Materials Handling and Warehousing

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Ekstern Lektor

Agenda

Distribution Structures and Warehousing

- Warehouse layouts and warehousing concepts
- Value adding activities,
  Cross Docking and Merge-in-Transit
- Warehouse management systems (WMS)
- Materials handling, storage and order picking
- Work organization and job design

Logistics Performance

Inventory turnover, cash-to-cash-cycle, supply chain ratio

Readings and Learning Objectives

CBS COPENHAGEN BUSINESS SCHOOL HANDELSHØJSKOLEN

Readings:

Textbook 4th ed. Chapter 11

Baker, P. (2007): An exploratory framework of the role of inventory and warehousing in international supply chains, *IJLM* Vol.18, No.1, pp. 64-80.

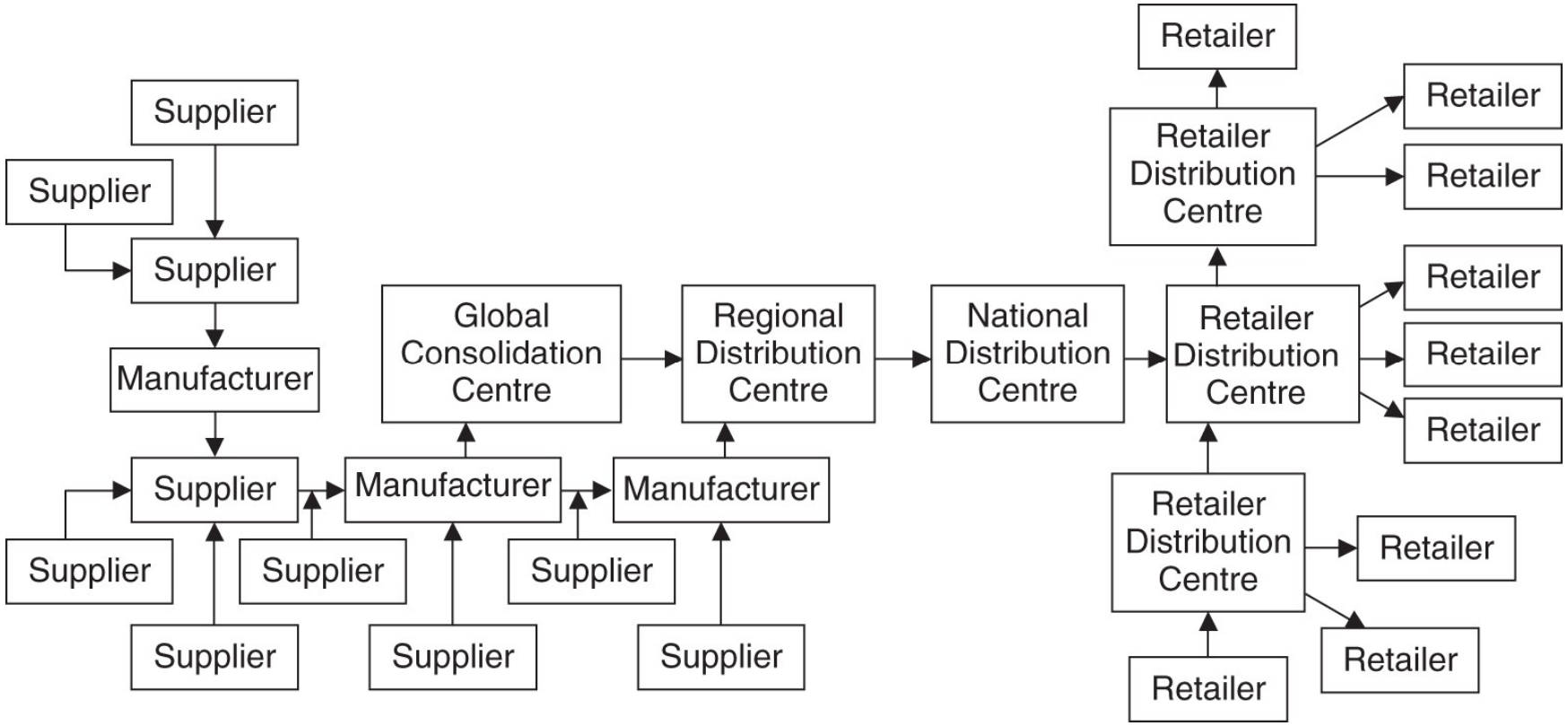
Johnson, M. and Templar, S. (2011): The relationships between supply chain and firm performance: The development and testing of a unified proxy, *IJPDLM* Vol.41, No.2, pp. 88–103.

Farris, M.T. and Hutchison, P.D. (2002): Cash-to-cash: the new supply chain management metric. *IJPDLM* Vol.32, No.4, pp. 288-298.

Learning Objectives:

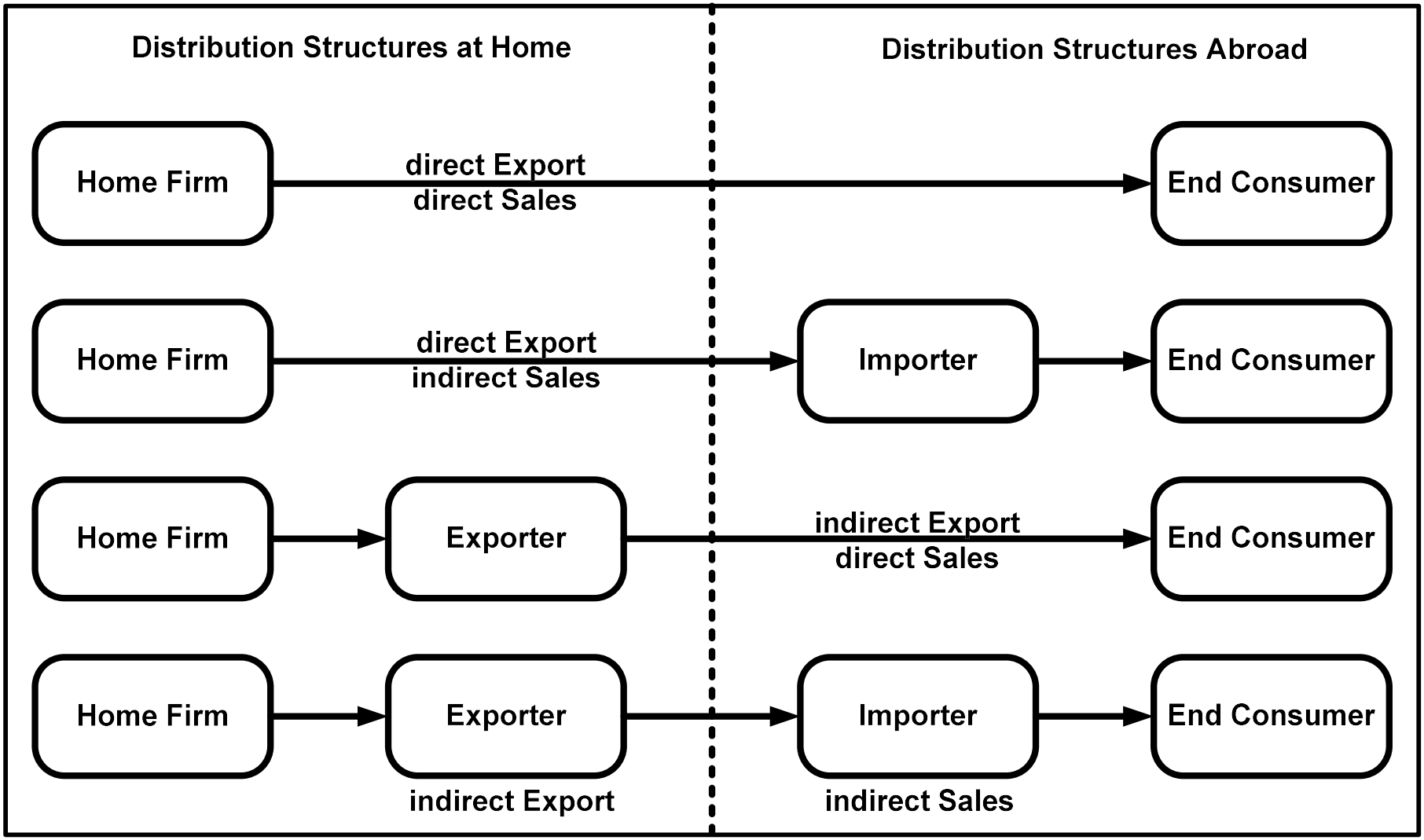
- Define the role of warehousing in global supply chains.
- Get insights into how warehouses are managed and how they add value to supply chains.
- Explain how material handling, storage and order picking are organized and executed.
- Summarize inventory management techniques and metrics.
- Demonstrate the importance of logistics or supply chain performance metrics in a single company or supply chain context.

Warehousing in Global Supply Chains



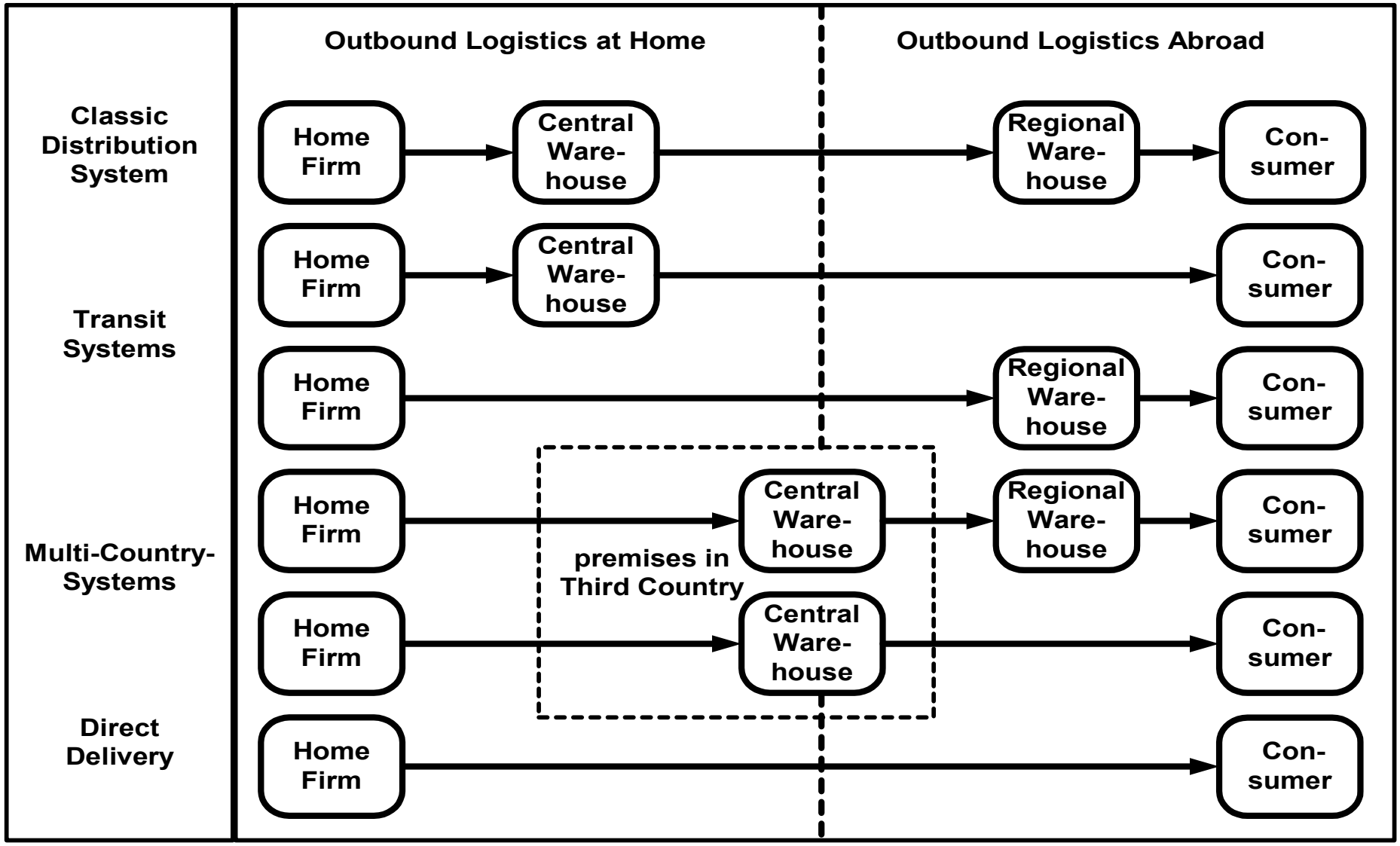
Source: Mangan et al. (2021)

International Distribution and Sales Channels



Source: Zentes und Swoboda (1997)

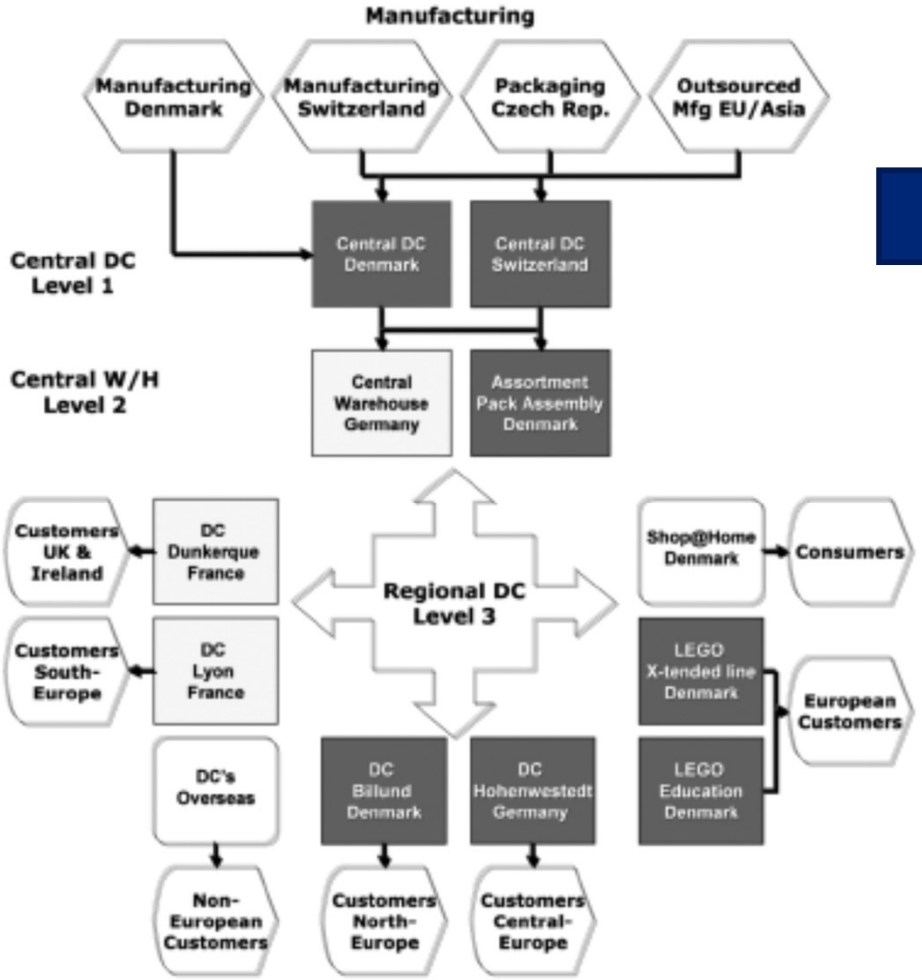
Outbound Logistics and Warehousing



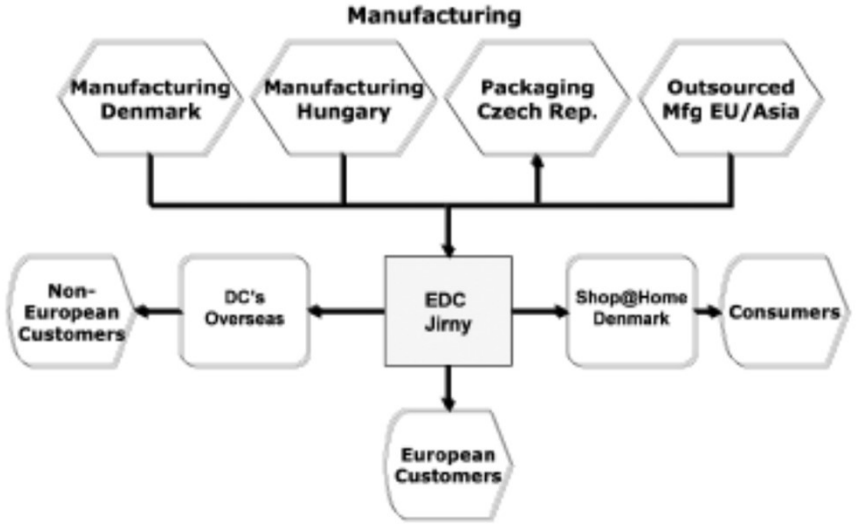
Source: Kummer, Schramm and Sudy (2009)

