



Material handling



Agenda

 <p>What is MH?</p> <p>KU LEUVEN</p>	 <p>Equipment taxonomy</p> <p>KU LEUVEN</p>	 <p>10 MH principles</p> <p>KU LEUVEN</p>	 <p>Management issues</p> <p>KU LEUVEN</p>
<p>What ? Importance ? Complexity ?</p>	<p>Transportation – Unit load formation – Positioning – Storage – Tracking & tracing – etc.</p>	<ul style="list-style-type: none">1. Planning2. Standardization3. Work Principle4. Ergonomic5. Unit Load6. Space Utilization7. System8. Automation9. Environmental10. Life Cycle Cost	<p># Suppliers – Space utilization & trucks – Level of automation – Productivity - Guidelines</p>
 <p>Illustrations</p> <p>KU LEUVEN</p>	 <p>Case studies</p> <p>KU LEUVEN</p>		
			

What is MH?



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What is it about?

Material handling is

“The art and science of moving, storing, protecting, and controlling materials.”

Material handling means using the

Right method, to provide the

Right amount, of the

Right material, at the

Right place, at the

Right time, in the

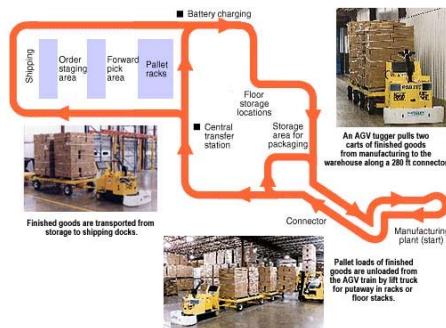
Right sequence, in the

Right position, in the

Right condition, at the

Right cost.

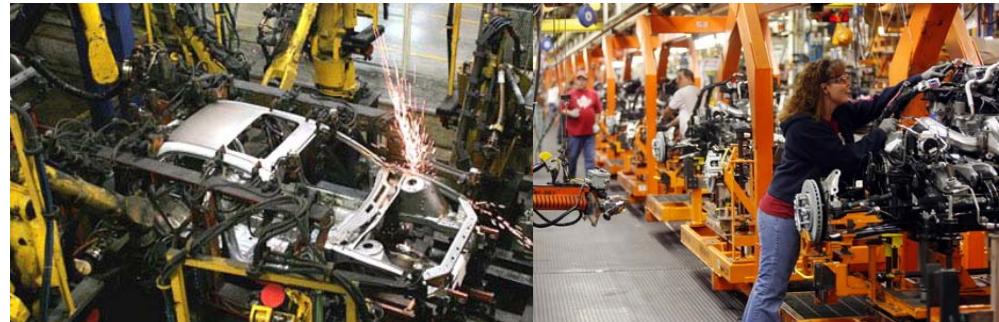




EXAMPLE



How & where
to store and
to move ?



New technologies
& still a lot of “old”
ones around

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Importance

Critical element in all facility designs

In most manufacturing facilities

25% of all employees

55% of factory space

87% of production time

15-70% of total mfg. cost

*Either labor or
capital intensive*

Usually the activity in which the greatest savings can be obtained

Can be the main backbone of a company's production execution strategy

Adds *time and place utility*



In a typical factory, material Handling accounts for:



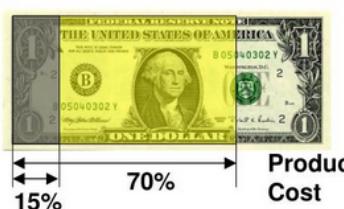
MH



Factory Space



87%
Production
time



Product
Cost

(ICESI)

Designer's dilemmas

Complex interrelationships between FP and MH

Many equipment types to choose from 

Many characteristics are hard to quantify

- Flexibility
- Expandability
- Speed of service

Multiple Objective

Lack of comprehensive design tools

Large combination of alternative solutions

Lack of data on life cycle costs and reliability.

*Technical characteristics
Process requirements
Handling requirements
Ergonomics
Constraints (budget, building, ...)*



Bloopers



Case history 1:

You have just installed a new material handling system featuring AGVs **interfacing** with a conveyor. You have spent many months and much money to get the system up and running. Now you discover that the conveyor/AGV interface just does not work. Worse the supplier of each system blames the other.



Case history 2:

Your new automated storage system works like a dream, bringing parts at the touch of a keyboard. Problem is, it is half empty since your company **changed** its inventory carrying strategy.



Case History 3:

A major US cosmetics company filed suit against its supplier of warehouse management software.

According to the **law suit**, the customer had complained that the software was not performing as expected and cancelled the second-half of a two-part contract. Maintaining that the customer was not fulfilling its part of the bargain, the software supplier disabled its proprietary software.

The action interrupted distribution center operations, halting product deliveries and idling workers

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BINNENLAND
Brandweerwagens kunnen gloednieuwe kazerne niet uit door constructiefout

donderdag 07 maart 2013, 13u29 Bron: VMMA VMMA

★ AANRADEN 4

VIDEO



SCHAARBEEK - De brandweer van Schaarbeek wacht al meer dan een jaar om te verhuizen naar een gloednieuwe kazerne. Een constructiefout zorgt ervoor dat de kazerne niet kunnen gebruiken. De brandweerwagens kunnen niet binnenrijden, door een niveauverschil tussen de straat en de garage.

Nog meer moeilijk toegankelijke treinen voor rolstoelen: nieuwe NMBS-wagens zijn niet aangepast aan perronhoogte



DeMorgen.

12 januari 2020,

Do you agree with this quote? Why (not)?

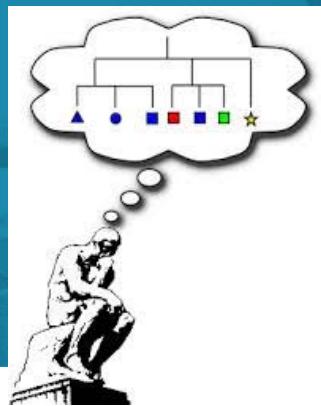
***“the best material handling is
no material handling at all”***



How & where
to store and
to move ?

New technologies
& still a lot of “old”
ones around

Equipment taxonomy



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Types of MH equipment

Transport equipment

Positioning equipment

Unit load formation equipment

Storage equipment

Identification and control equipment

Taxonomy



Old adage (that applies to a lack of material handling (MH) equipment knowledge): *"If the only tool you have is a hammer, it's amazing how quickly all your problems seem to look like nails."*

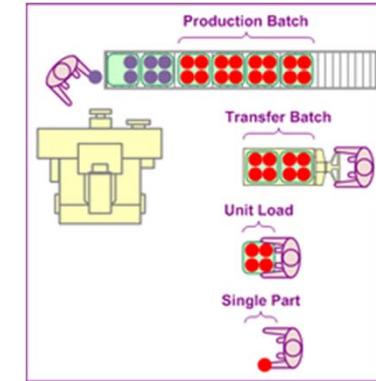
Remark: other classification schemes exist !

Interesting resources: www.mhi.org/mediabank/



Unit loads shall be appropriately sized and configured in a way which achieves the material flow and inventory objectives at each stage in the supply chain.

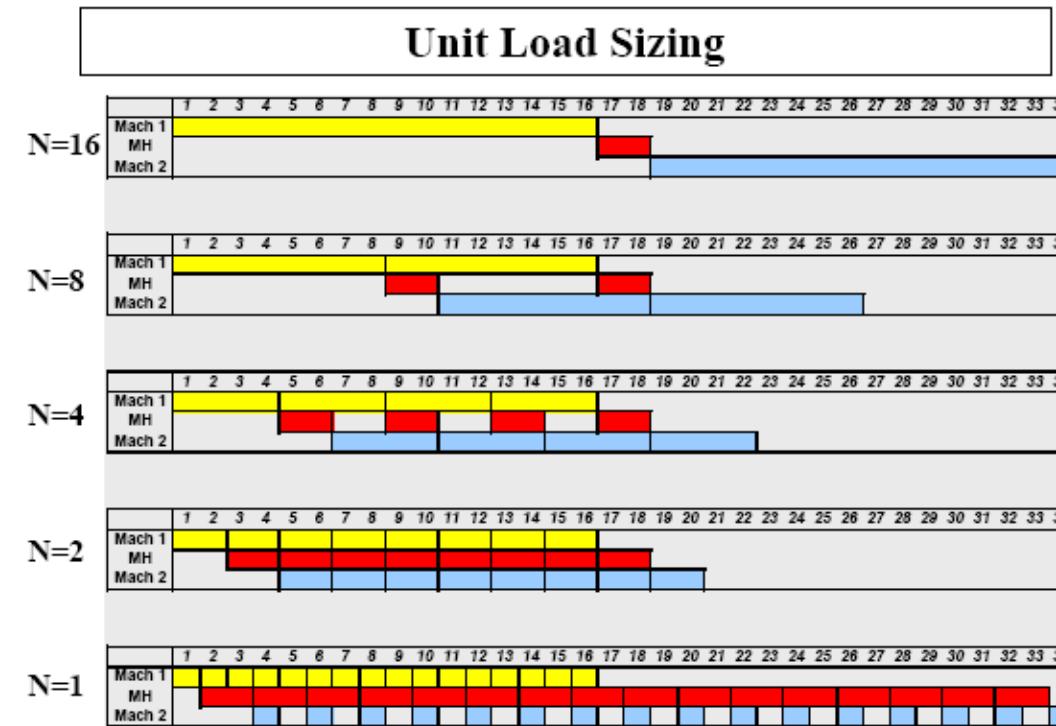
Definition: A unit load is one that can be stored or moved as a single entity at one time, such as a pallet, container or tote, regardless of the number of individual items that make up the load.



