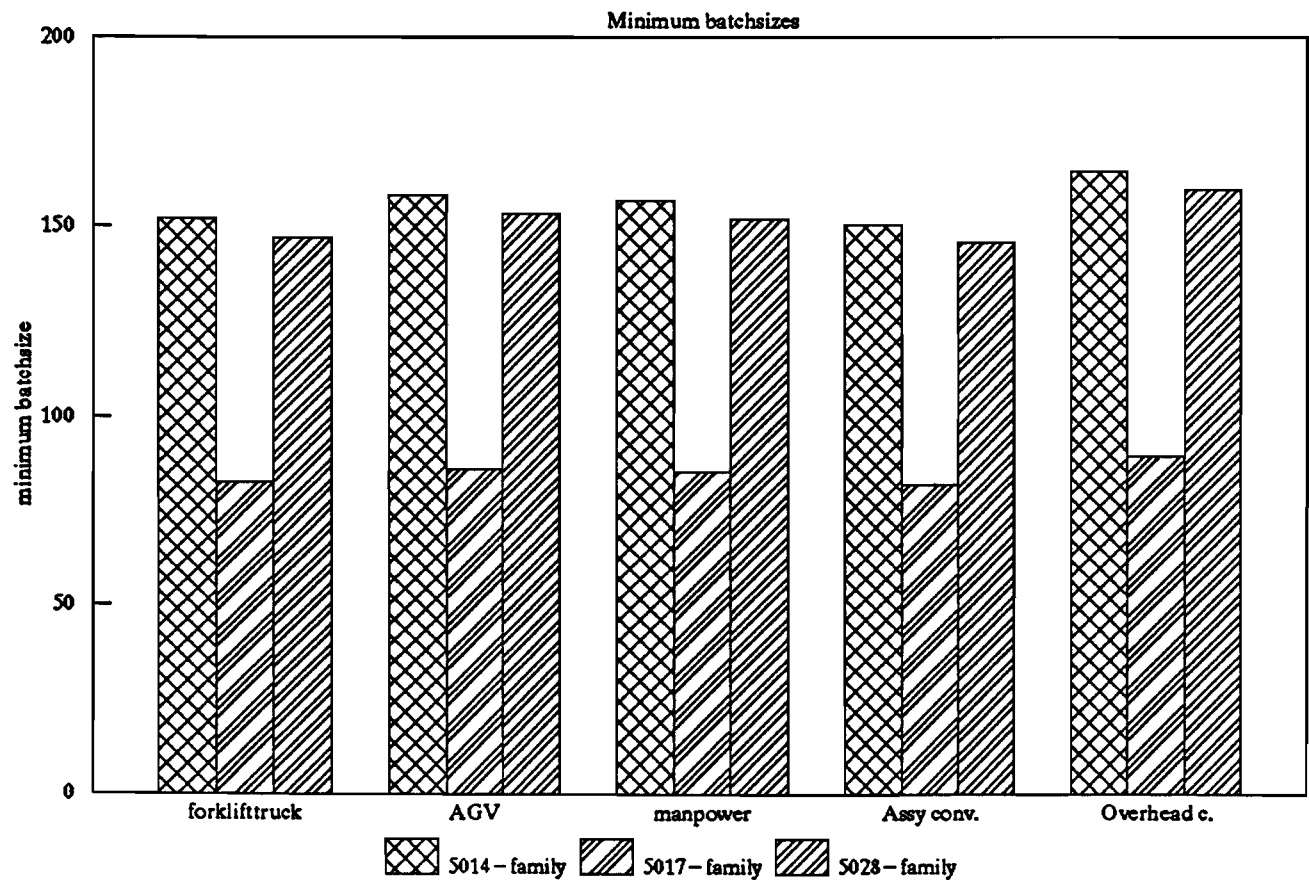