Example of LEGO

Complex 3-level Distribution Structure of LEGO 2004-2005



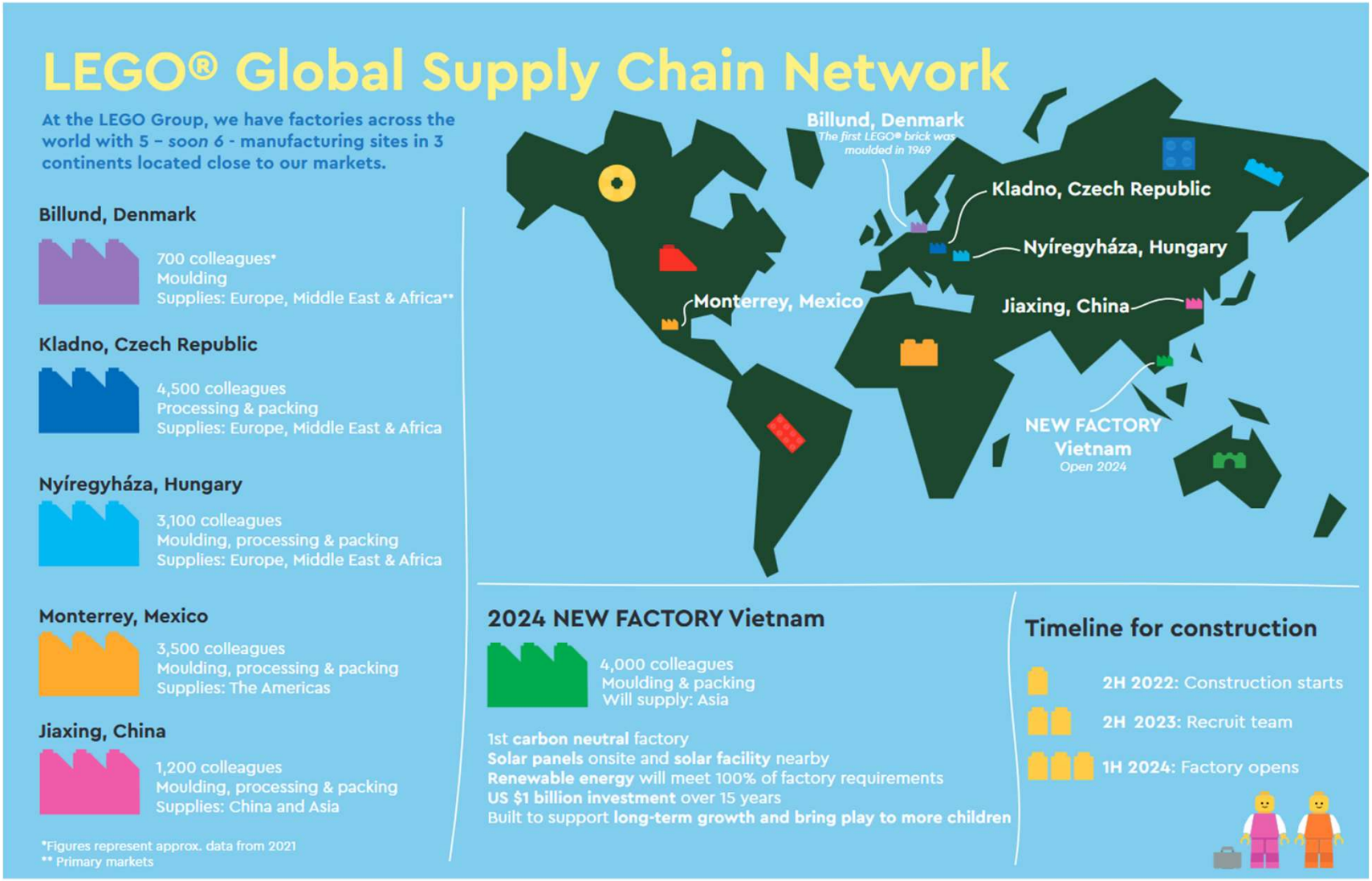
Simplified Distribution Structure of LEGO in 2007



In 2008, LEGO won the European Supply Chain Excellence Award in the „Logistics and Fulfilment“ category….

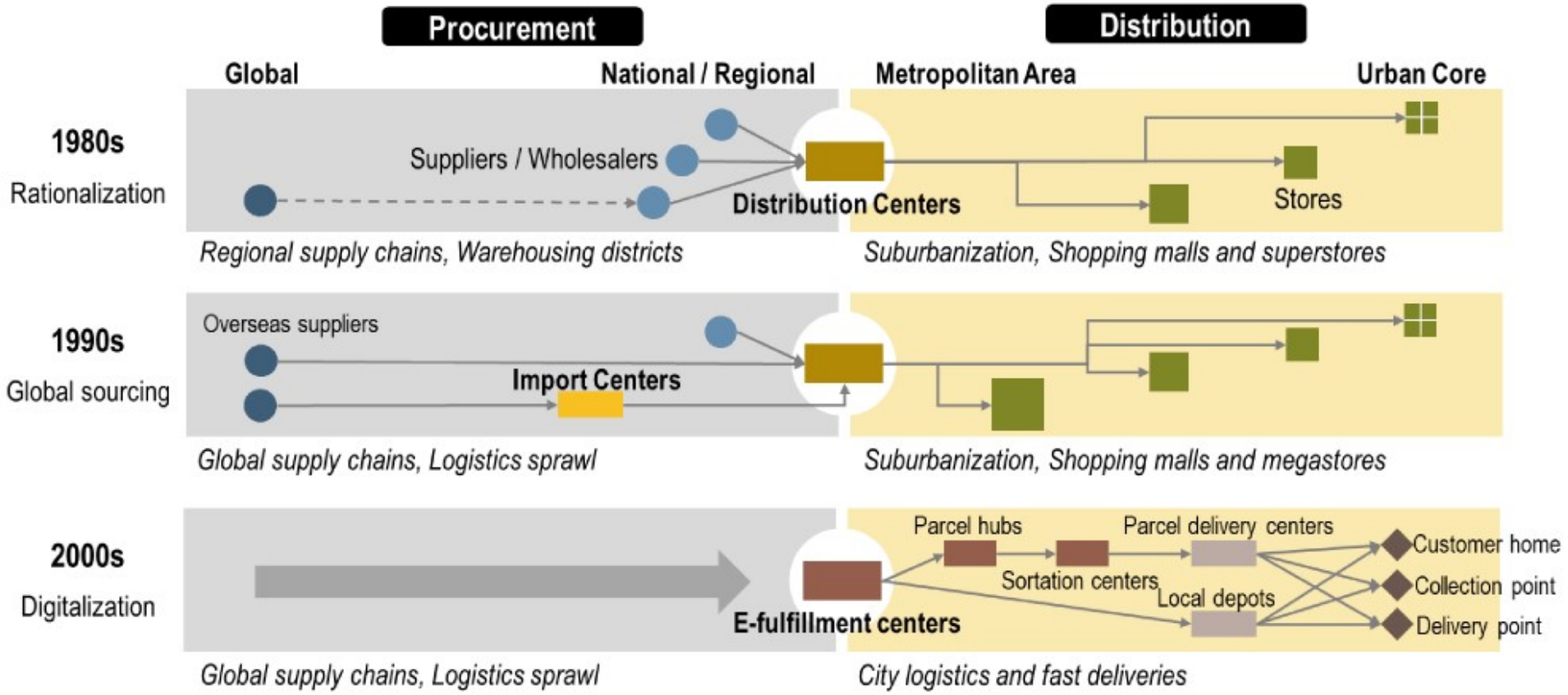
Source: Cordon et al. (2013)

Global Supply Chain Network of LEGO Today…



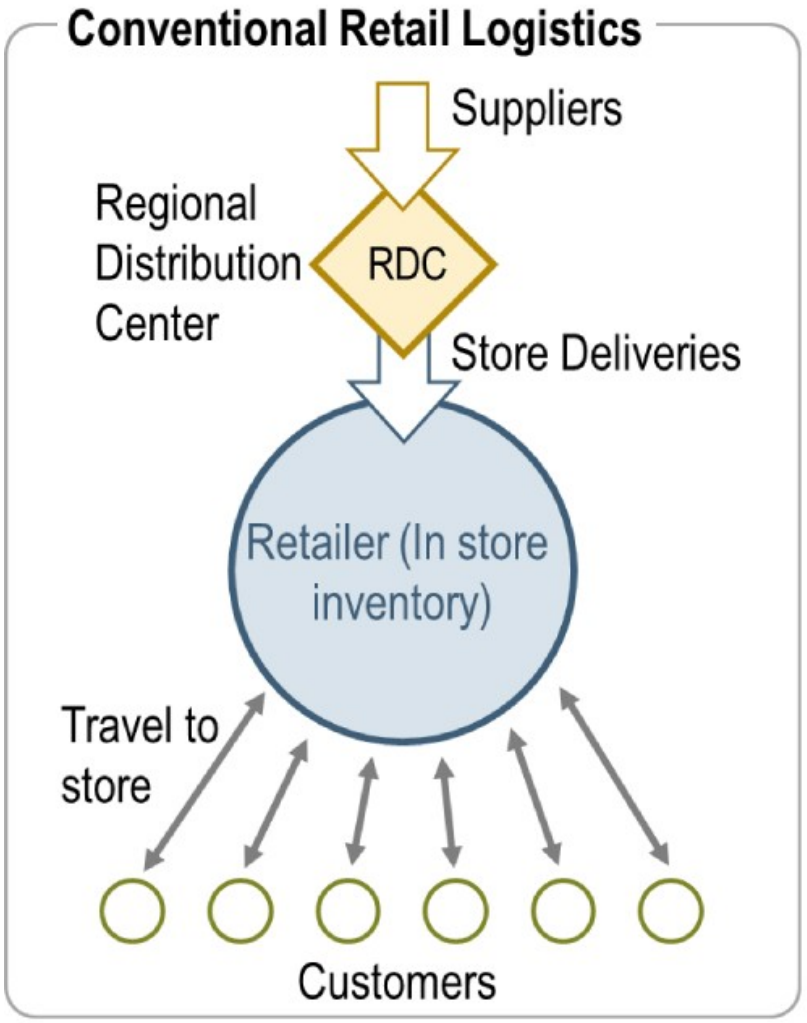
Source: https://www.lego.com/cdn/cs/aboutus/assets/bltf074cba805ec2479/EN_LEGO_Global_Supply_Chain_Network.pdf

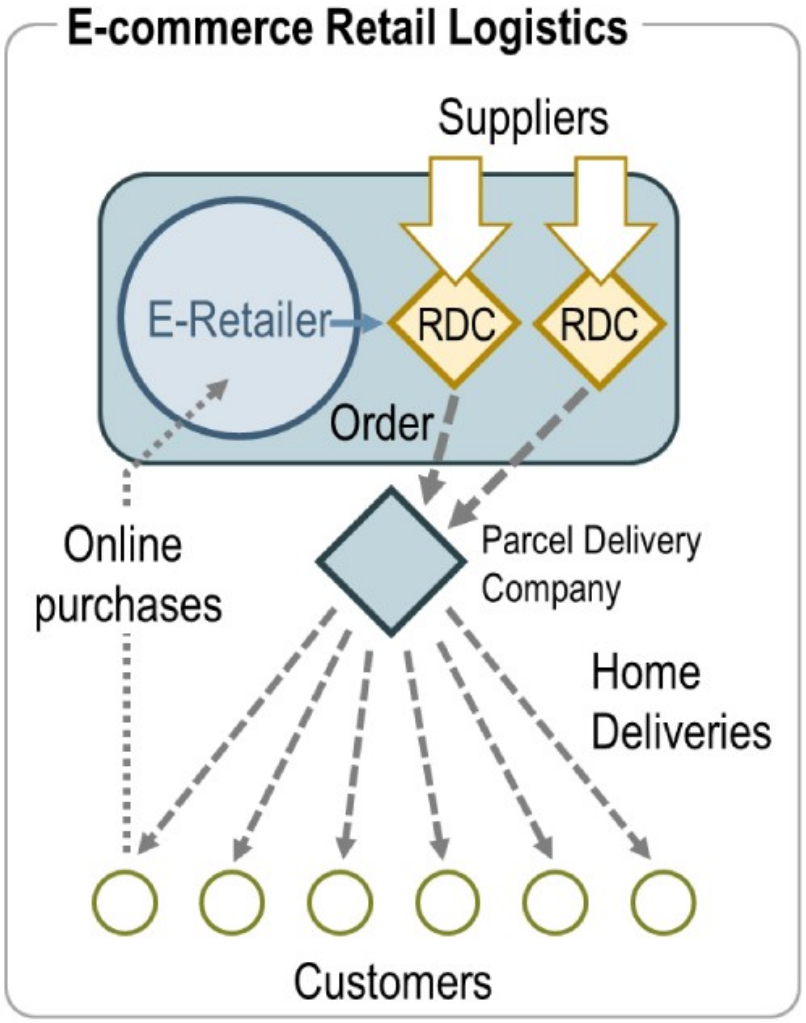
Changes of Distribution Structures over Time