Stock Keeping Unit

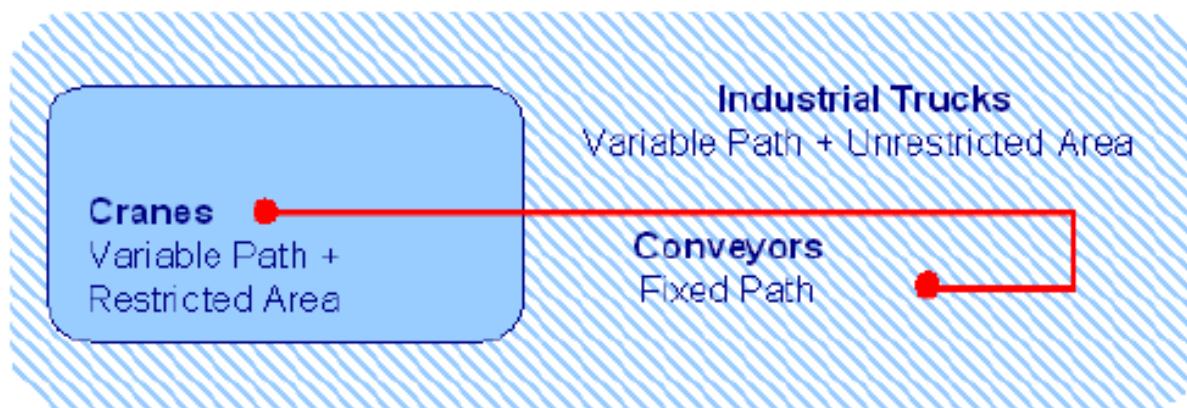
More commonly known as an **SKU**, this term pertains to the unique identification of a particular product. It's used in inventory management and enables retailers to track and distinguish products from one another. An SKU represents all the attributes of an item, including style, brand, size, color, and more.

EXAMPLE



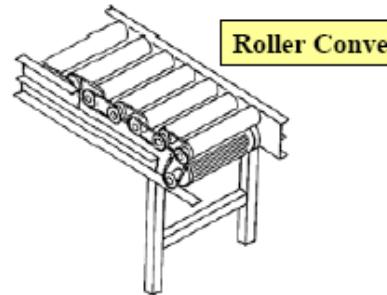
Transportation equipment

Equipment used to move material from one location to another (e.g., between workplaces, between a loading dock and a storage area, etc.). The major subcategories of transport equipment are conveyors, cranes, and industrial trucks. Material can also be transported manually using no equipment.

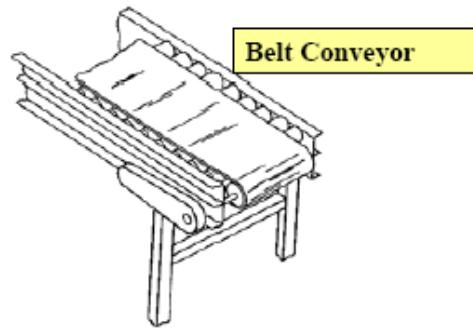


Characteristics	Conveyors	Cranes & hoists	Trucks
Area served	Moderate area (adjacent)	Limited area	Wide area
Movements	Continuous	Intermittent	Intermittent
Path	Fixed	Fixed	Not fixed
Unit load	Uniform	Not uniform	Rather uniform
Utilization	High	Low	High
Operator	(No)	(Yes)	(Yes)
Interferences	Combination with other operations possible Vulnerable for breakdowns Hindrance for mobile equipment	Minimum interference with floor Safety hazards	Good running surfaces and clearances needed Safety hazards

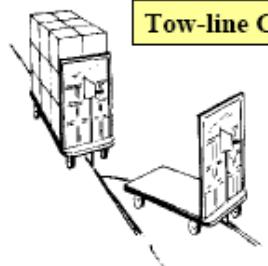
EUVEN



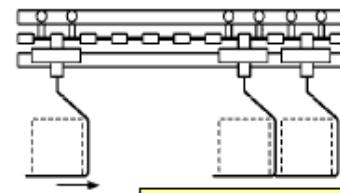
Roller Conveyor



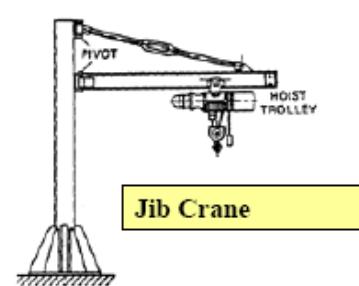
Belt Conveyor



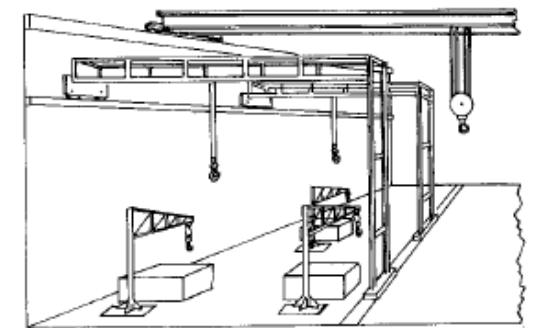
Tow-line Conveyor



Power and Free Conveyor



Jib Crane



Bridge Crane



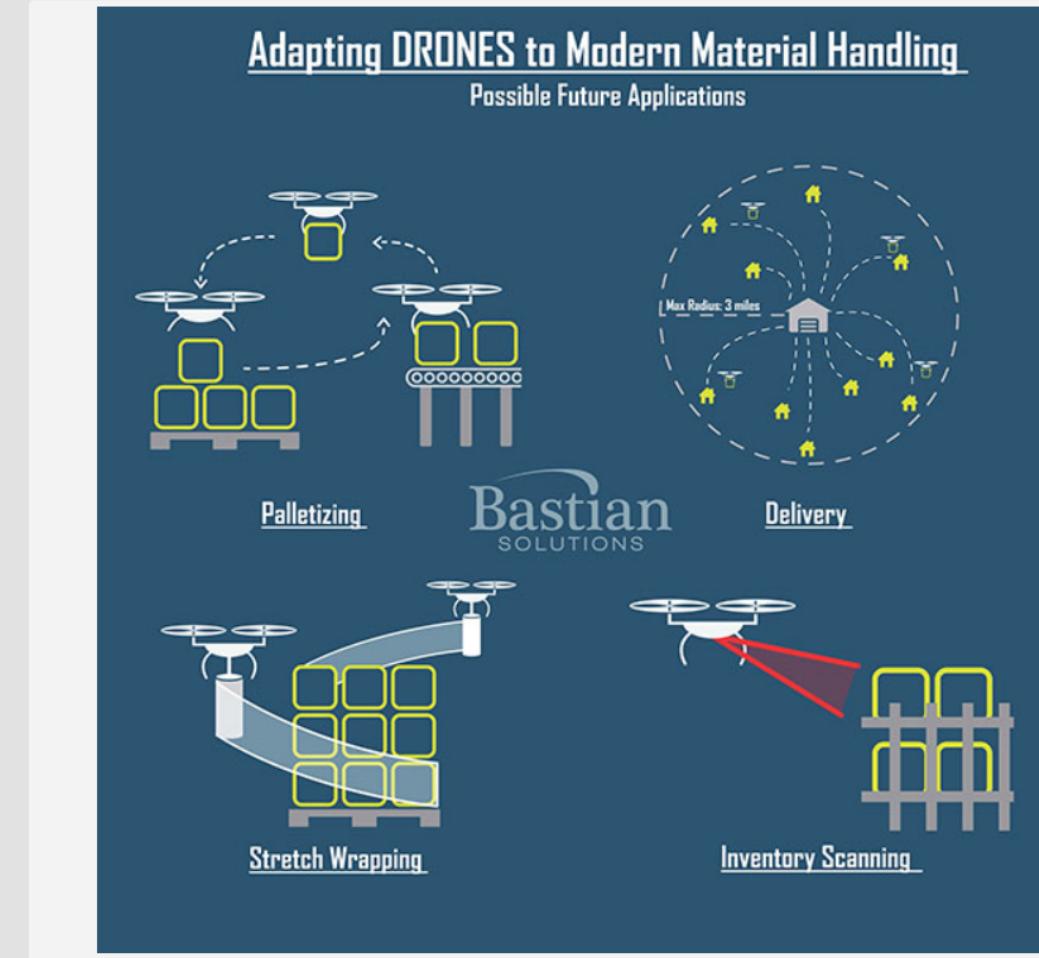
Gantry Crane

EXAMPLE

EXAMPLE

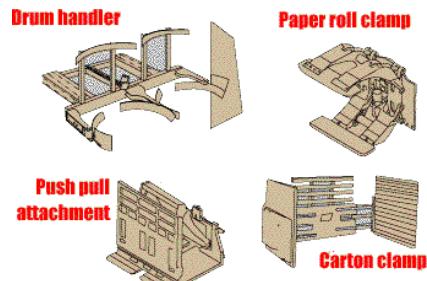


There is much discussion on the use of delivery drones, but how else could technology be used for material handling? What are the challenges ahead?