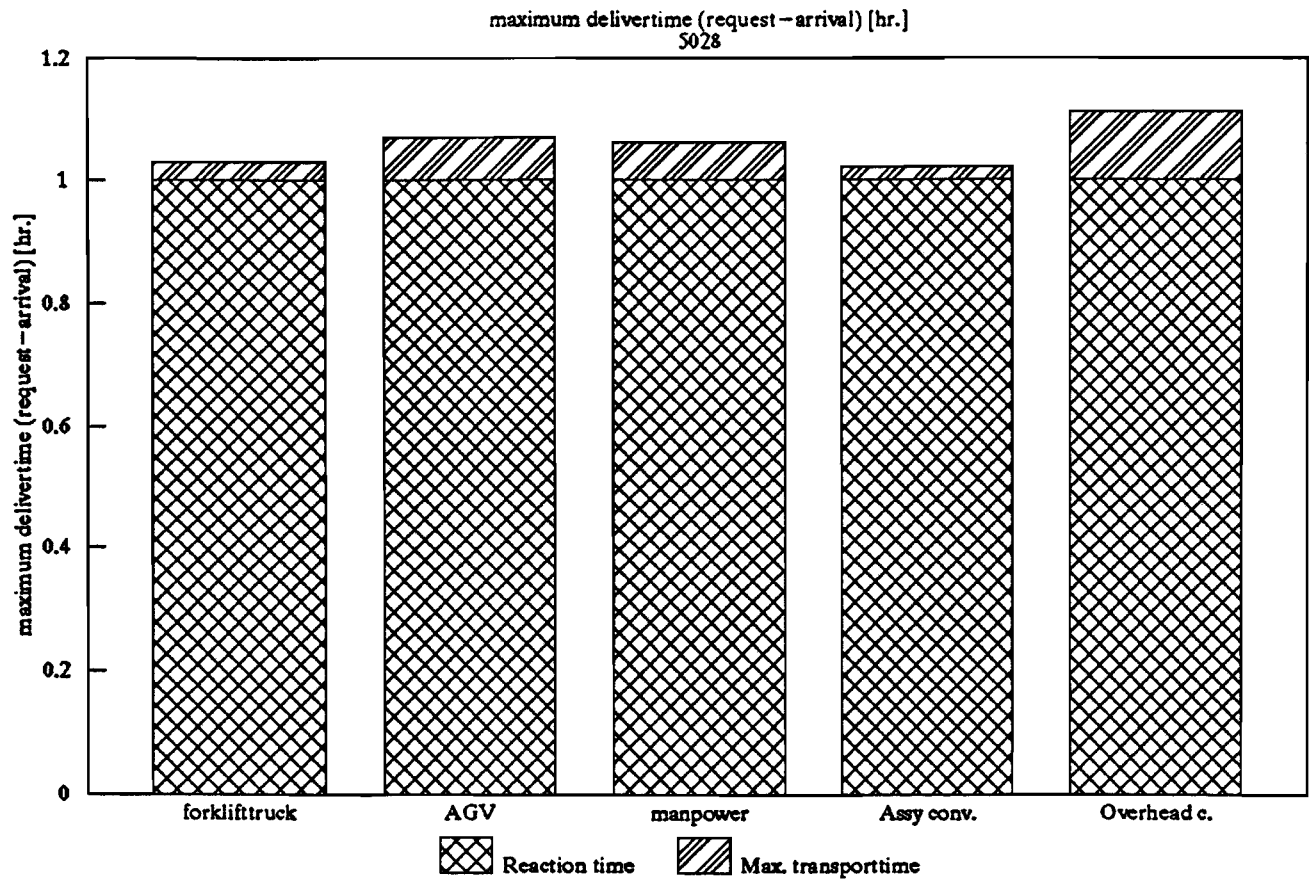
table A2.2.1