Source: Rodrigue (2020)

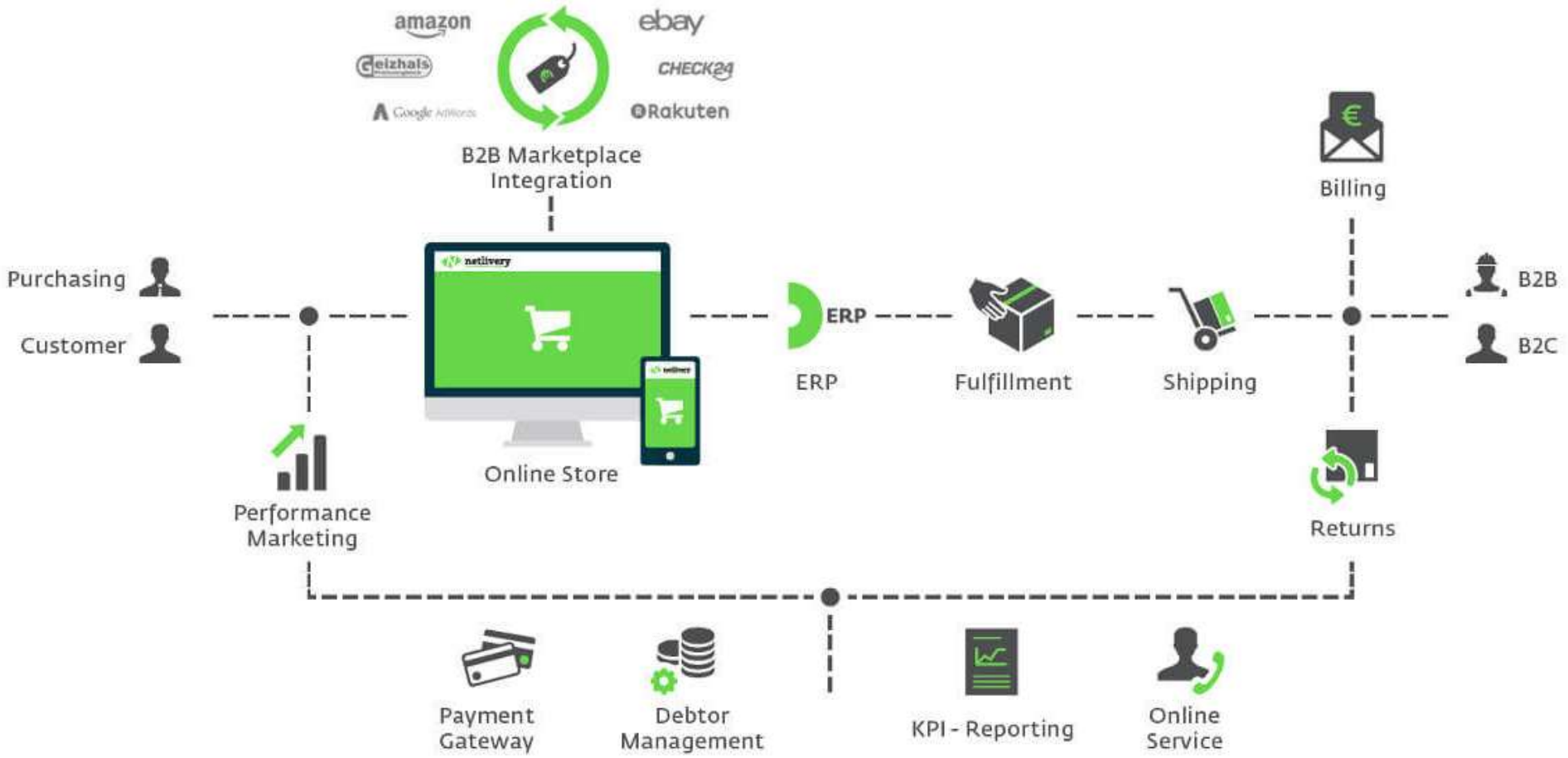
Conventional versus eCommerce Retail Logistics





Source: Rodrigue (2020)

Example of Netlivery



Or see here their youtube video:

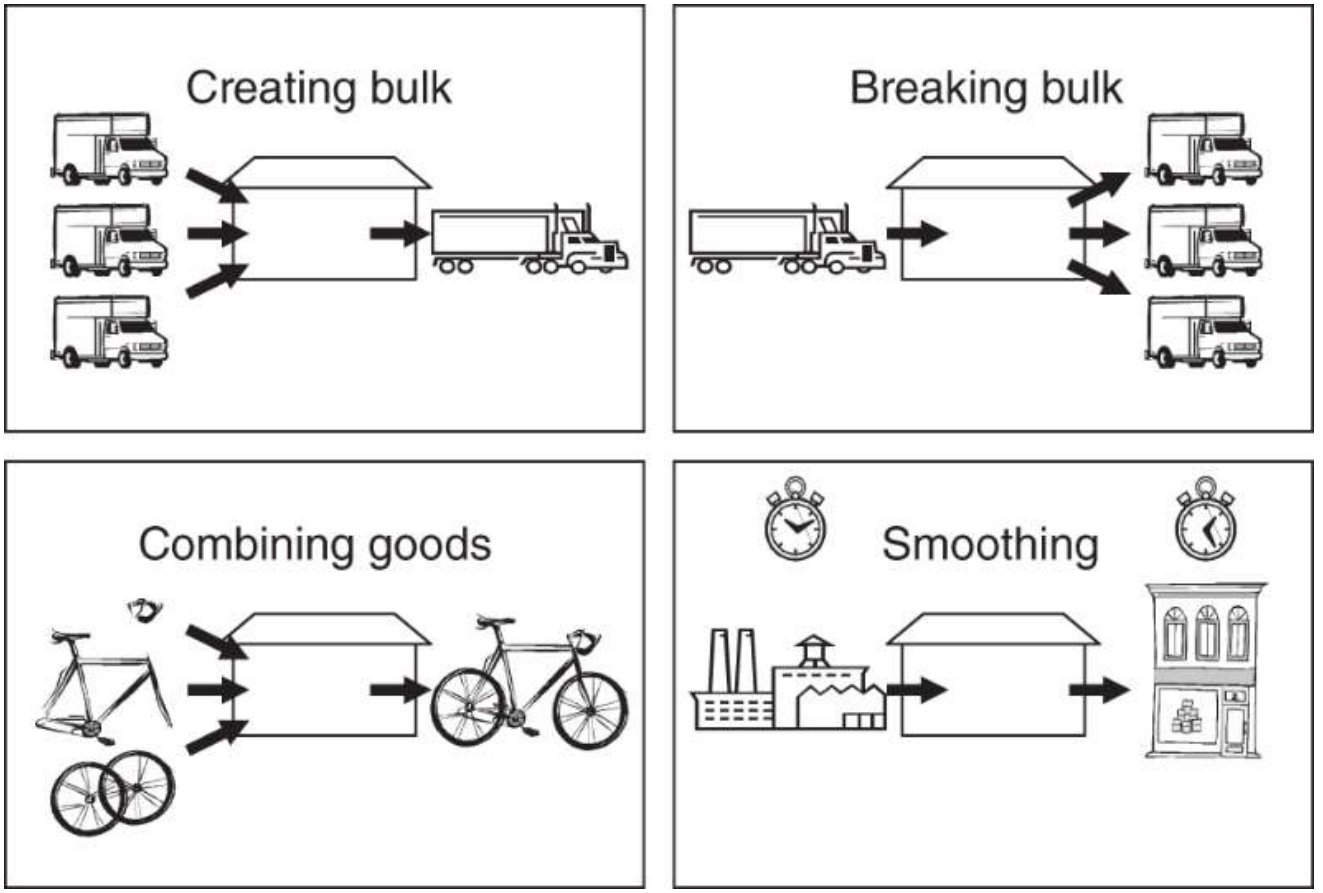
https://www.youtube.com/watch?v=QpRg0asJwUU

Value-Adding Activities

Warehousing should aim to provide value-adding services as well as minimizing operating costs.

The four principal value adding activities are:

- Creating/Breaking bulk consignments (for better trans-port economies)
- Combining freight (postponement)
- Smoothing supply to meet demand (buffer stocks e.g. in leagile supply chains))

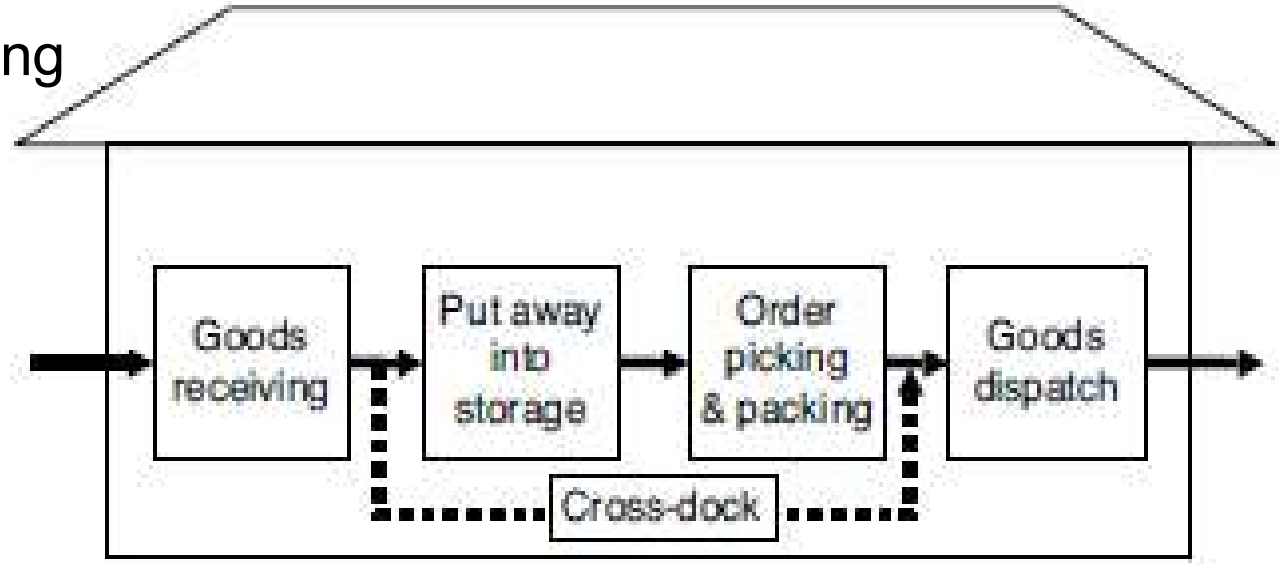


Source: Mangan et al. (2021)

Generic Warehouse Functions

All activities within a warehouse are associated with one of the following core functions of:

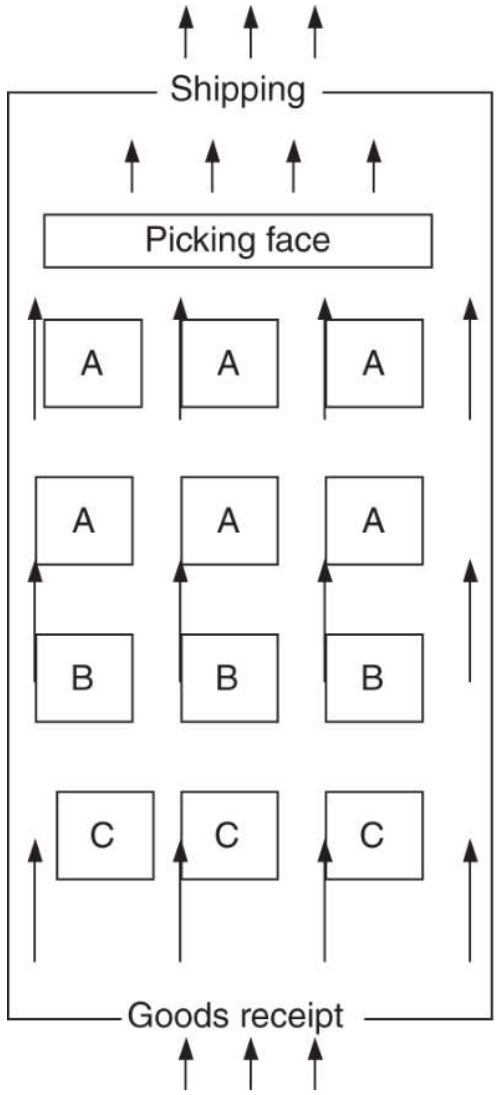
- Goods receiving
- Put away into storage
- Order picking & packing
- Goods dispatch



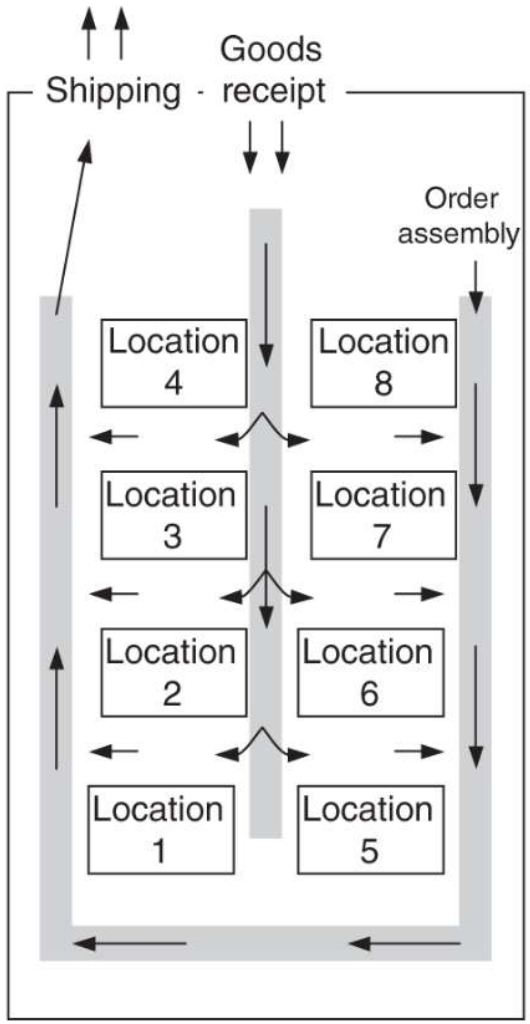
In cross docking, goods coming in bypass the storage area…

Source: Mangan et al. (2021)