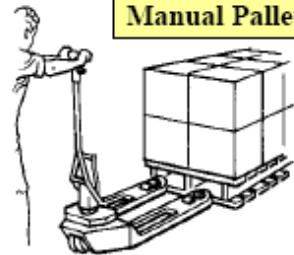


<https://www.bastiansolutions.com/blog/index.php/2015/12/04/adapting-drones-for-material-handling/#.VuKkyObGqb8>

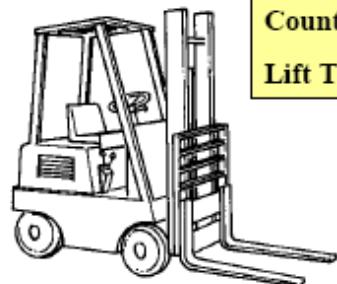
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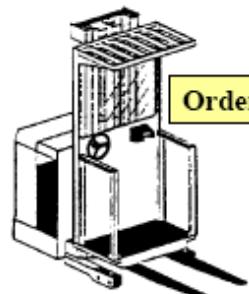
Manual Pallet Jack



Counterbalanced Lift Truck



Order Picker



Unit Load AGV



Positioning equipment

Positioning equipment is used to handle material at a single location so that the material is in the correct position for subsequent handling, machining, transport, or storage. Unlike transport equipment, positioning equipment is usually used for handling at a single workplace. Material can also be positioned manually using no equipment. The major types of positioning equipment are:

Manual (no equipment)

Lift/tilt/turn table

Dock leveler

Ball transfer table

Rotary index table

Parts feeder

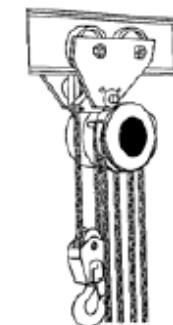
Air film device

Hoist

Balancer

Manipulator

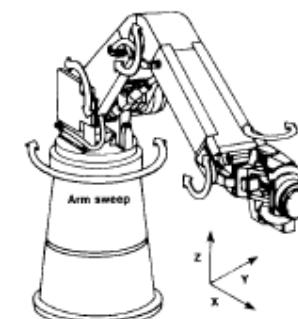
Industrial robot



Hoist



Lift Table



Robot



Unit load formation equipment

Equipment used to restrict materials so that they maintain their integrity when handled as a single load during transport and for storage. If materials are self-restraining (e.g., a single part or interlocking parts), then they can be formed into a unit load with no equipment. [Self-restraining \(no equipment\)](#)

[Pallets](#)

[Skids](#)

[Slipsheets](#)

[Tote pans](#)

[Pallet boxes/skid boxes](#)

[Bins/baskets/racks](#)

[Cartons](#)

[Bags](#)

[Bulk load containers](#)

[Crates](#)

[Intermodal containers](#)

[Strapping/tape/glue](#)

[Shrink-wrap/stretch-wrap](#)

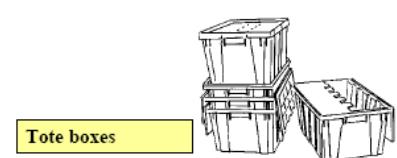
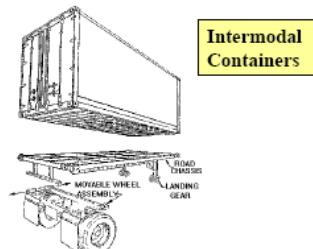
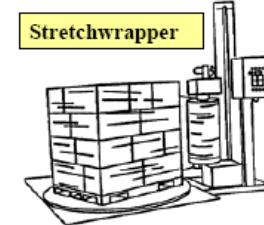
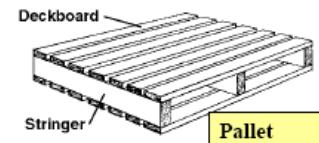
[Palletizers](#)

Advantages of unit loads:

- More items can be handled at the same time, thereby reducing the number of trips required and, potentially, reducing handling costs, loading and unloading times, and product damage.
- Enables the use of standardized material handling equipment.

Disadvantages of unit loads:

- Time spent forming and breaking down the unit load.
- Cost of containers/pallets and other load restraining materials used in the unit load
- Empty containers/pallets may need to be returned to their point of origin.



EXAMPLE



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Storage equipment

Equipment used for holding or buffering materials over a period of time. Some storage equipment may include the transport of materials (e.g., the S/R machines of an AS/RS, or storage carousels). If materials are block stacked directly on the floor, then no storage equipment is required.

[Block stacking \(no equipment\)](#)

[Selective pallet rack](#)

[Drive-through rack](#)

[Drive-in rack](#)

[Flow-through rack](#)

[Push-back rack](#)

[Sliding rack](#)

[Cantilever rack](#)

[Stacking frame](#)

[Shelves/bins/drawers](#)

[Storage carousel](#)

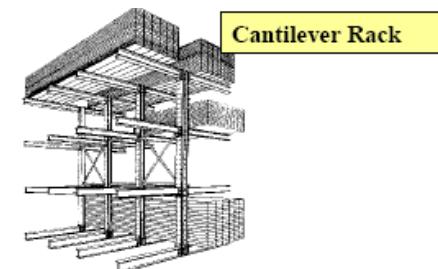
[Automatic storage/retrieval \(AS/RS\)](#)

[Split case order picking system](#)

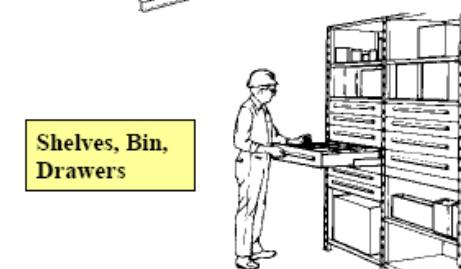
[Mezzanine](#)

The most common reason for storing a product is to buffer against variation so that the organization operates more efficiently.

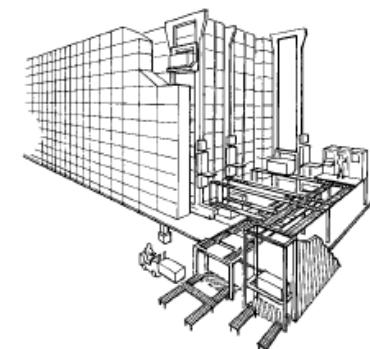
Other potential reasons for storage include: time bridging—allows product to be available when it is needed (e.g., storing spare machine parts at the facility); processing—for some products (e.g., wine), storage can be considered as a processing operation because the product undergoes a required change during storage; and securing—e.g., nuclear waste storage.



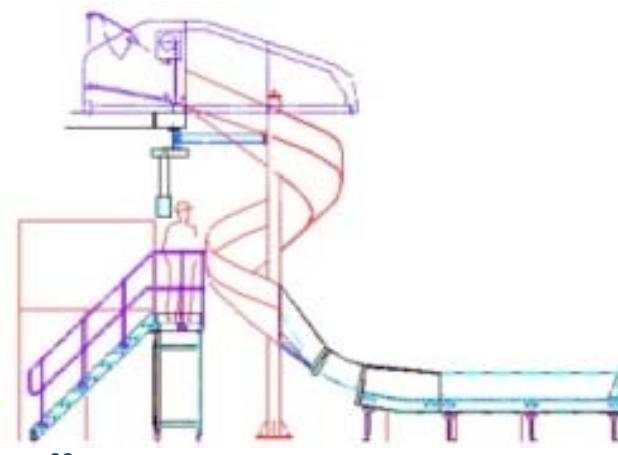
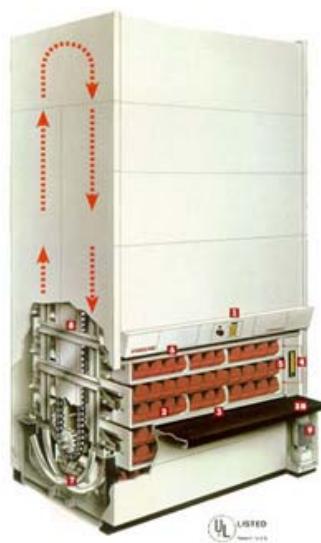
Cantilever Rack