Accumulated width	Number of assy stations	Percentage of all assy stations
0-80	17	43.6
80-160	14	35.9
160-240	5	12.8
240-320	1	2.6
320-400	1	2.6
400-480	0	0
480-560	0	0
560-640	1	2.6

table A2.2.2

## Appendix 10 Minimal batchsizes.

In the figures below the relation is shown between the reaction time, the maximum transporttime and the minimal batchsizes.



## Appendix 11      Choices for the concept designs

The automation of the handling of the storing process can be divided in 4 actions:

- Container from assembly line
- Container in store
- Empty container on assyline.
- Controlling: the sensor & controlingsystem.

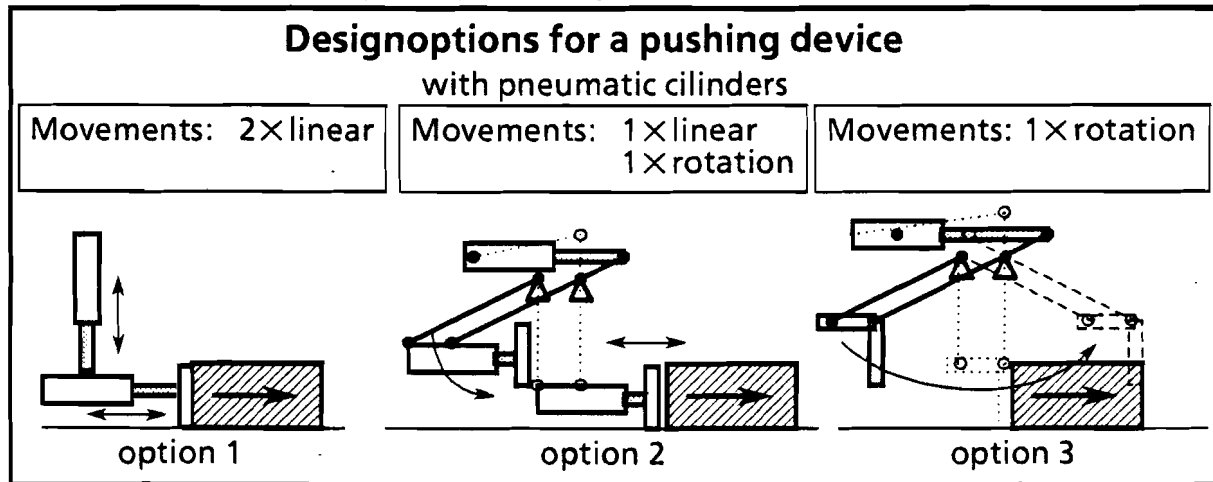
### a. Container from assembly line

Options:

- Assembly conveyer adaption.
- Robot.
- Pushing device:
  - Pneumatic cilinders (pushing from behind).
  - Caterpillar push unit (traction from the top).

Choice:            Pneumatic cilinders

Reasons:        Relatively cheap and easy to control.



Choice:            Option 2

Reasons:        There is no load on the cilinders, perpendicular to the direction of movement , and the reach is sufficient. Option 1 and 3 do not meet these requirements.

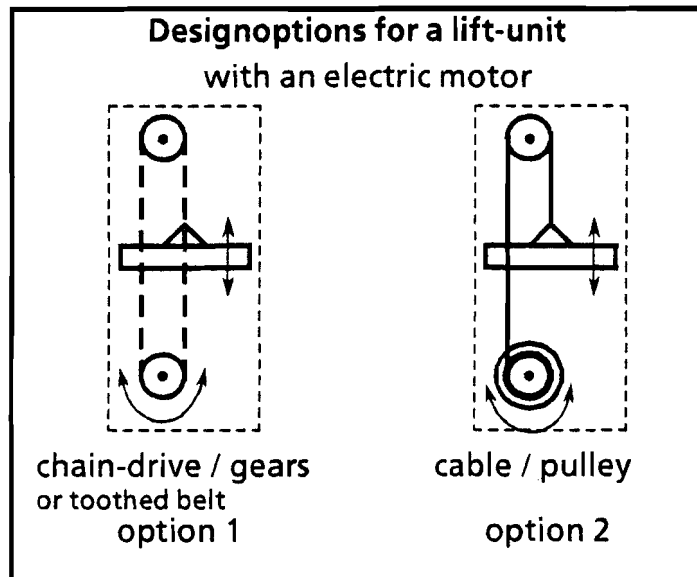
**b. Container in store**

**Options:**

- Robot;
- Patre nostre;
- Lift-unit, with:
  - Pneumatic cilinder;
  - Electromotor;
  - propellor-shaft.

**Choise:** Lift-unit with an electric motor

**Reasons:** The reach of the lift would need an impractical long cilinder.  
Relatively cheap.



**Choise:** Option 1: Electromotor with toothed belt.

**Reasons:** Low noise production  
Accurate position control

**c. Empty container on assyline.**

**Options:**

- Robot
- Empty containerstore, with:
  - Pushing device: - Pneumatic cilinders (pushing from behind)
  - Caterpillar/belt push unit (traction).

**Choice:** Pushing device with a pneumatic cilinders (pushing from behind).

**Reason:** Relatively cheap and easy to control.

**d. Controlling: the sensor & controlingsystem.**

Automation means not only mechanizing a process, but also making a system that controls that mechanized process. The control system should be able to "observe" by means of sensors (input) and regulate the process with motors and/or pneumatic devices (output).

## Appendix 12 The specification of input and subproblems

1. The product( parts) classification and volumes (*input*);
  - Number of products that should be produced (specified by sort): S.P.A. volumes.
  - Sorts of products (classification).
    - division in product families.
    - division in product groups (per family).
    - Number of parts per box/container or pallet per parts group.
    - Sort(s) of originating point(s) of the parts that have to be transported: (Store, O.D.plant, PMS, ...).
2. Way of producing: Blockbuild, mixbuild: batchsizes (*input*).
  - Blockbuild, mixbuild...
  - Batchsizes per product or product family.
  - Allowed tool change time.
3. Partscontrol (*subproblem*);
  - Sort / way of partscontrol.
    - Push partscontrol: several possibilities adoptions and applications. (MRPII, XBMS).
    - Pull partscontrol: several possibilities adoptions and applications. (JIT)
4. Safety stock (*subproblem*);
  - Demanded size of the safety stock at the assembly line per productpart; is also determined by minimalizing transportation and storing costs.
5. Batchsizes for the partssupply; frequency of the partssupply (*subproblem*); is also determined by minimalizing transportation and storing costs.
6. Productcontainers (*subproblem*);
  - Way of presenting to the operator/machine.;
  - Sort of productcontainers to store;
  - The number of product containers that can be present in the store at the same time.
  - Material, shape, length, height, width;
  - Special requirements / adjustments;
  - Costs.
7. Total available area of the workingfloor (*input*);
8. The assembly layout (*input*);
  - Number of different product parts per working place.
  - Number of working places per product;
9. Way(s) of transport (*subproblem*);
  - Sort/way of transport (capacity of the transport). This is also determined by minimalizing transportation and storing costs.Properties:
  - Transport velocity;
  - Maximum carrying weight / maximum number of boxes/containers;
  - Sort of transport boxes/containers;
  - The needed floor area for transport;
  - Costs.
10. Way of floor lay out (*subproblem / input*).
  - Working place layout:
    - Number of free palletplaces per workingplace / operator;