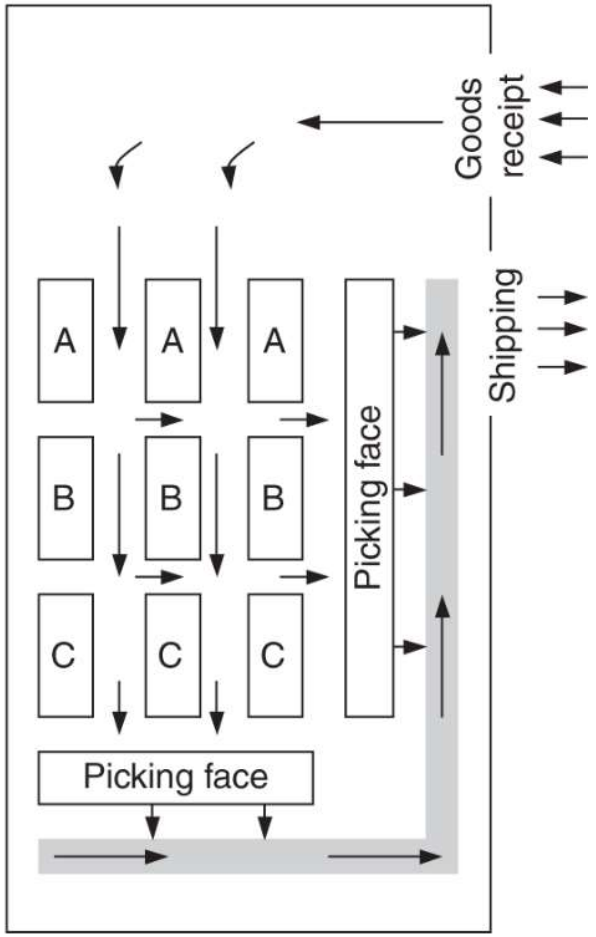
Typical Warehouse Layouts



A straight flow operation



A 'U' flow operation with conveyors

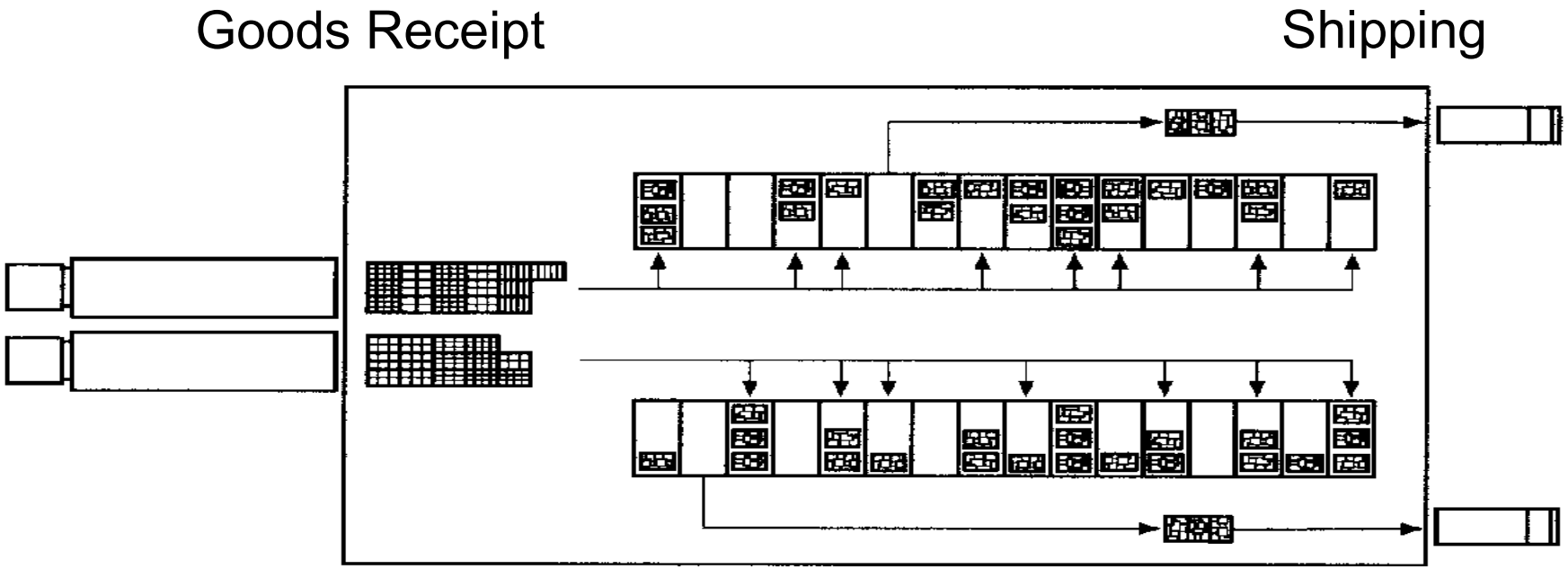


An 'L' flow operation with conveyor

Source: Warman, J. (1971) *Warehouse Management*, Heinemann, London, p. 59. Reproduced with permission of Pearson Education.

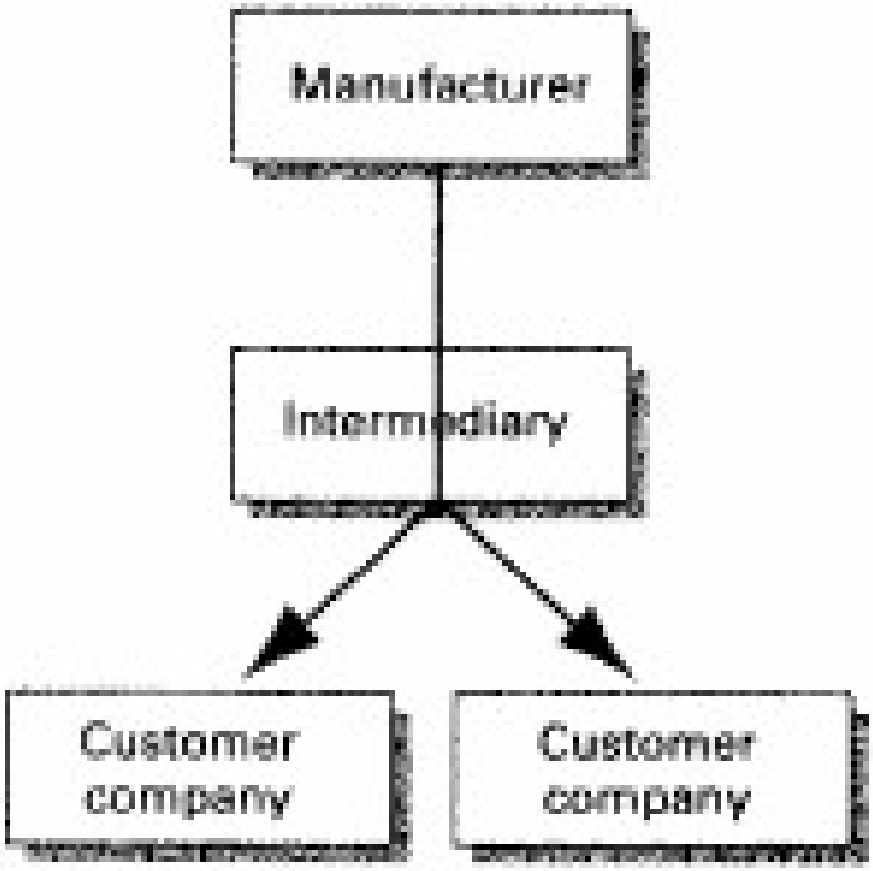
Cross Docking Layout

In cross-docking, items received at the warehouse are not received into stock, but are prepared for shipment to another location or for retail stores. Cross docking can realize a huge cost reduction by skipping storage processes.

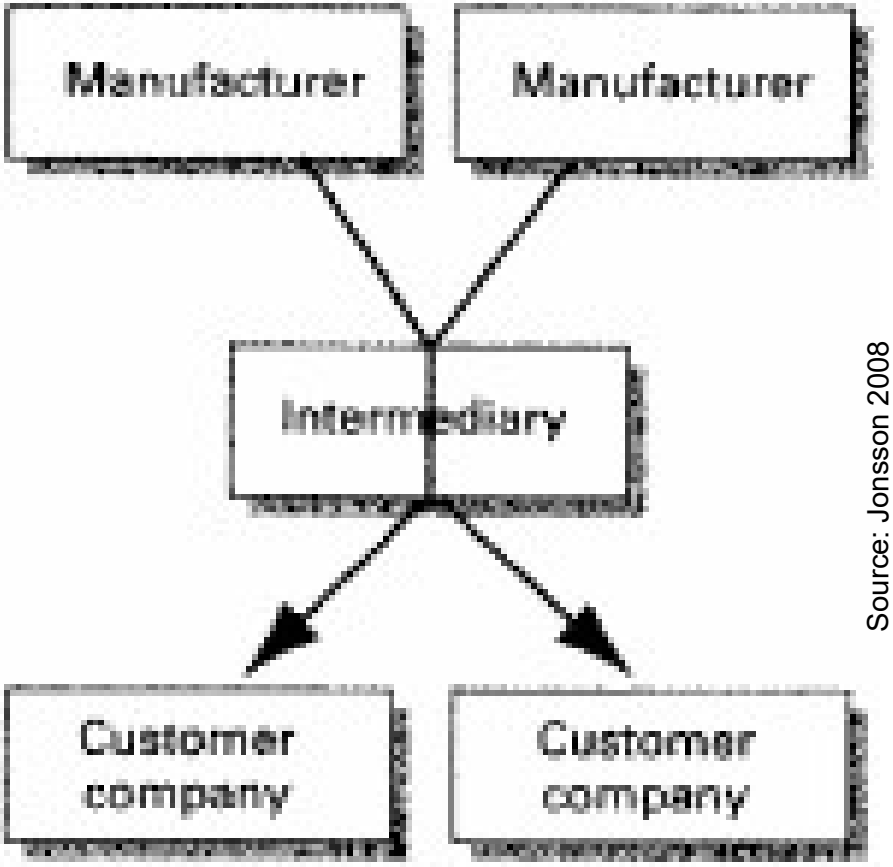


Source: Jonsson 2008

Cross Docking and Merge-in-Transit



Material flows in cross-docking



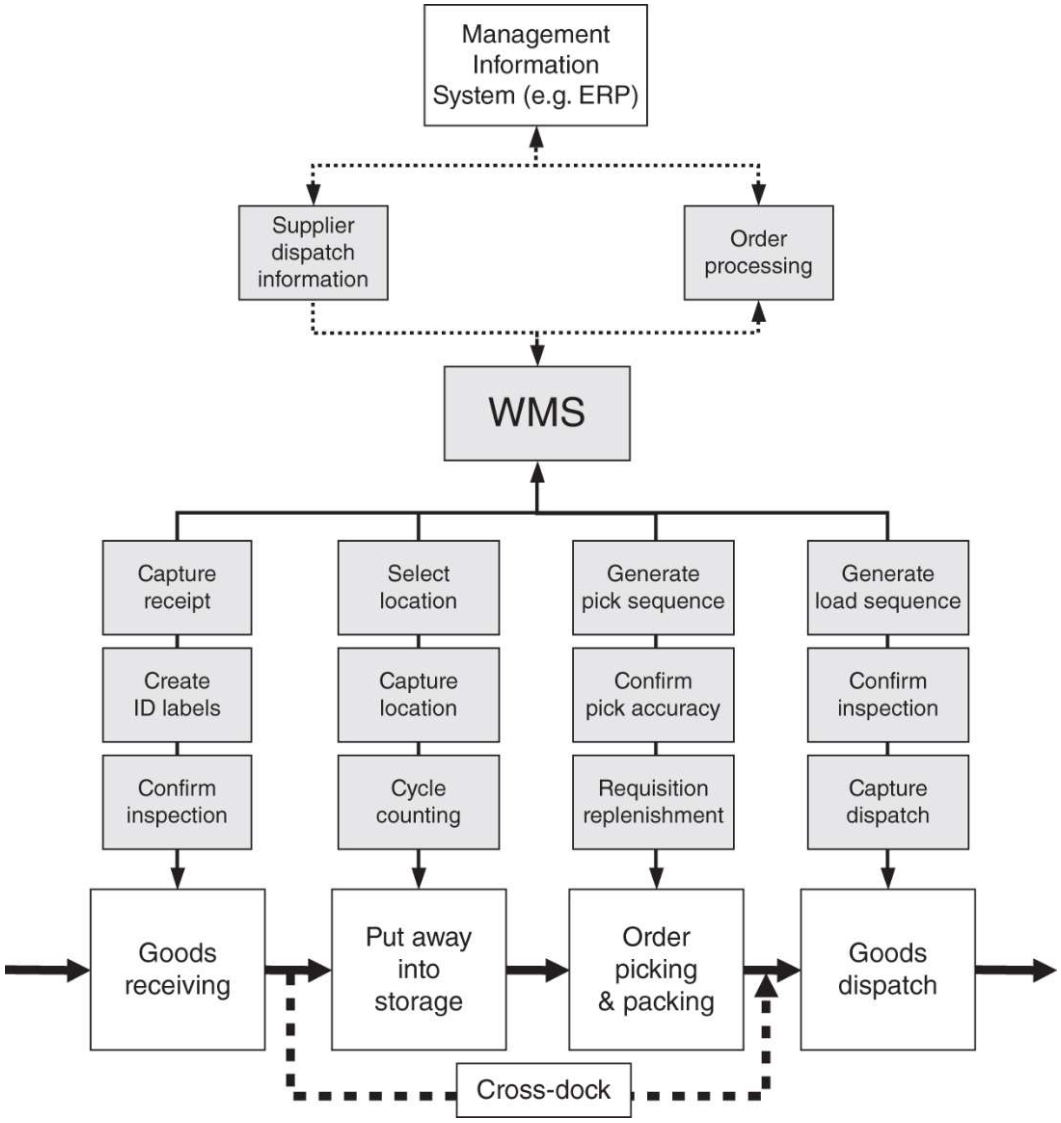
Material flows in merge-in-transit

Source: Jonsson 2008

Warehouse Management Systems

A Warehouse Management System (WMS) manages information processes and material requirements transmitted from the management information system (such as an Enterprise Resource Planning / ERP system like SAP) to:

- Trigger the right work
- at the right time across the operation
- to meet demand.



Source: Mangan et al. (2021)

Material Handling and Storage

Storage solutions vary depending on the volume, variety and throughput of freight in a warehouse of distribution system.

- Pallet storage
- Non-pallet storage

Pallets (or other sorts of unit loads) help to ease goods movements by use of **material handling equipment** (MHE).

Automated material handling improves and standardises warehouse performance by minimising human intervention.