Shelves, Bin,
Drawers

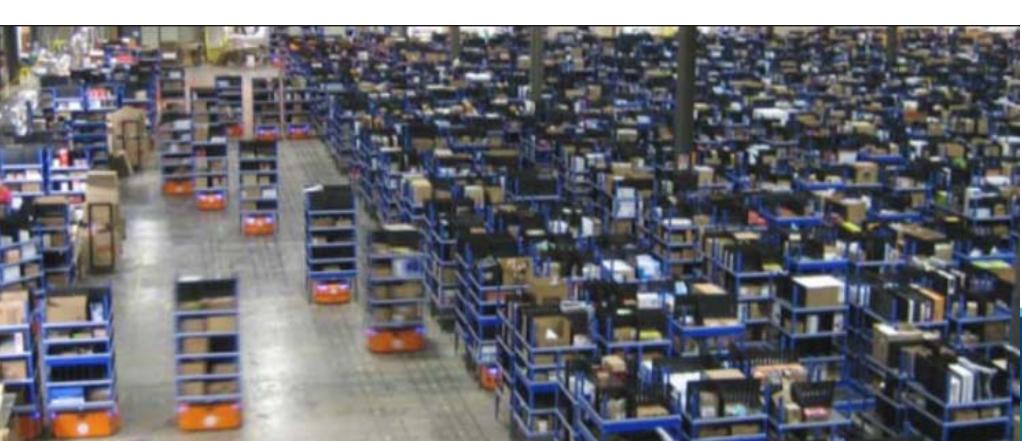
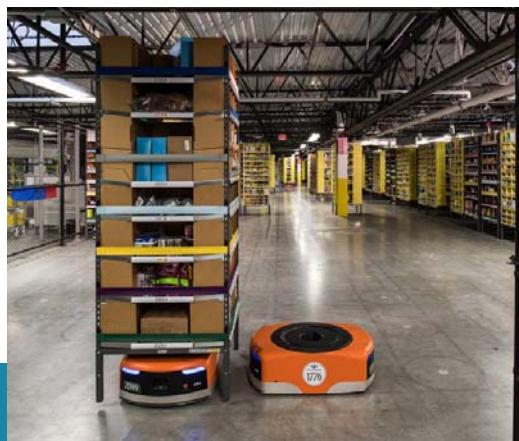
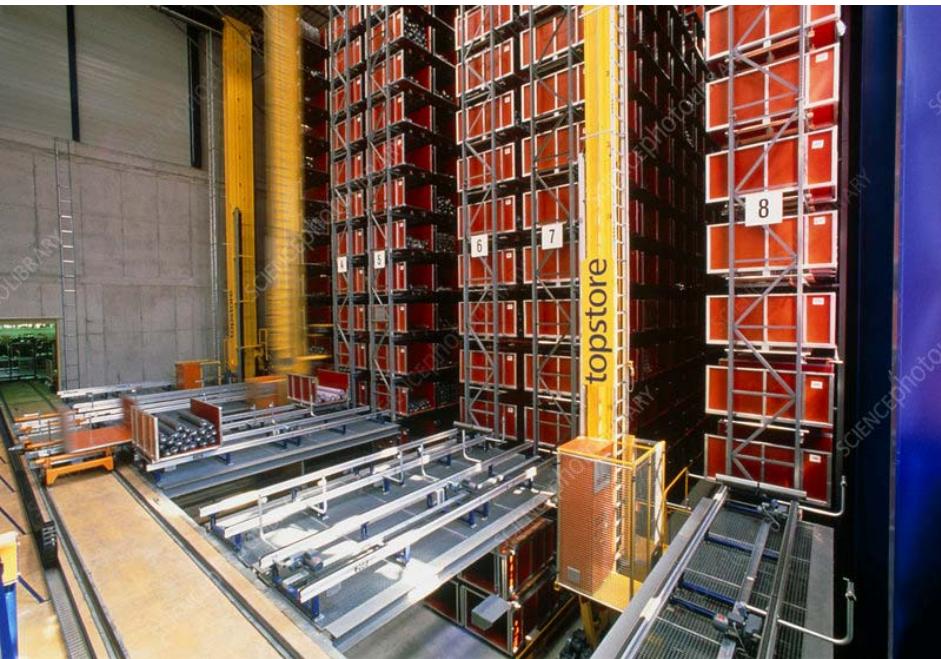


Unit Load ASRS



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EXAMPLE

Identification and control equipment



Identification and control equipment is used to collect and communicate the information that is used to coordinate the flow of materials within a facility and between a facility and its suppliers and customers. The major types of identification and communication equipment are:

Manual (no equipment)

Bar codes QR codes

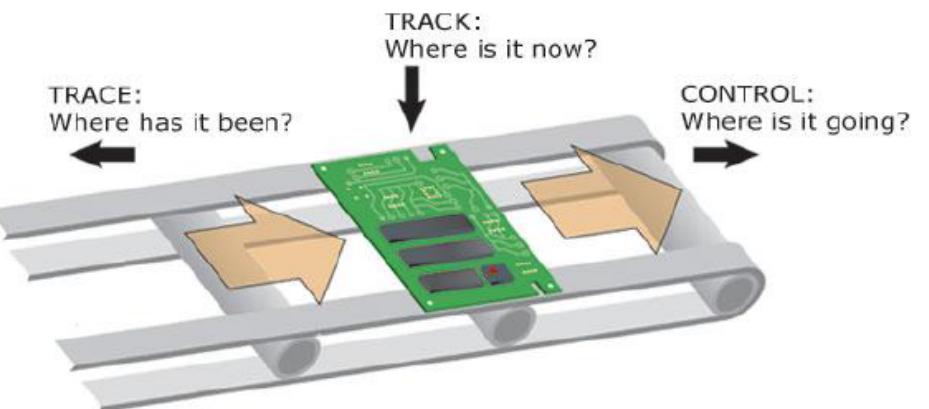
Radio frequency (RF) tag

Magnetic stripe

Machine vision

Portable data terminal

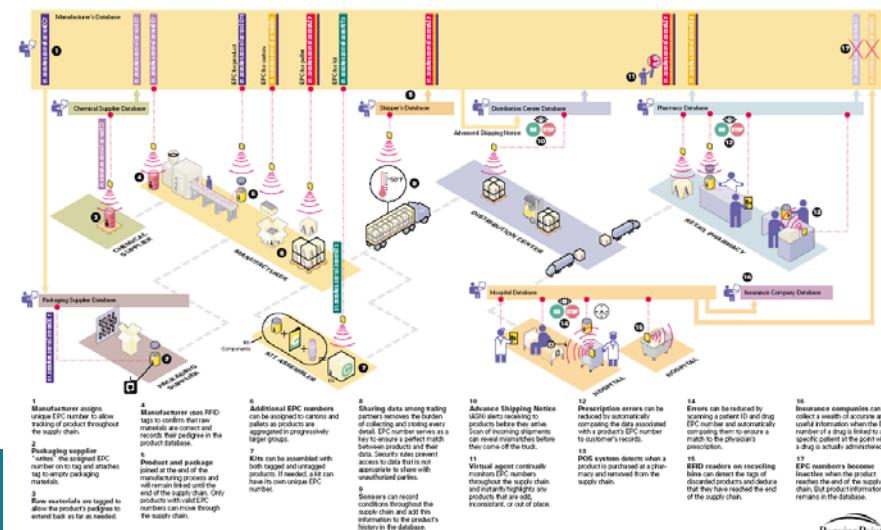
Electronic data interchange (EDI)



HOW MARKS & SPENCER WILL USE RFID TO IMPROVE STOCK AVAILABILITY



How RFID Technology Protects Pharmaceutical Supply Chain



EXAMPLE



Medical instrumentation



Lottracking medication



Administration of medication



Monitoring refrigerators



Clothing

Materials (asset) management



Inventory management
Kwaliteitszorg

LEUVEN

EXAMPLE



Clothing system



passive tag

Replenishment



Retrieval



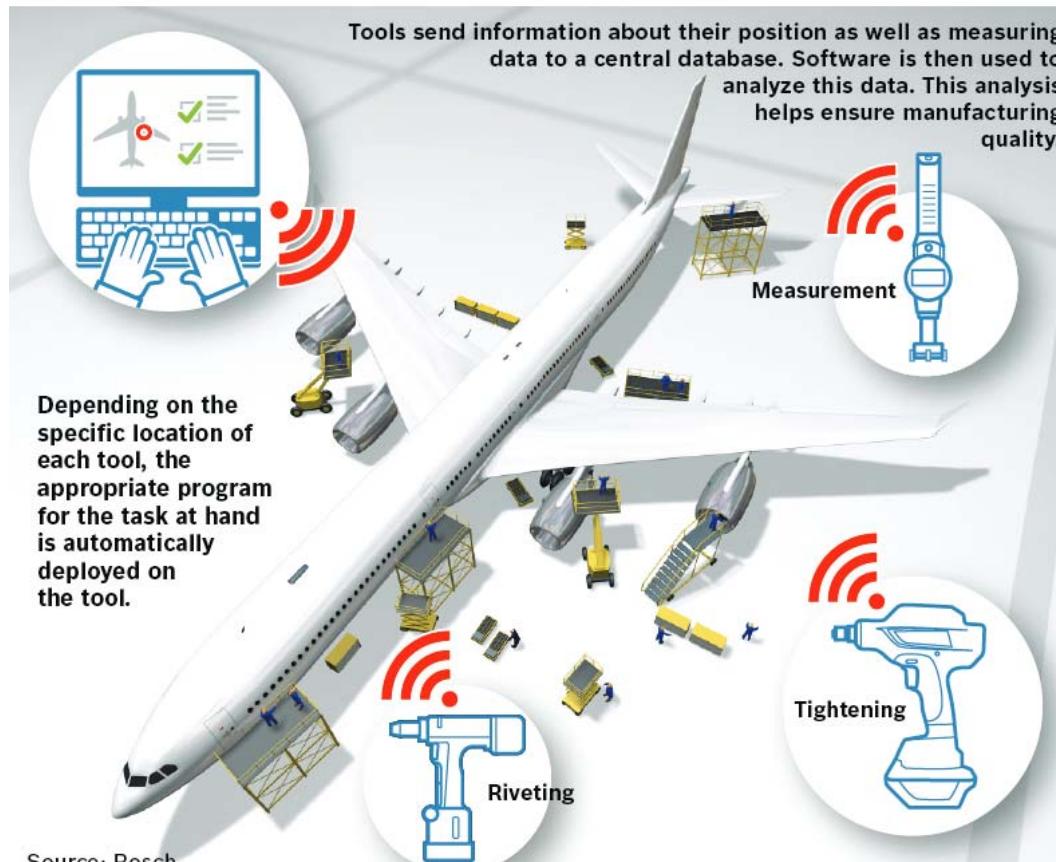
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(P. Timmermans, 2017)

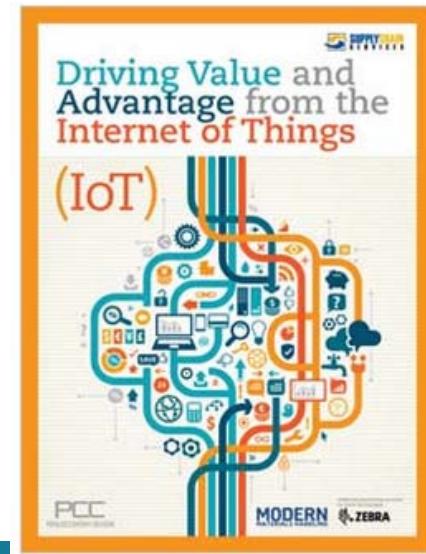
EXAMPLE

Connected tools in manufacturing

In the international Track and Trace project, Bosch and its partners in the Industrial Internet Consortium are exploring the interconnection and management of industrial tools.