- Floorarea available for store / handling unit;
  - Floorarea available for assembly.
  - Requirements/designconditions for floor mapping design.
  - The part of the total available area, that is available for transport.
  - Distances from origin to destination.
11. Ergonomical demands (for the handling of / the supplying of the assembly operator) (*input*);
  12. Automation requirements (for the handling of / the supplying of the assembly machines) (*input*);
  13. Further design requirements: modular (*input*).
  14. Store / handling unit at assembly line (*subproblem*);
    - Sort/way of storing / handling of the products or the constructive design of the supplying mechanism.
      - Way of presenting to the operator/machine.;
      - Way of transferring the containers from the transport to the store at the assembly line.
      - Sort of product containers to store;
      - The number of product containers that can be present in the store at the same time.
      - Material, shape, length, height, width;
      - Special requirements adjustments;
      - Costs.
  15. Originating point of transport (*subproblem*);
    - Deliver process properties;
      - Process properties of the production at the O.D. plant; production batchsizes (minimum and maximum), tool change times;
      - Buffer size at the O.D. plant;
      - Process properties of the P.M.S.: production batchsizes (minimum and maximum), tool change times;
      - Buffer size at the P.M.S. ;
      - Reaction time of the delivery process of parts from the store. production batchsizes (minimum and maximum).

Appendix 13

Ergonomic tables

Maximum acceptable weight of lift (kg) for females (Snook, 1978)																
Vertical distance: 51 cm																
Height level: from knuckle to shoulder height																
Box length (cm)	One lift every (time period)															
	5 sec		9 sec		14 sec		1 min		2 min		5 min		30 min		480 min	
	$\bar{x}$	S*	$\bar{x}$	S	$\bar{x}$	S	$\bar{x}$	S	$\bar{x}$	S	$\bar{x}$	S	$\bar{x}$	S	$\bar{x}$	S
75	10	1.2	13	1.2	13	1.2	14	2.4	15	2.4	18	2.4	19	2.4	20	3.0
49	10	1.2	13	1.2	13	1.2	14	2.4	15	2.4	18	2.4	19	2.4	20	3.0
36	10	1.2	14	1.2	14	1.2	15	2.4	16	2.4	19	3.0	20	3.0	21	3.7

table 4.4.a

Maximum acceptable weight of lift (kg) for males (Snook, 1978)																
Vertical distance: 51 cm																
Height level: from knuckle to shoulder height																
Box length (cm)	One lift every (time period)															
	5 sec		9 sec		14 sec		1 min		2 min		5 min		30 min		480 min	
	$\bar{x}$	S*	$\bar{x}$	S	$\bar{x}$	S	$\bar{x}$	S	$\bar{x}$	S	$\bar{x}$	S	$\bar{x}$	S	$\bar{x}$	S
75	15	3.0	20	4.2	23	4.9	24	5.5	25	6.1	25	6.1	32	6.7	34	7.3
49	15	3.6	20	4.2	23	4.9	24	5.5	25	6.1	25	6.1	32	6.7	34	7.3
36	16	3.0	21	4.2	24	4.9	26	6.1	27	6.7	27	6.7	34	7.9	36	8.5

t:  $\bar{x}$  = mean; \*: S = standard deviation

table 4.4.b












	: safe weight of lift	a few times a minute					
	: absolute maximum	different object-widths					
		object no longer than 75 cm					
		30 cm		40 cm		50 cm	
start position from the ground		10		10		8	
start 40 cm above the ground		15		13		11	
start 75 cm above the ground		20		17		10	

table 4.4.c \*: K.J. Poll, NIA



safe weight of lift absolute maximum	different lift-frequencies per minute for a object with a width of 40 cm.					
	1 - 3		3 - 6		6 - 10	
startposition from the ground	7	20	5	15	2.5	7
start 40 cm above the ground	10	30	6	18	3	10
start 75 cm above the ground	13	40	9	27	4	13

table 4.4.d      \*:K.J. Poll, NIA