Common Retrieval systems are

- LIFO: last-in-first-out
- FIFO: first-in-first-out

Unit Loads

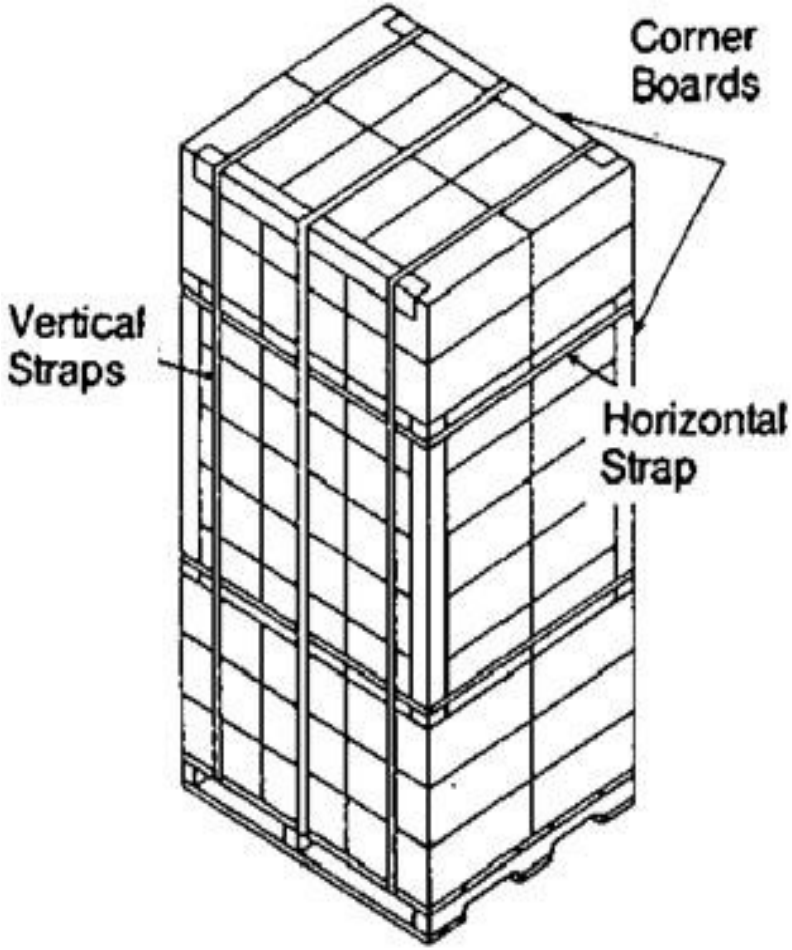
A unit load combines individual items or items in boxes etc. into a single "unit" that can be moved easily with material handling equipment.

It fits tightly into store racks, trucks, intermodal containers etc.

Most consumer and industrial products move through the supply chain in unitized or unit load form for at least part of their distribution cycle.

Unit loads make handling, storage, and distribution more efficient.

They help reduce handling costs and damage by reducing handling of individual items.



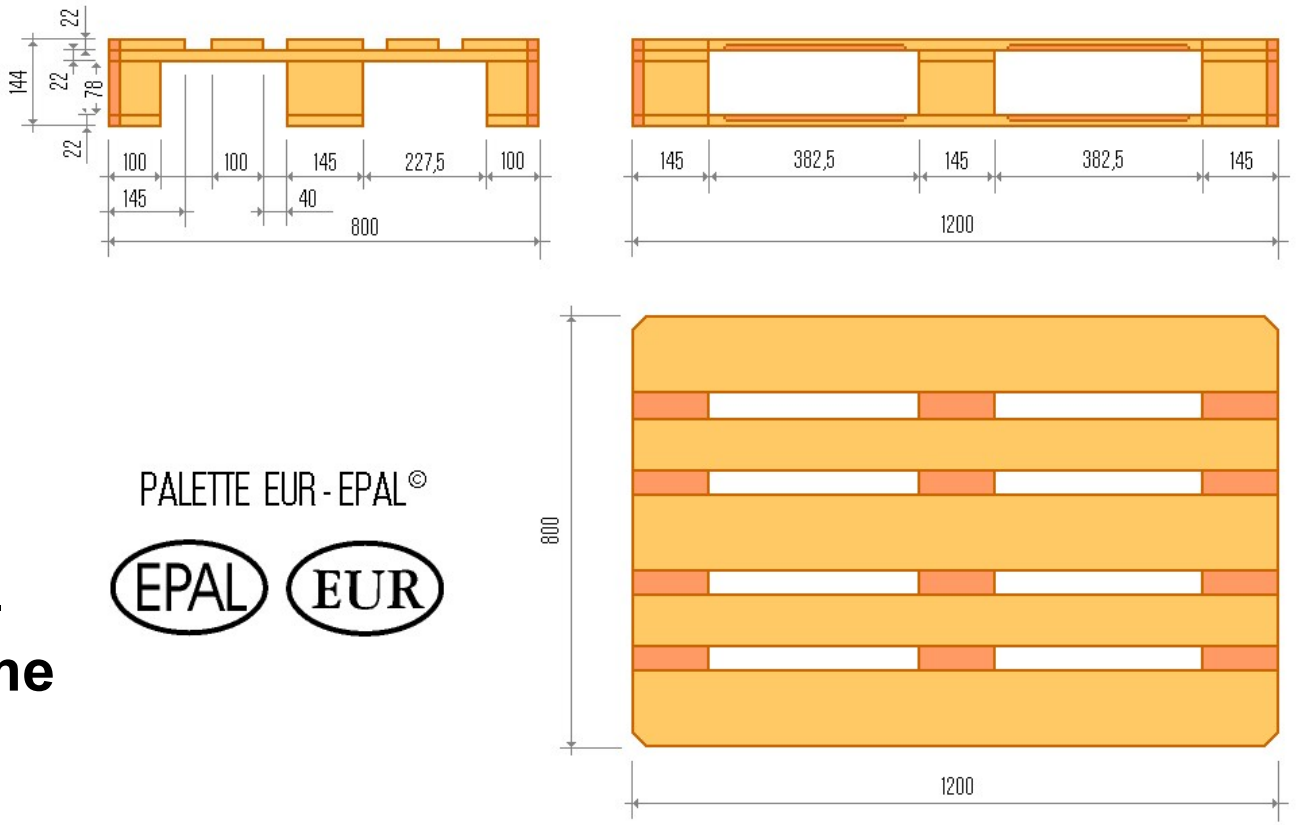
Example Europallet System

It is a **building block system**: all packages are build as modules wholly divisible by 400 x 600 mm and placed on a standardized pallet with 800 x 1,200 mm

Storage systems are designed accordingly not to waste storage space

Finally it fits then well into European trucks, waggons, containers etc.

but not in ISO-1 maritime containers (TEU/FEU)!

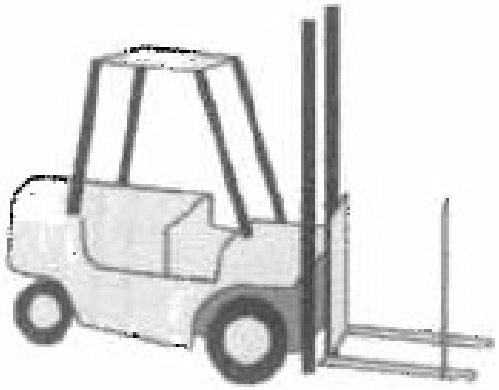


PALETTE EUR - EPAL©

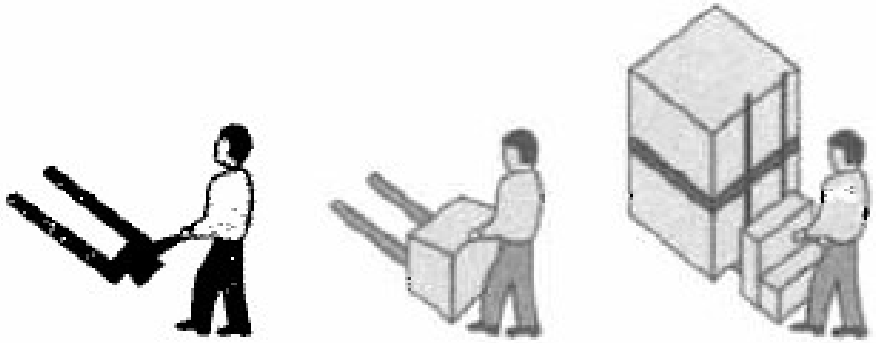
EPAL EUR

Material Handling Equipment

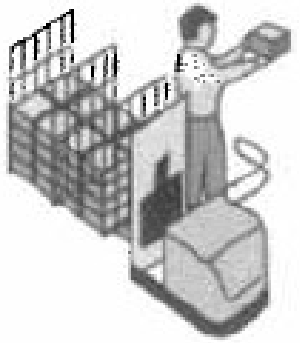
By the way, the forklift is about 100 years old! See: https://web.archive.org/web/20191211171814/https://www.clarkmhc.com/Company/History