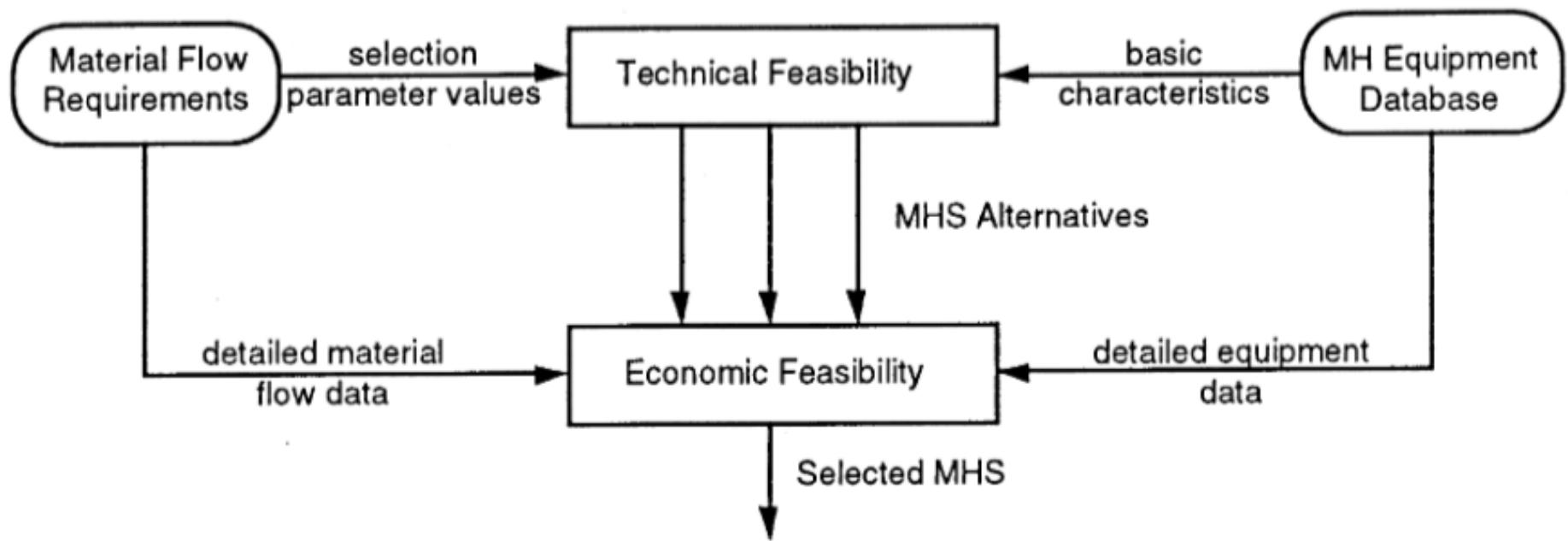


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MH equipment selection



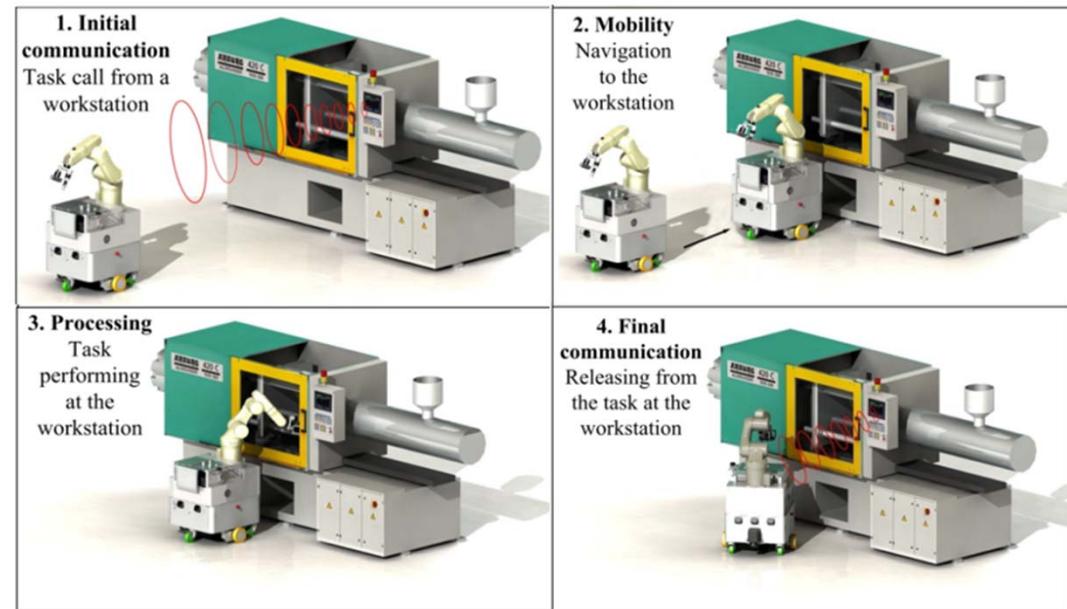
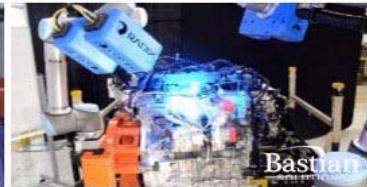
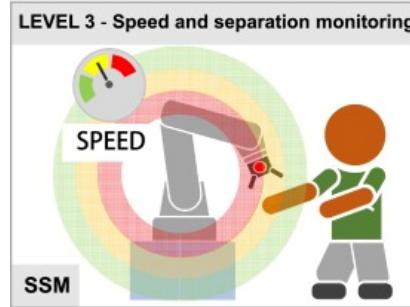
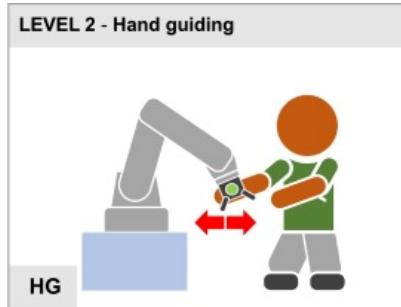
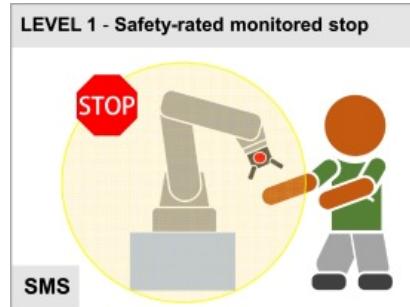
MH – system integration

Combination of equipment ... different tasks ... control ... automation



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and production



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10 MH principles



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The MHI's MH principles

10 basic principles

Concise statements of the fundamentals of MH practice

“Rules-of-Thumb”

Developed by:

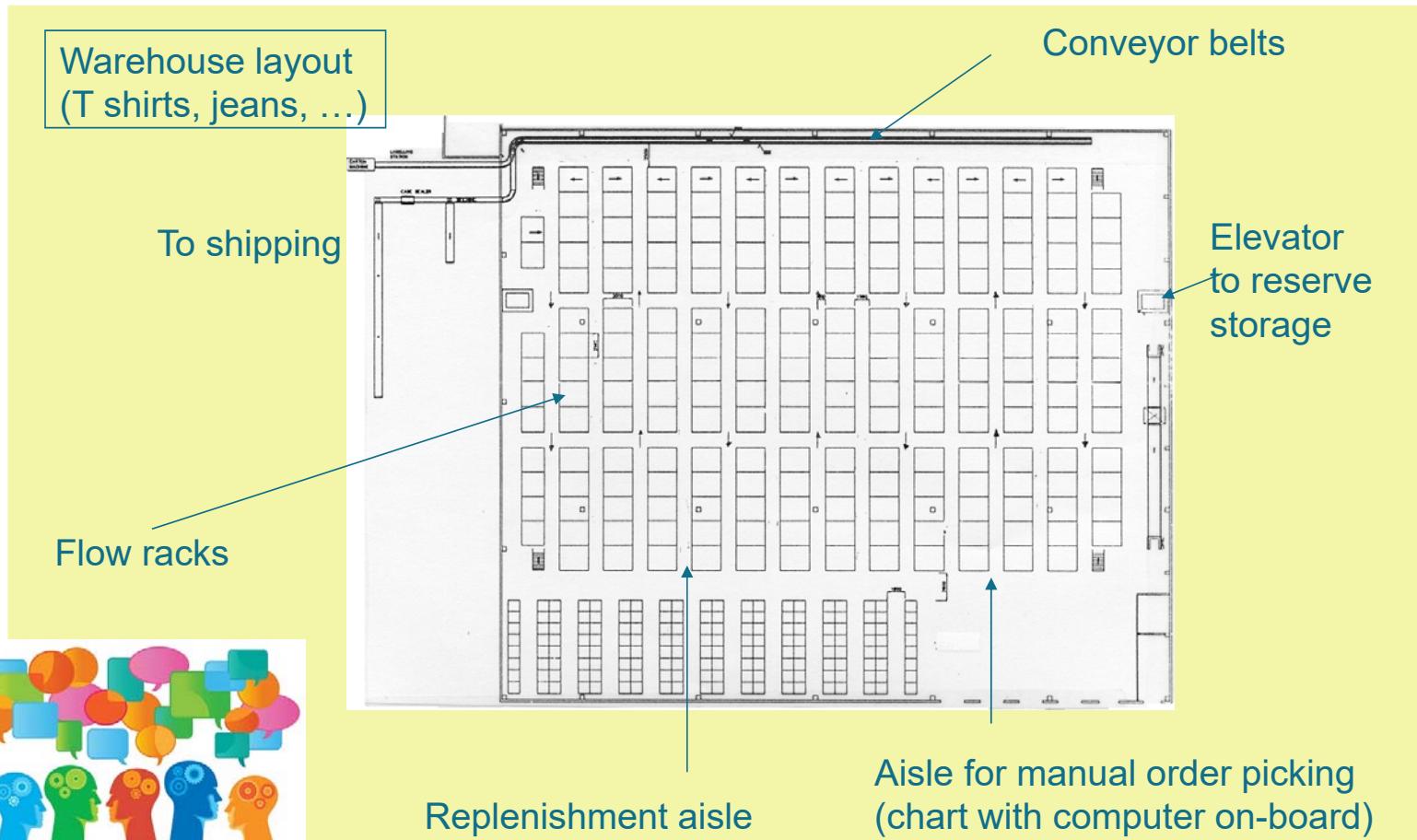
*College-Industry
Council on Material
Handling Education
(CIC-MHE)*

Reduced from 20 to 10

1. Planning
2. Standardization
3. Work Principle
4. Ergonomic
5. Unit Load
6. Space Utilization
7. System
8. Automation
9. Environmental
10. Life Cycle Cost



*Find out how the “10 material handling principles” have been applied here
(or were maybe overlooked ?)*



Management issues



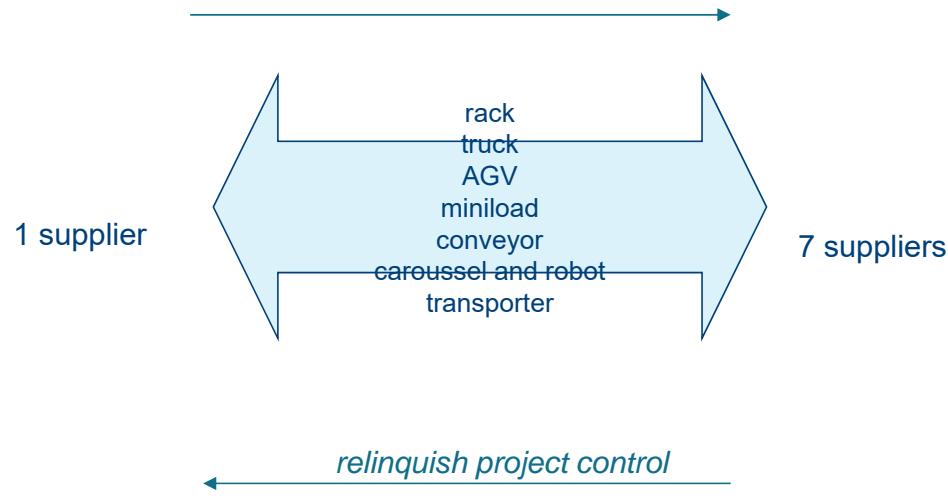
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Some considerations

Number of suppliers

Risk of incompatibility vs project control

risk of equipment and software incompatibility



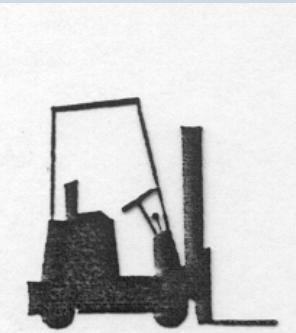
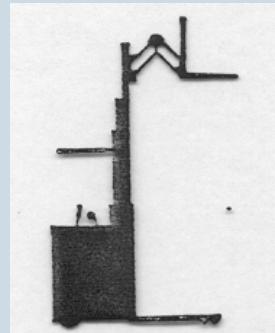
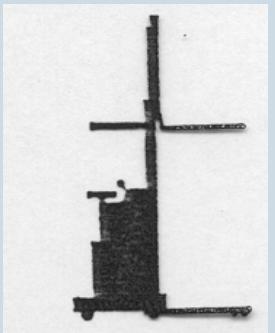
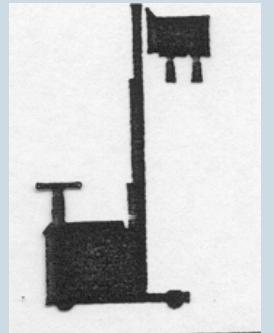
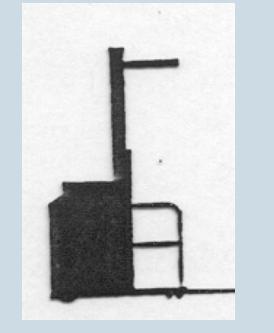
Quid system integrators



<https://www.bastiansolutions.com/solutions>

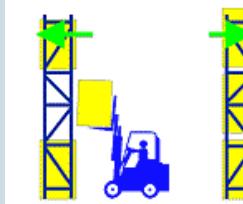
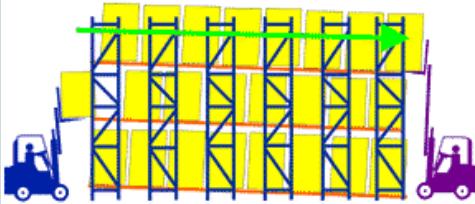
Space utilization – trucks

Trucks <> Aisles <> Layout

Counter-balanced lift truck	Reach truck	Straddle truck	Side-loader	Order-picker
				
10-15 feet aisle width	8 feet aisle width	6.5-7.5 feet aisle width	5-7 feet aisle width	4 feet aisle width

Space utilization – racks

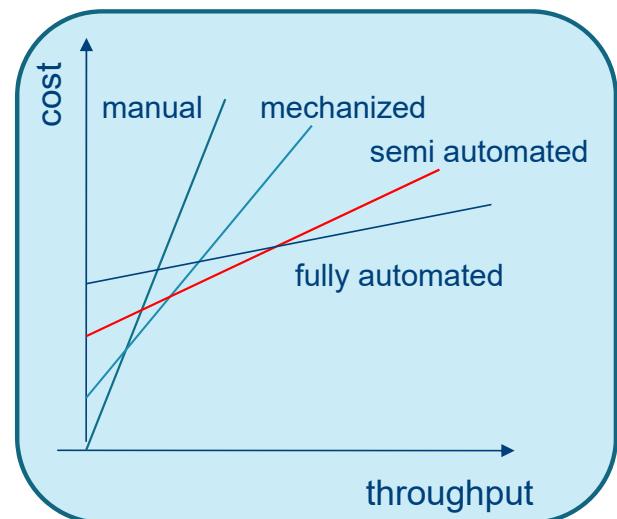
Selectivity vs Density

One deep pallet rack	Flow-through rack	Push back
		
Narrow-aisle truck	Narrow-aisle truck	Narrow-aisle truck
100 % selective storage	FIFO storage	LIFO storage
Total of 4800 pallets	Total of 8160 pallets	Total of 8160 pallets
10 aisles	3 aisles	3 aisles
4 ft ² per pallet	2.3 ft ² per pallet	2.3 ft ² per pallet
40-ft-high building with available storage area of 160 ft * 120 ft and a pallet load of 40 in * 48 in * 48 in high		

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Appropriate level of automation

level	<u>control</u>	<u>power (physica l)</u>	description characteristics
1	manual	manual	hand
2	manual	manual	hand equipment
3	manual	manual	mechanized hand equipment
4	manual	gravity	gravity
5	manual	external	power equipment, hand control
6	manual	external	power equipment, remote hand control
7	automatic	external	power equipment, program control
8	automatic	external	power equipment, feedback control
9	automatic	external	adaptive systems
10	automatic	external	fully automated systems



MABA –MABA
MenAre BetterAt –Machines Are BetterAt

- | | |
|----------------------|---|
| Speed | ● |
| Memory | ● |
| Sensing | ● |
| Perceiving | ● |
| Reasoning | ● |
| Consistency | ● |
| Computation | ● |
| Power Output | ● |
| Information Capacity | ● |

TheFittsList, 1951

Productivity measures

Examples-1

$$MHL = \frac{\text{personnel assigned MH}}{\text{total operating personnel}}$$

$$HEU = \frac{\text{items moved per hour}}{\text{theoretical capacity}}$$

$$SSU = \frac{\text{storage space occupied}}{\text{total storage space available}}$$