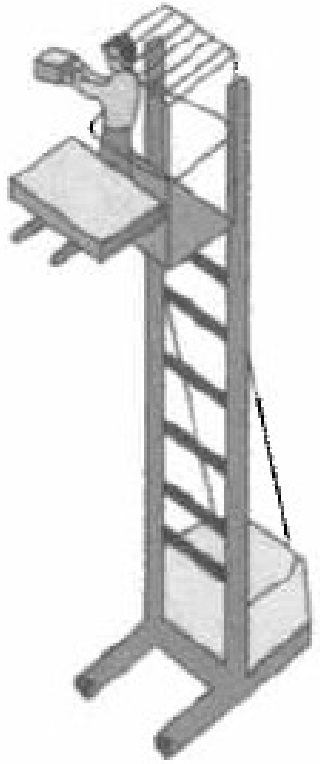


Counterbalance truck / fork lift



Lift truck, low loaders and stackers

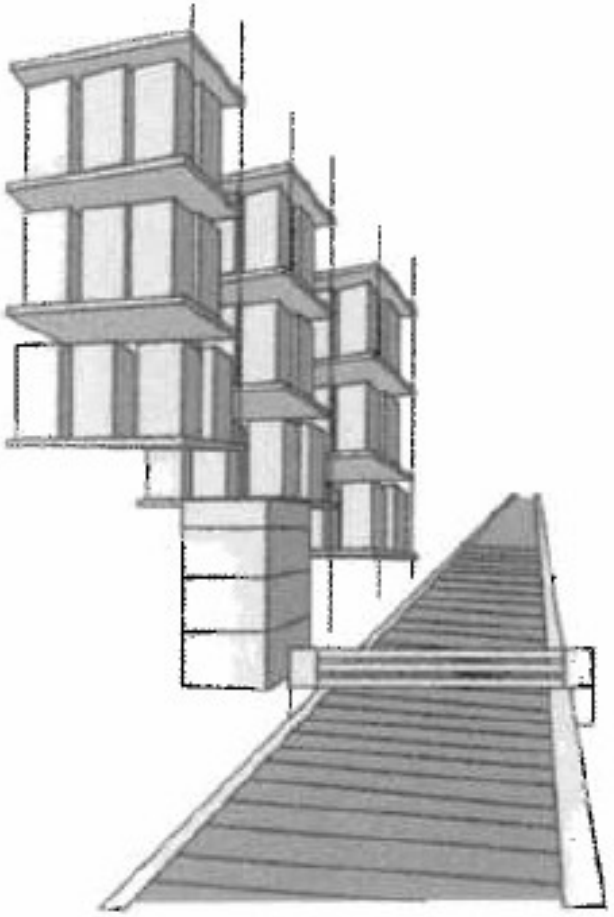




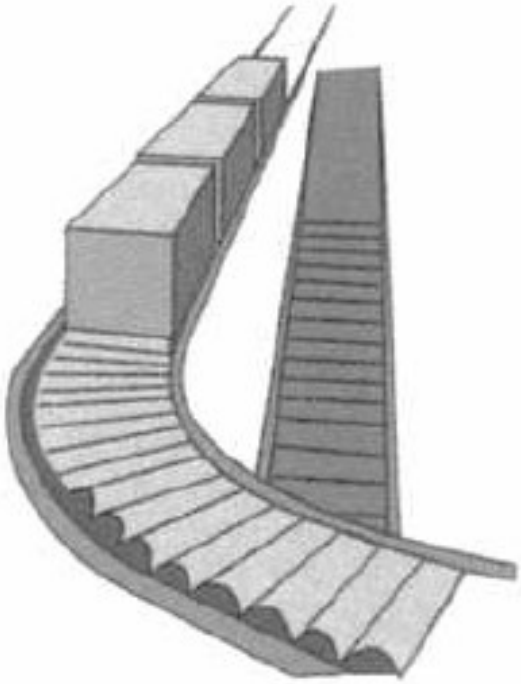
Source: Jonsson 2008

Low and high picking trucks

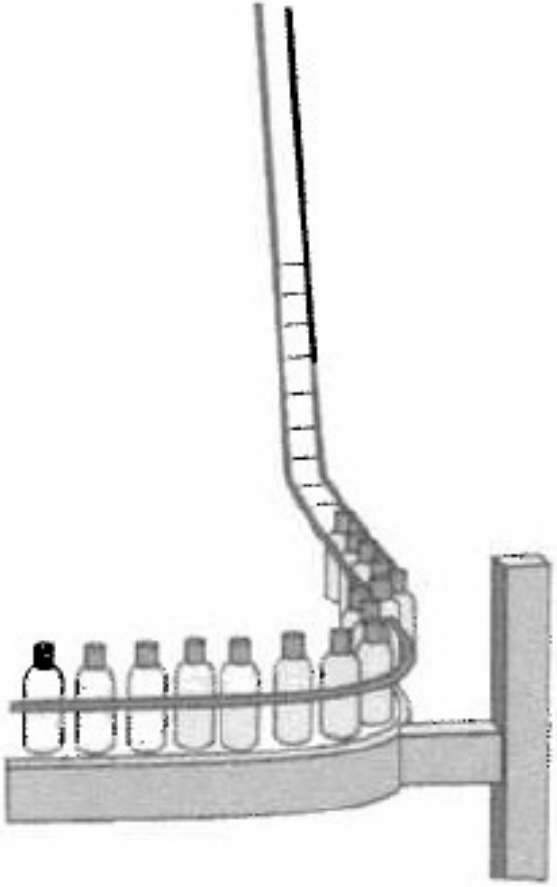
Conveyor Systems



Roller tracks in high warehouse



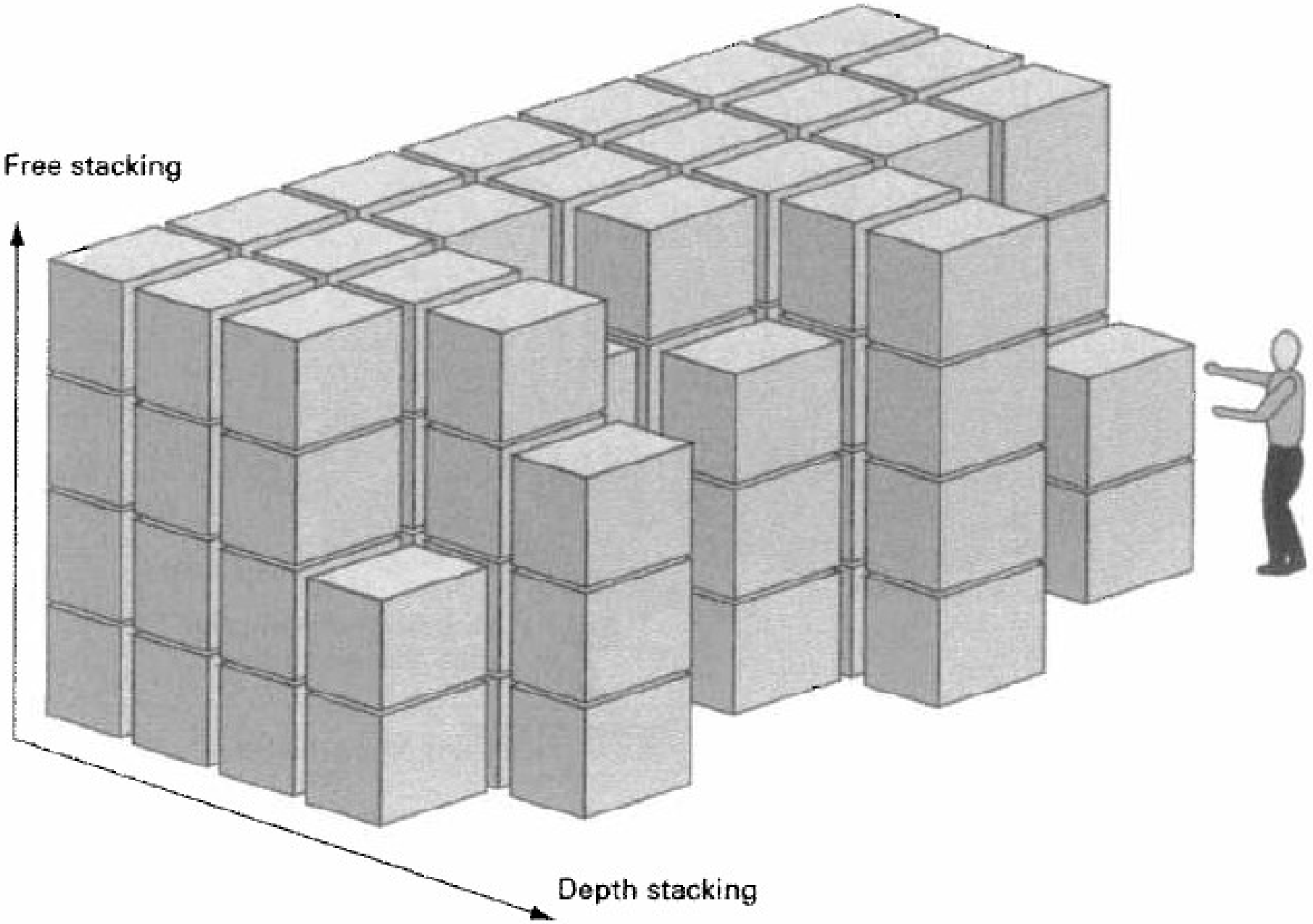
Roller tracks in production



Chain-linked ceiling and floor-based conveyors

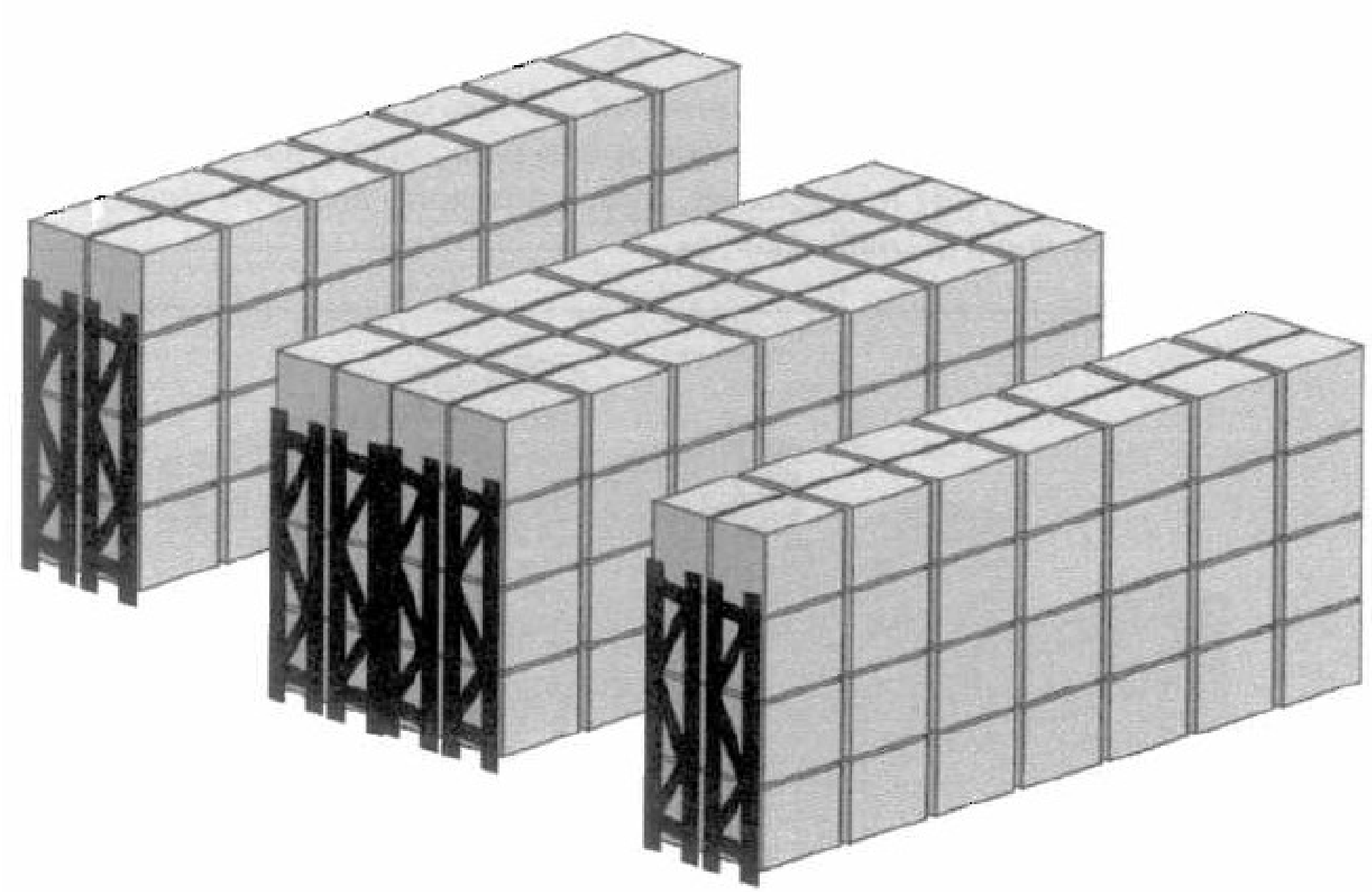
Source: Jonsson 2008

Block Stacking



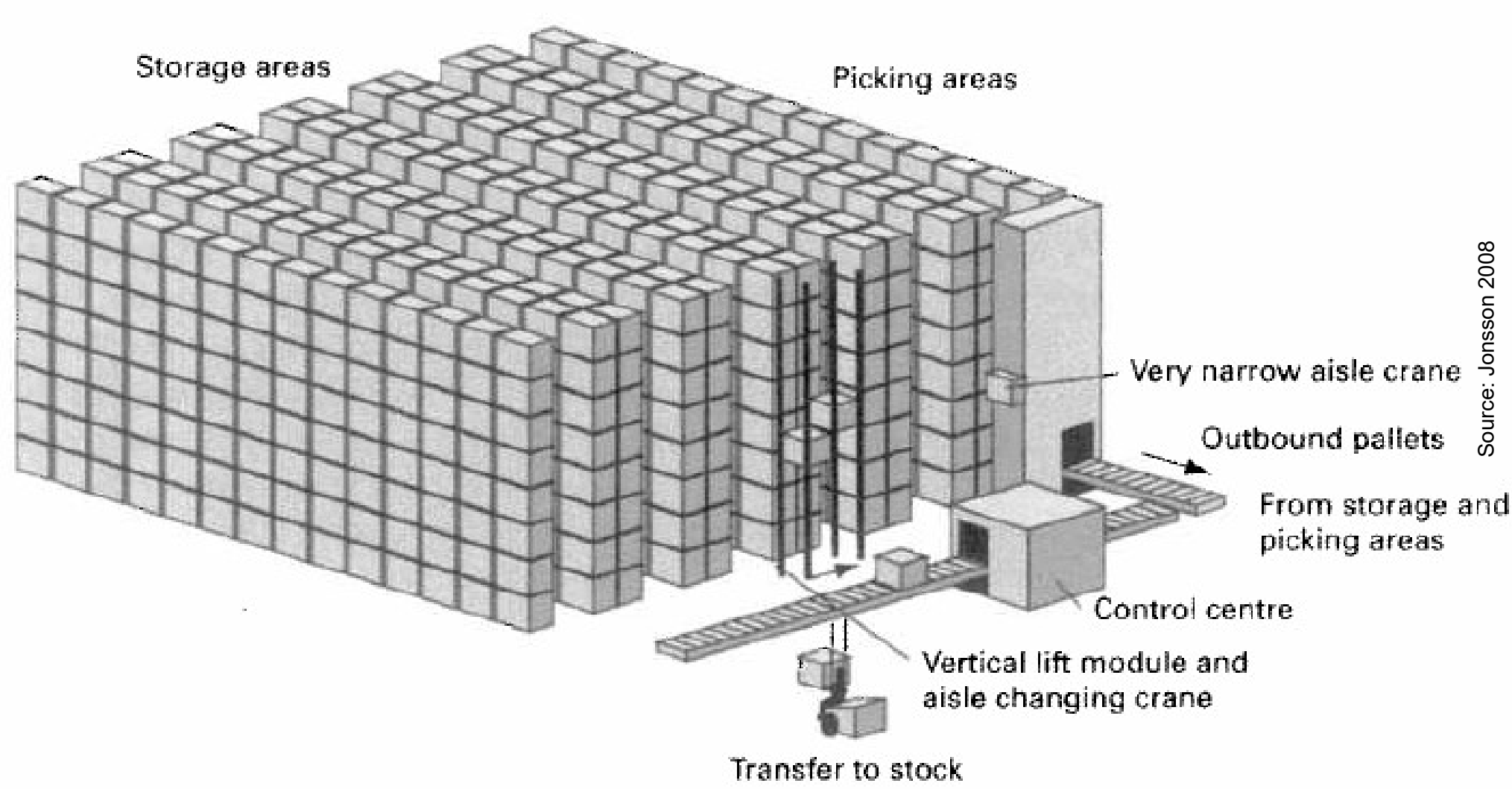
Source: Jonsson 2008

Rack Storage System



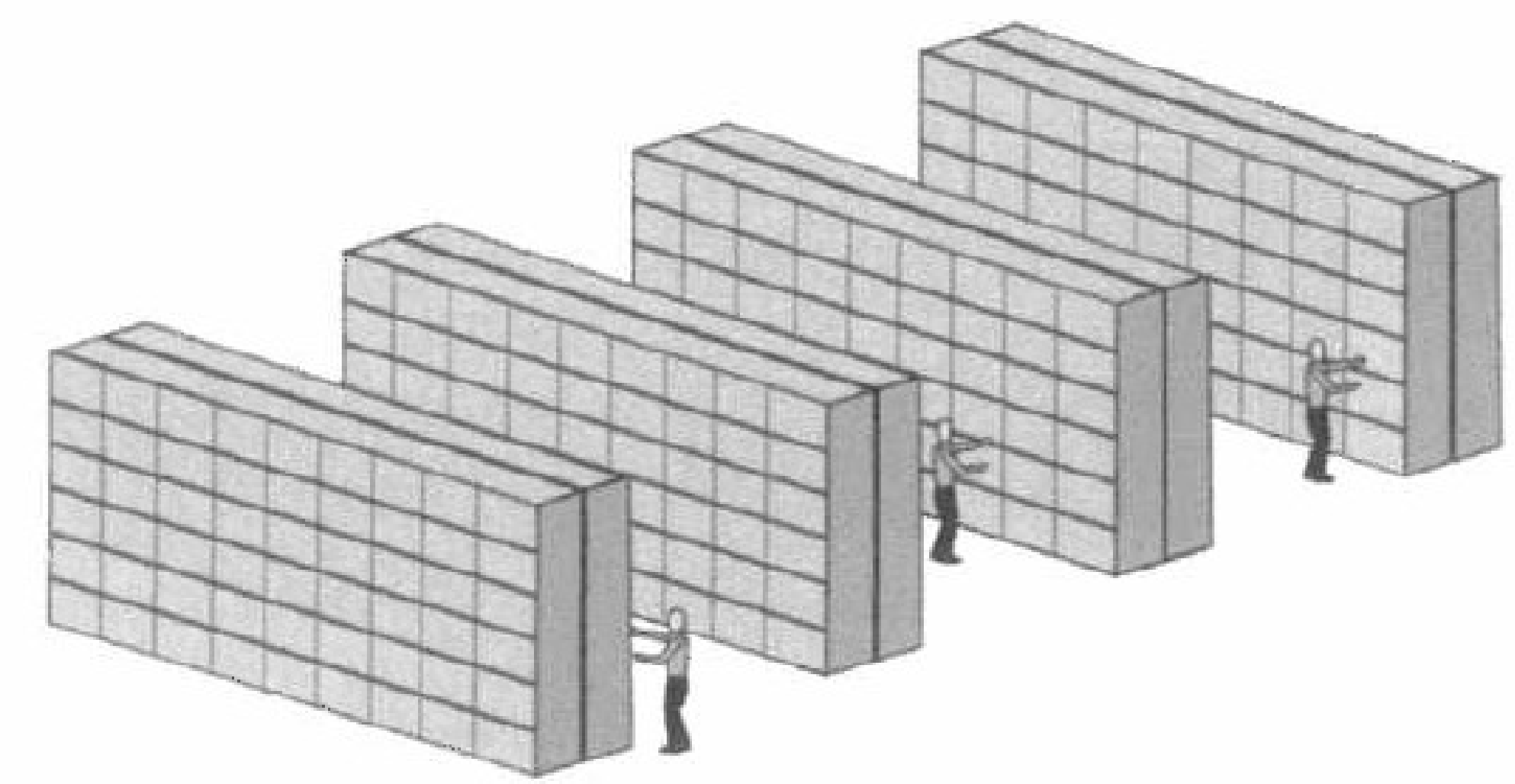
Source: Jonsson 2008

Automated Storage and Retrieval System (AS/RS)