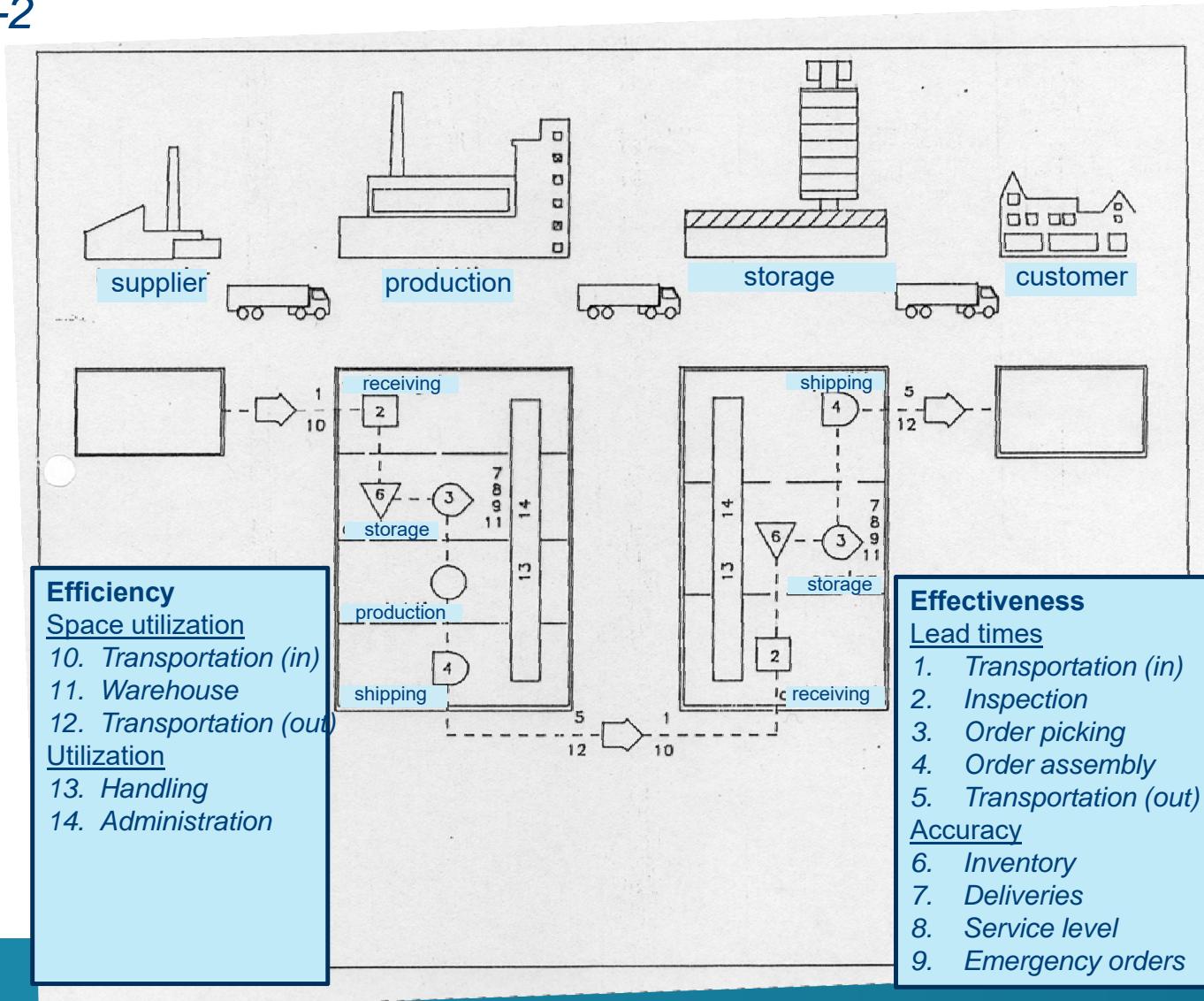
$$ASP = \frac{\text{space occupied by aisles}}{\text{total space}}$$

$$MO = \frac{\text{number of moves}}{\text{number of productive operations}}$$

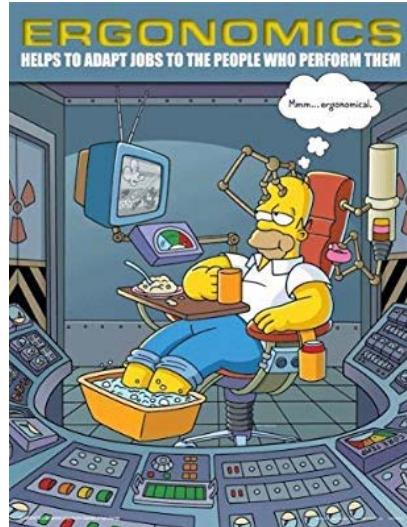
$$DL = \frac{\text{number damaged loads}}{\text{total number of loads}}$$

$$ER = \frac{\frac{\text{total energy consumption}}{\text{in warehouse}}}{\text{warehouse space}}$$

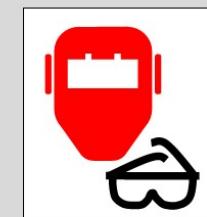
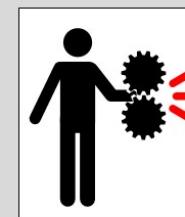
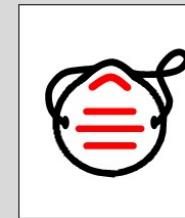
Example-2



Human factor



OSHA's 2018 Top 10 Most Frequently Cited Violations



General guidelines

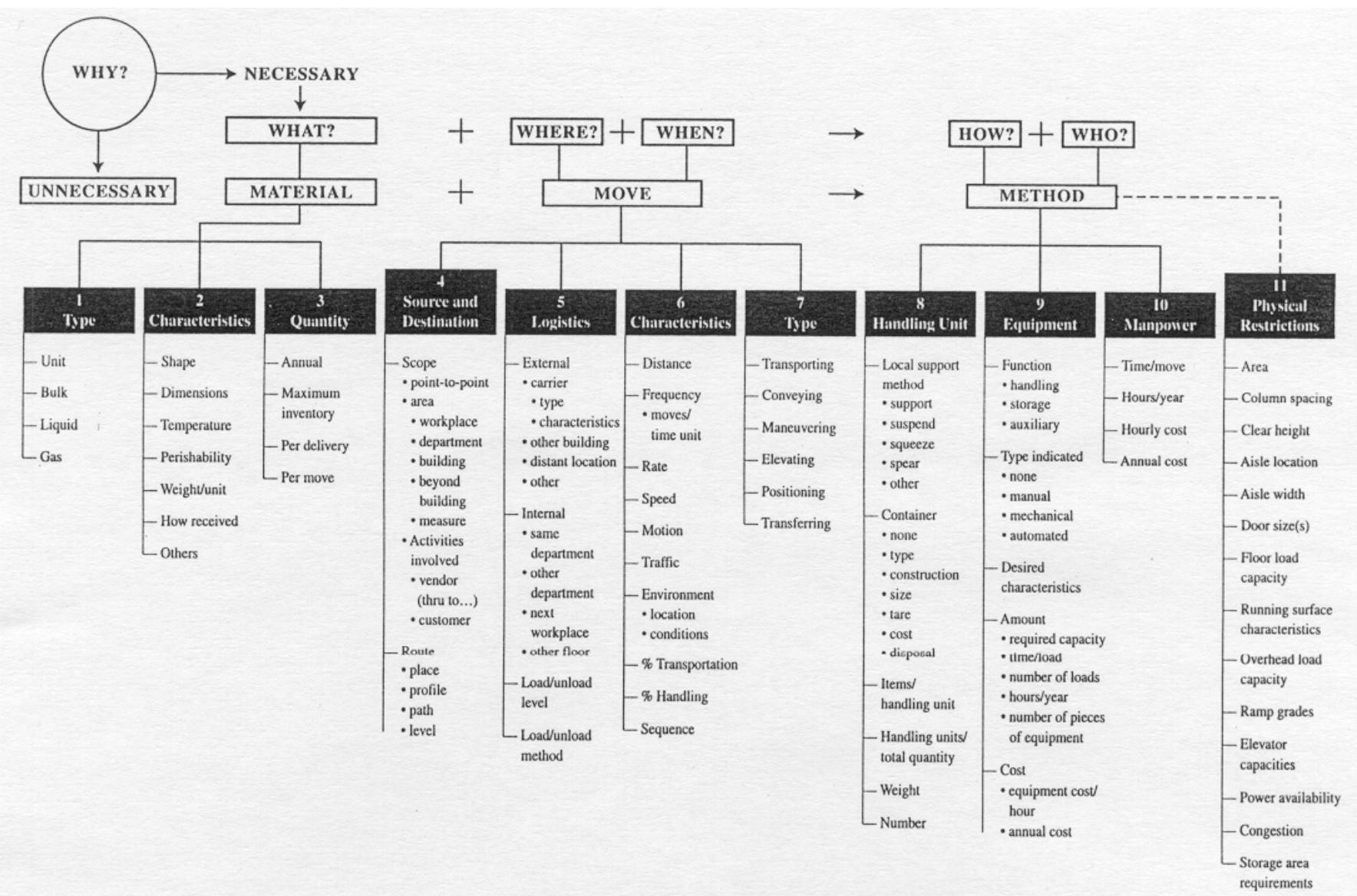
Ask many questions before you start
using the *MH* equation (Kipling based)
5W1H: what-when-why-who-where-how

using a *checklist* from “literature”