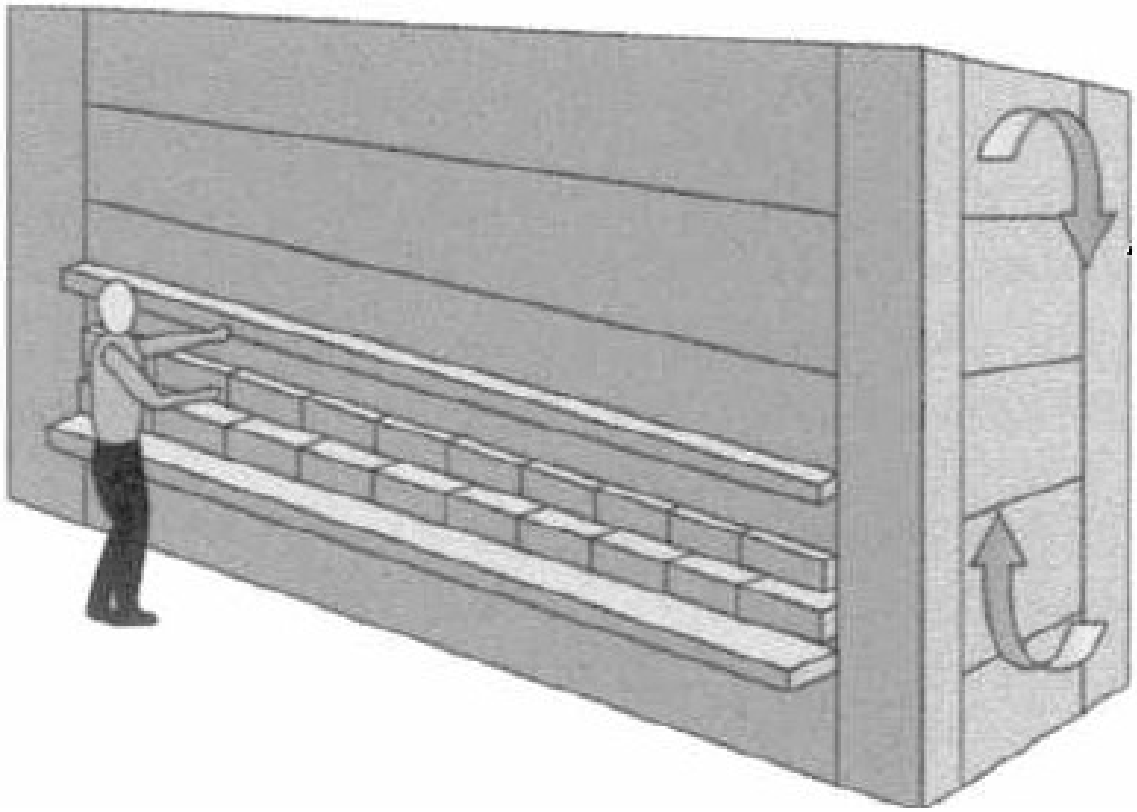
Source: Jonsson 2008

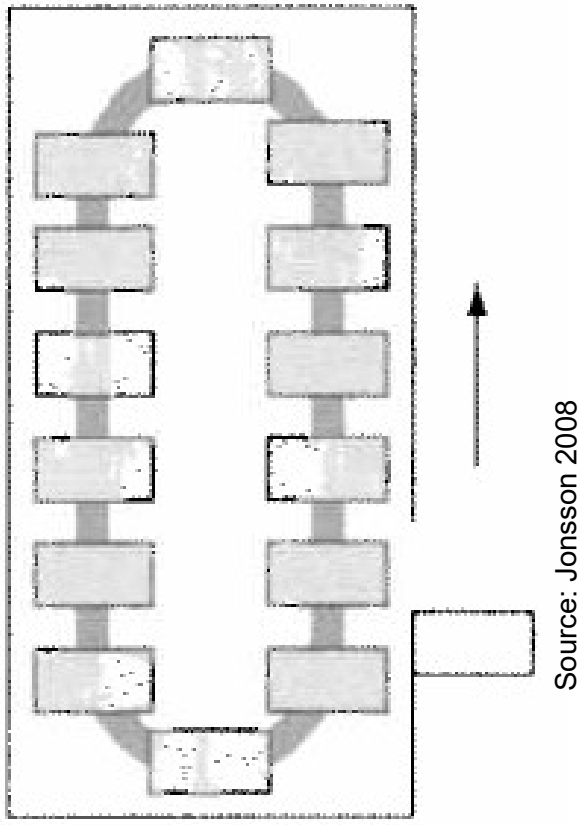
Metal Shelfing Storage



Source: Jonsson 2008

Vertical and Horizontal Carousel Storage

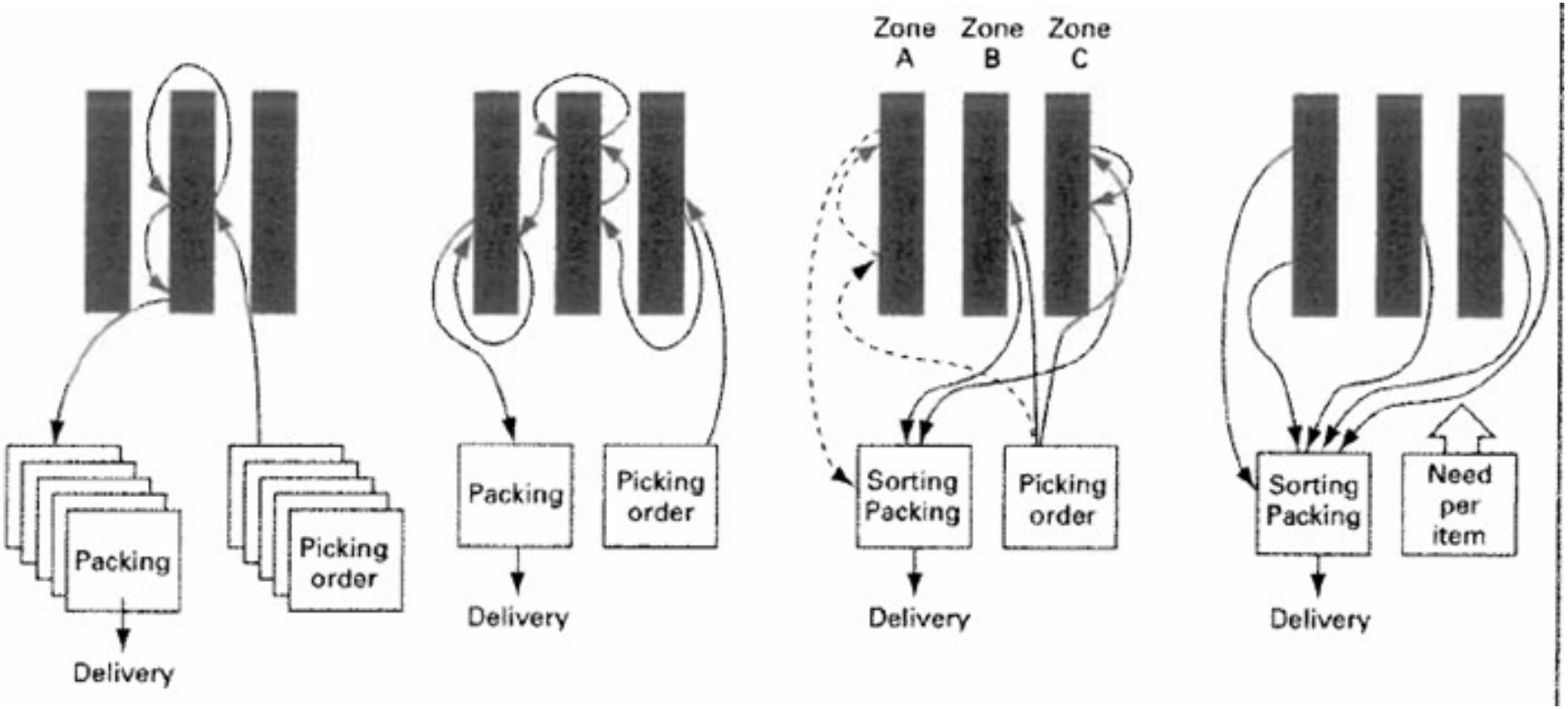




Source: Jonsson 2008

Order Picking

Picking solutions vary depending on freight volume, variety and throughput:



Source: Jonsson 2008

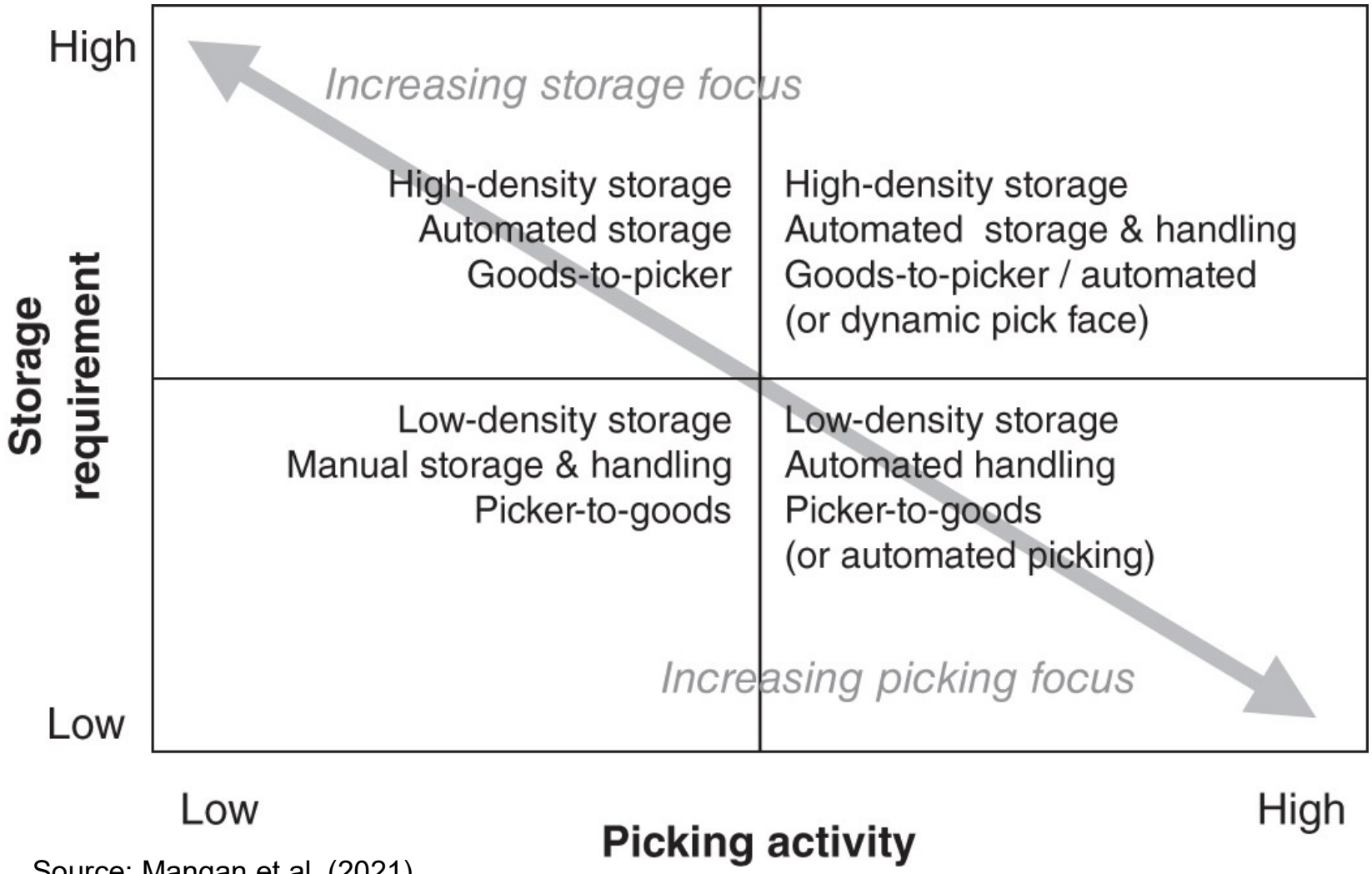
(1) Pick-to-order **(2) Batch Picking** **(3) Zone Picking** **(4) Wave Picking**

Other principles are “picker-to-goods”, “goods-to-picker” …

State of the Art Order Picking

Source: https://www.youtube.com/watch?v=udr0OOxmPbc

Storage and Picking Combinations



Source: Mangan et al. (2021)

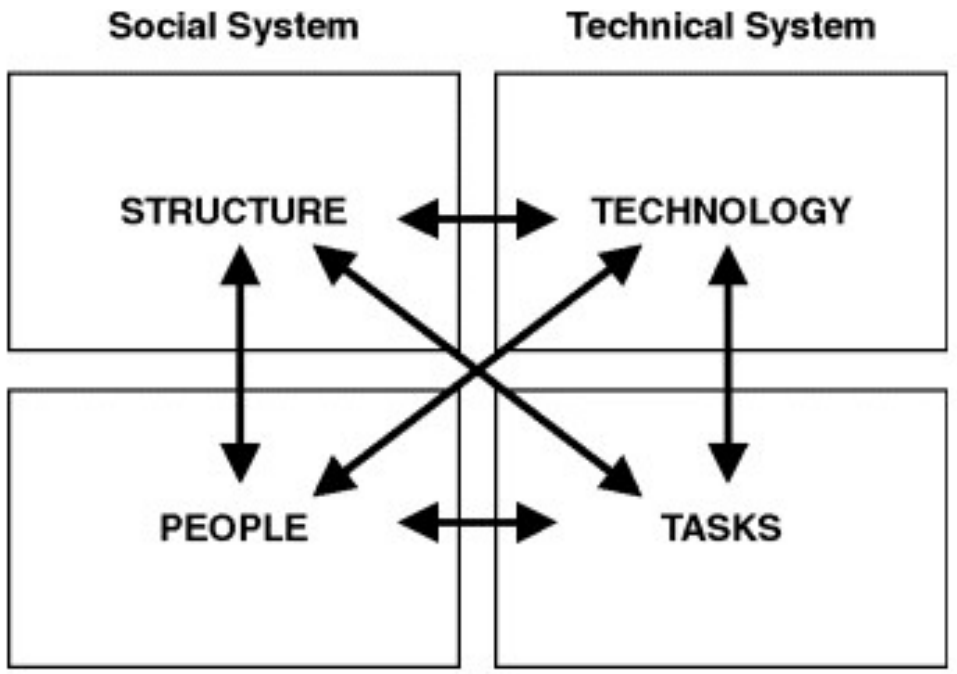
Work Organization and Job Design

Automation and computerisation is reducing human intervention in the physical handling of freight, and increasing information interaction which has implications for job design.

Socio-Technical System Theory (STS) focuses on the impact of implementing warehouse technologies on the workforce.