104

- Backtracking in material flow path
- Built-in hindrances to flow
- Cluttered aisles
- Confusion at the dock
- Disorganized storage
- Excess scrap
- Excessive handling of individual pieces
- Excessive manual effort
- Excessive walking
- Failure to use gravity
- Fragmented operations
- High indirect labor costs
- Idle machines
- Inefficient use of skilled labor
- Lack of cube storage
- Lack of parts and supplies
- Long hauls
- Material piled up on the floor
- No standardization
- Overcrowding
- Poor housekeeping
- Poor inventory control
- Product damage
- Repetitive handling
- Service areas not conveniently located
- Trucks delayed or tied up
- Two-person lifting jobs



Illustrations



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**STORAGE EQUIPMENT
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<https://www.youtube.com/watch?v=ruBv8jpGh4Y>

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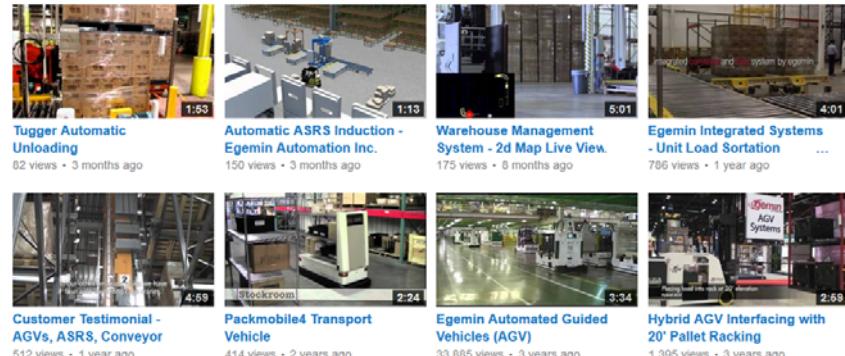


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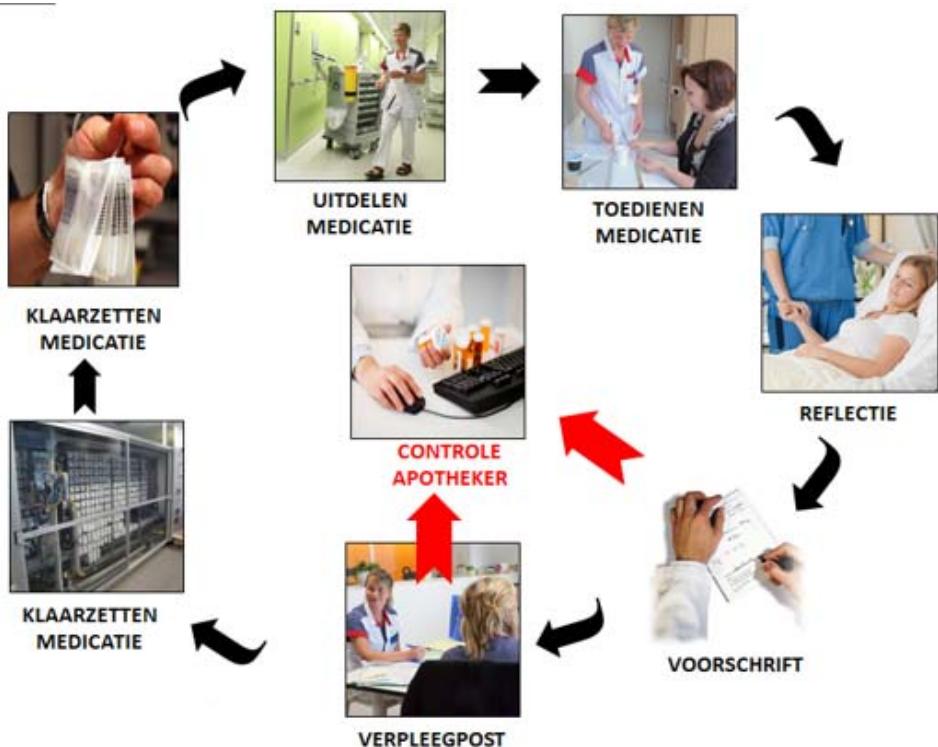


<https://www.youtube.com/watch?v=rv-Y0-ruzI8>



<https://www.youtube.com/watch?v=wC4viTSVXoA>

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*Process: distribution
Sector: healthcare*

Reden automatisatie:

Voordelen/nadelen:

Uitdagingen:

Syste(e)m(en):

Lessons learned (algemeen – specifiek):

De “10 MH principles” toegepast:

<https://www.youtube.com/watch?v=6dmnBef9ufk>



Case studies



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Case study examples



Hawkins

Jaw



Acme

Rosemarie



White

PalletFlo



Case study I

SITUATION

The Hawkins Supply Company is currently faced with an inventory rotation problem. This difficulty stems from the fact that some supplies must be used prior to a stated expiration date. Upon receipt, a new shipment of these perishable items must be stacked beneath the boxes that are currently in inventory. A substantial amount of time is consumed in restacking the items according to their expiration dates.

QUESTION

The company would like to reduce the double and sometimes triple handling of items. How can this goal be achieved? Are there alternative solutions which might be effective?



Case study II

SITUATION

The JAW Bottling Company has recently introduced a new beer to the market called HEAVY. It is extra high in calories. It has been developed specifically for those people that enjoy feeling full after only one beer.

The materials handling supervisors at JAW Bottling have been receiving complaints from lift truck drivers that cases of the new HEAVY beer are slipping off pallets during intra-plant movement and truck deliveries.

QUESTION

How can the case slippage problem be solved?





Case study III

SITUATION

The Acme Warehouse Company received a consignment of 20' lengths of 3" diameter stainless steel pipes. Acme had never handled pipe as part of their warehousing operation. The forklift truck operator assigned to this job used the truck's forks as a ram to load, handle, and unload the pipe. Inspection of the pipe by the owners revealed that the forks were bending and damaging the pipe.

QUESTION

Suggest several alternative methods for eliminating the problem of pipe damage. From a cost and ease in application standpoint, select one alternative solution for adoption.



Case study IV

SITUATION

The Rosemarie Cosmetic Company has a warehouse of 20 high pallet racks serviced by counter balanced fork trucks. The aisles between racks are 12 feet wide.

Storage space has become a premium with new product lines being added. A warehouse expansion is currently being planned.

QUESTION

How can the warehouse handling system be improved without expanding the warehouse?

Case study V

SITUATION



The White Manufacturing Company produces a spring loaded replacement spike for power rakes. Because of the small size of this item, they are packaged in separate small containers that are in turn packed into a larger carton (24 count) for shipping. The packing operation for this unit is one the third floor of a multistory building.

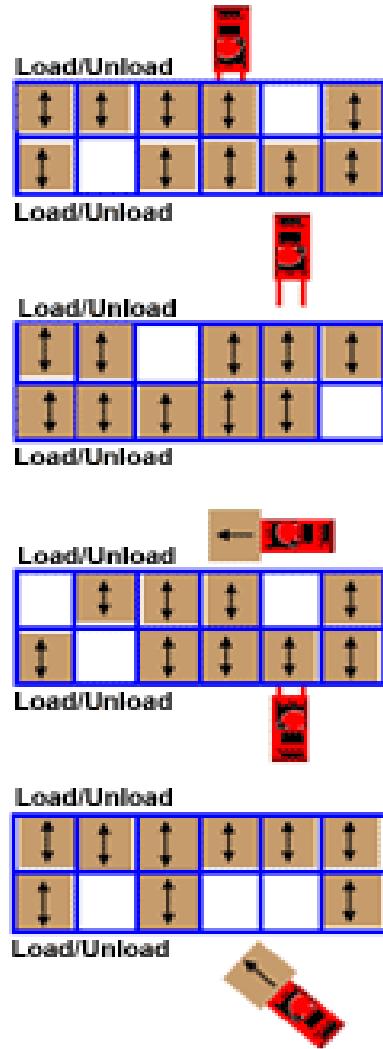
Upon completion of the packing operation the shipping cartons are placed on semi-level skids and taken to the second floor using an elevator. The same elevator is also used to move other materials to various floors in the plant for processing. On the second floor packages are sorted according to trucking line. After sorting, all packages are placed on a semi-live skid and moved to the first floor via the same elevator. On the first floor, the packages are stored awaiting shipment (pick up by the assigned truck line).

QUESTION

Disregarding labor requirements, how can the movement of packages be improved?

Case study VI

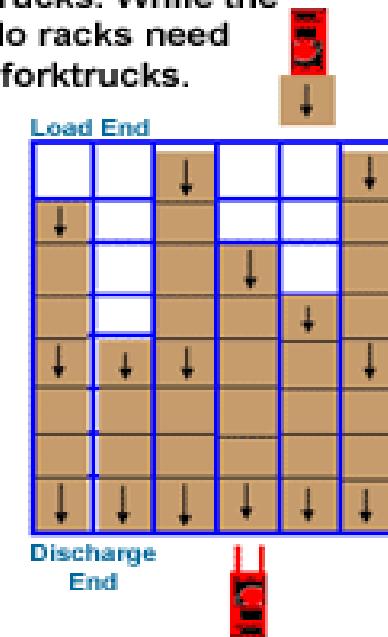
Comments on this ad?



Palletflo Racks Saving space & equipment

Each of the warehouse rack
setups have 144 pallet
positions per level.

The standard racks need
5 forklifts. While the
Palletflo racks need
only 2 forklifts.



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Wrap-up



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Important issues

What is MH and why is it important?

What about MH equipment taxonomy? What are commonly used MH equipment types? Where/when are they used?



<http://mhwebportal.org/taxonomy>

Ten MH principles: what do they tell?

Management issues: Things to think about – Complex interaction

Case studies: applying the above in a real life situation?