Fundamental principles of STS theory are

- Joint optimisation of the technical and social system
- Quality of work life
- Employee participation in system design
- Semi-autonomous work groups

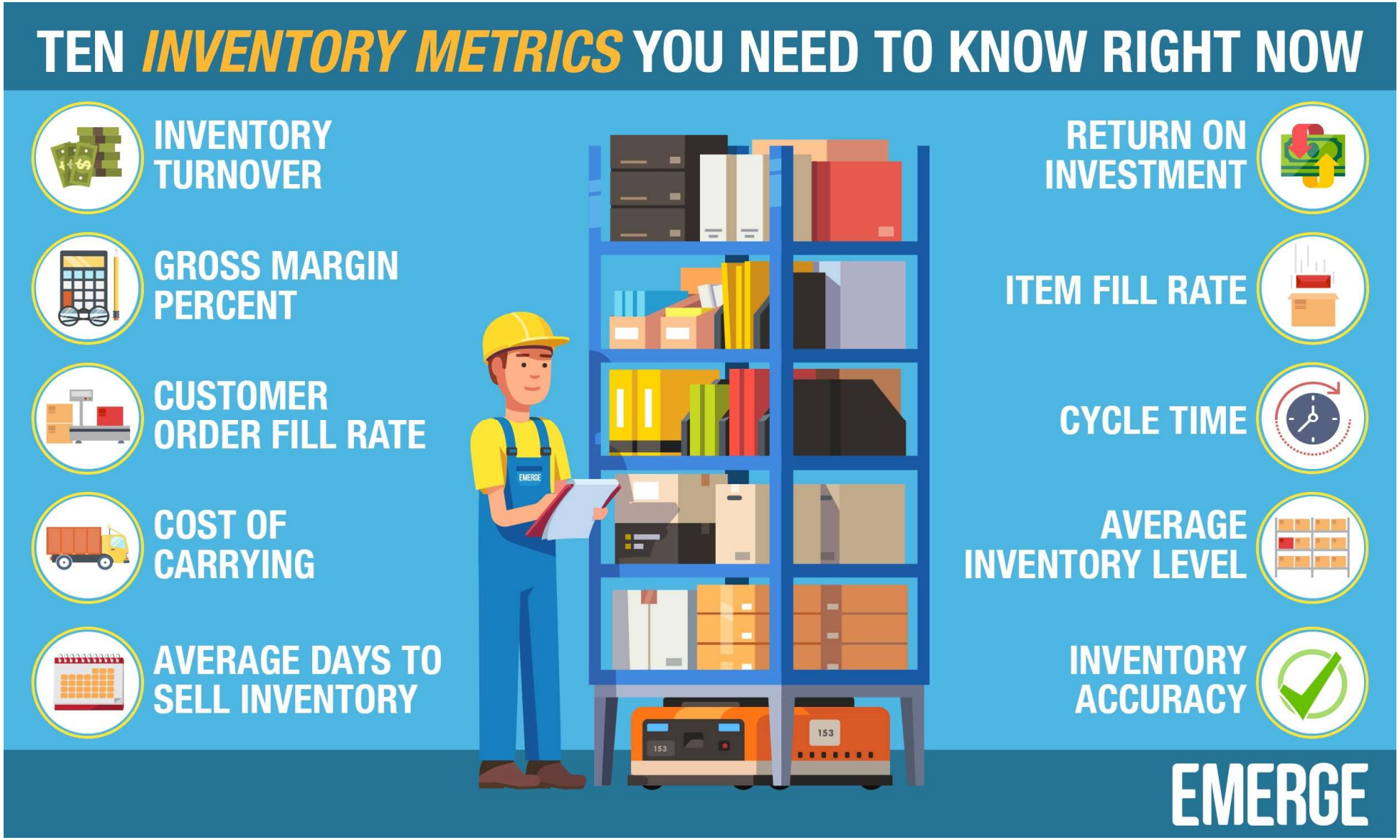


Source: Modified from Bostrom, R. & Heinen, J. (1977) MIS problems and failures: a socio-technical perspective, *MIS Quarterly*, September, 17–31.

Inventory Management…

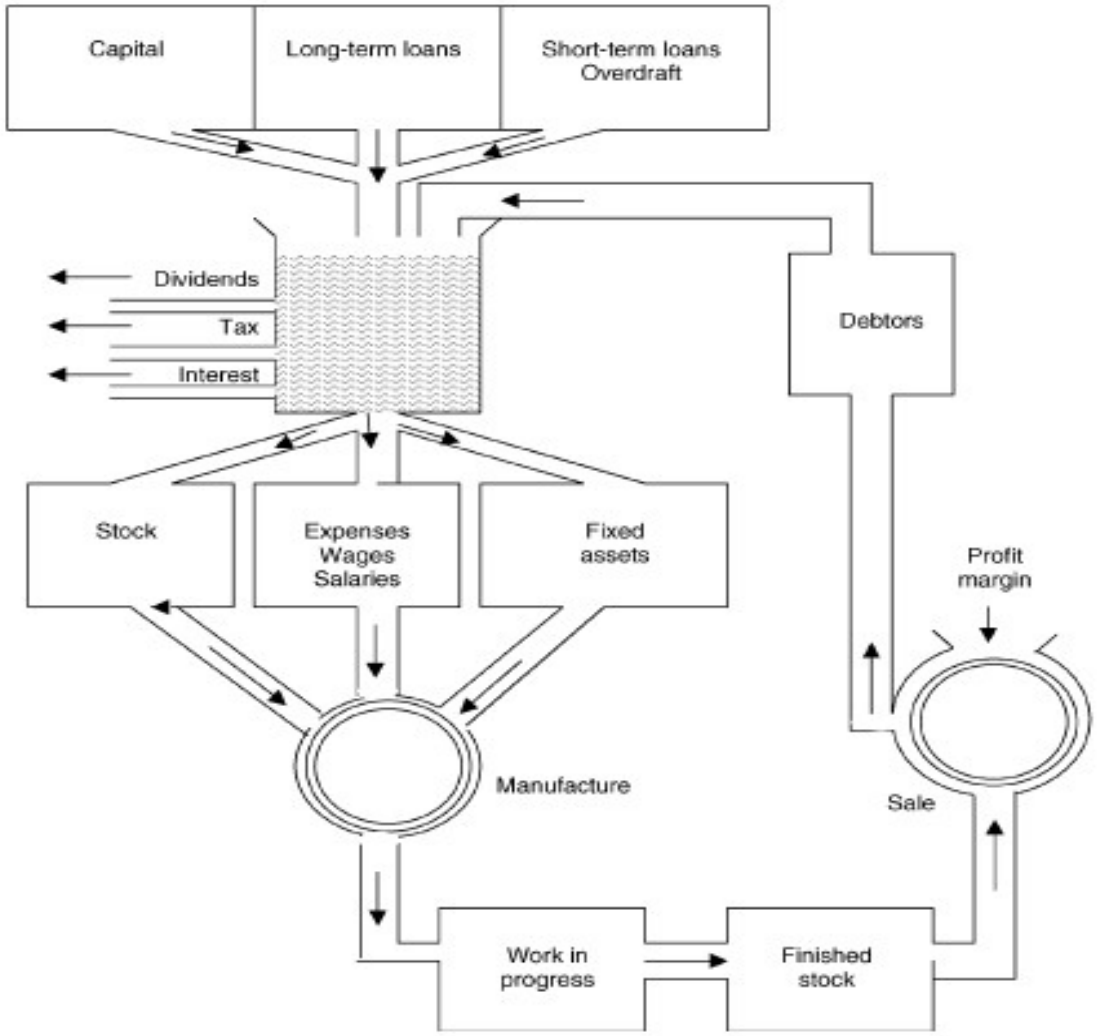
Source: https://emergeapp.net/inventory-reports/inventory-management-techniques/

…and Control



Source: https://emergeapp.net/inventory-reports/10-inventory-metrics-for-smbs/

Flow of Funds in a Typical Manufacturing Business



Source: Mangan et al. (2012)

Some of the Forbes Billionaires 2022 are VERY good in this respect, see https://www.forbes.com/billionaires/#5611a65f251c

Cash-to-Cash Cycle Calculation

	accounts receivable (A/R) period	→	DSO
+	inventory period (storage and production time)	→ +	DIH
–	accounts payable (A/P) period	→ –	DPO
=	cash-to-cash cycle	→ =	C2C

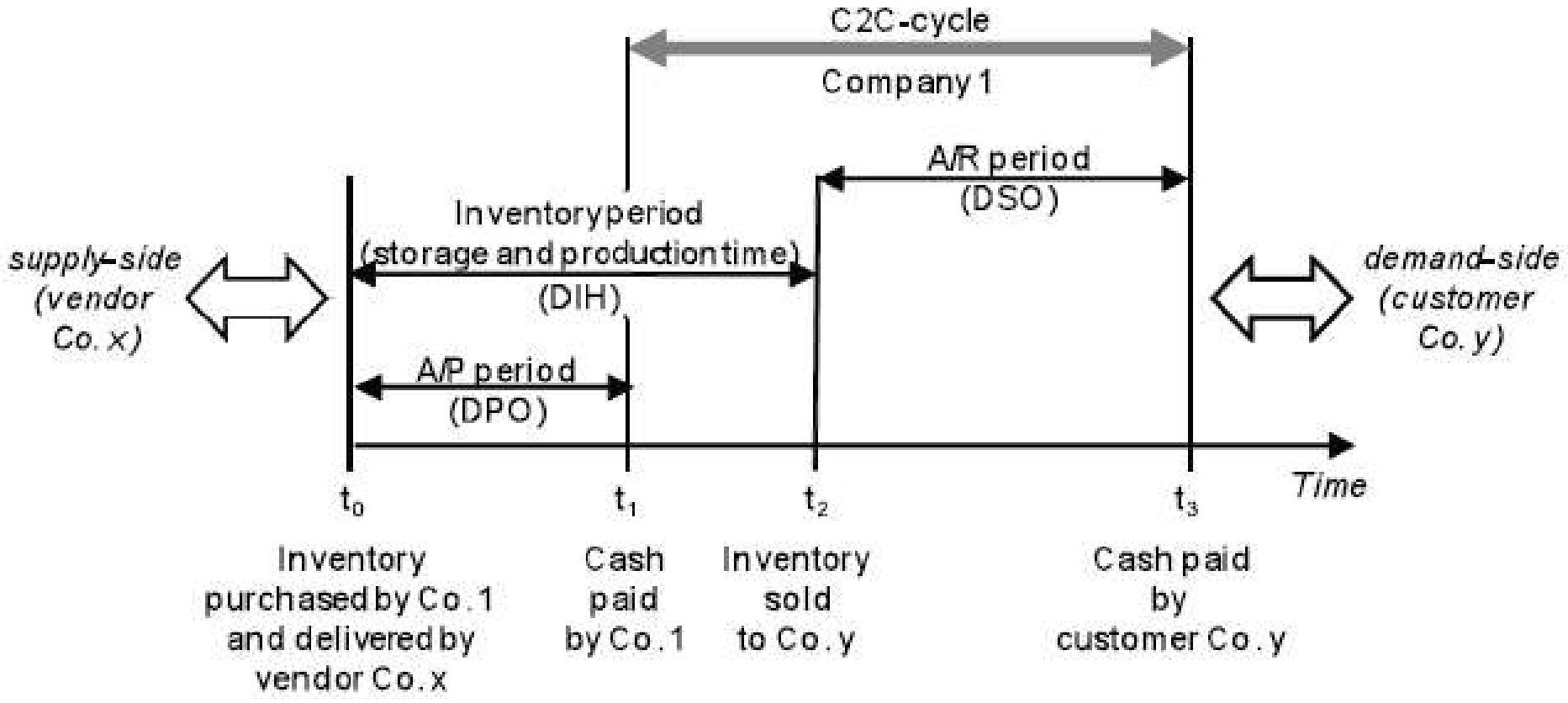
Days sales outstanding (DSO) = ø A/R / (revenue / days in the year (365)):
The number of days between the sale of a product and the receipt of a cash payment (A/R period);

Days inventory held (DIH) = ø inventory / (costs of goods sold / days in the year (365)):
The speed with which the stock value of raw materials, work in progress and finished goods of a company are converted into product sales. In the case of a manufacturing company, the days inventory held also includes the production time (inventory period);

Days payables outstanding (DPO) = ø A/P / (costs of goods sold / days in the year (365)):
The number of days between the purchase of an input from a vendor and cash payment to that supplier (A/P period).

Source: Hofmann and Kotzab (2010)

Cash-to-Cash Cycle Time: Single Company Perspective

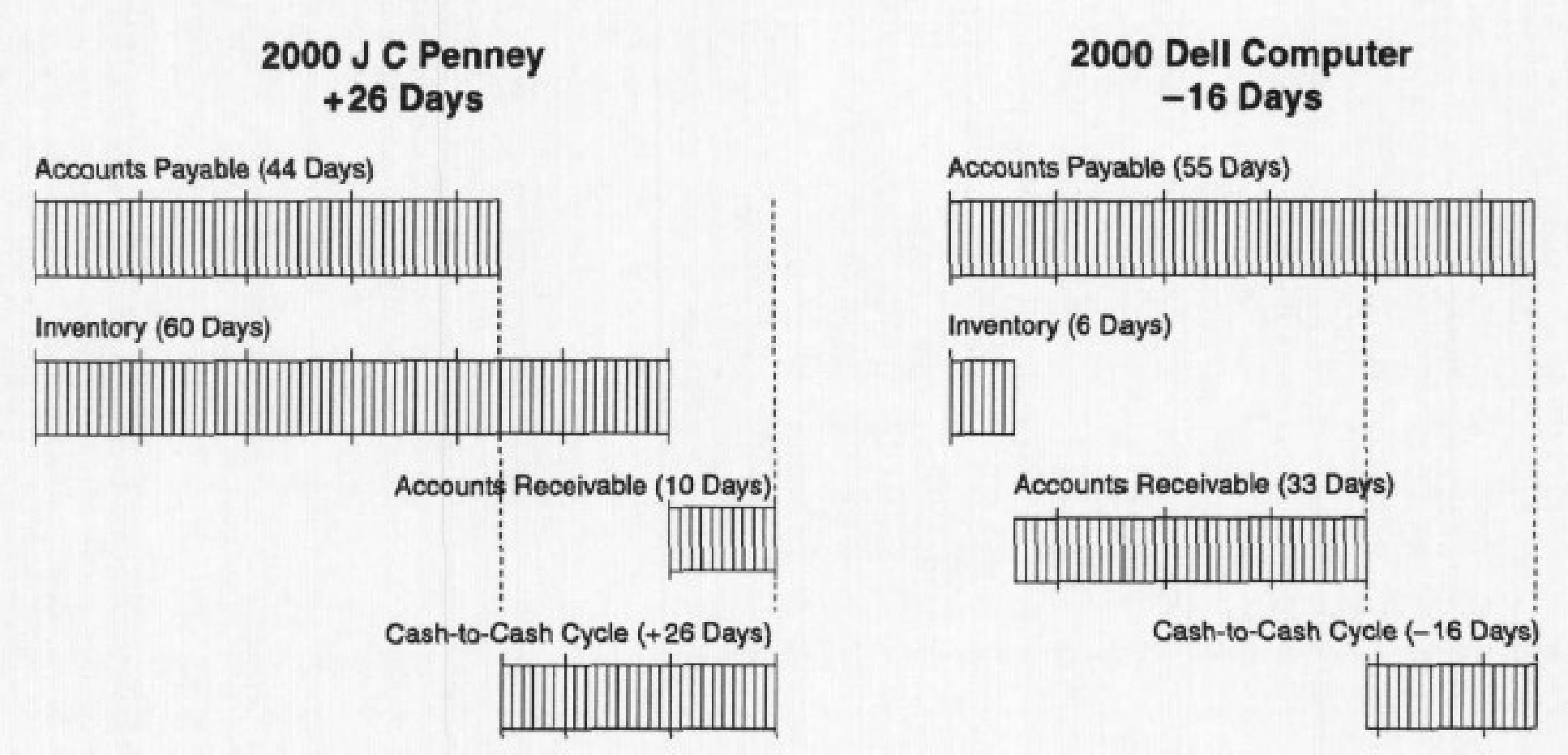


Source: Hofmann and Kotzab (2010)

How to Manage the Cash-to-Cash Cycle

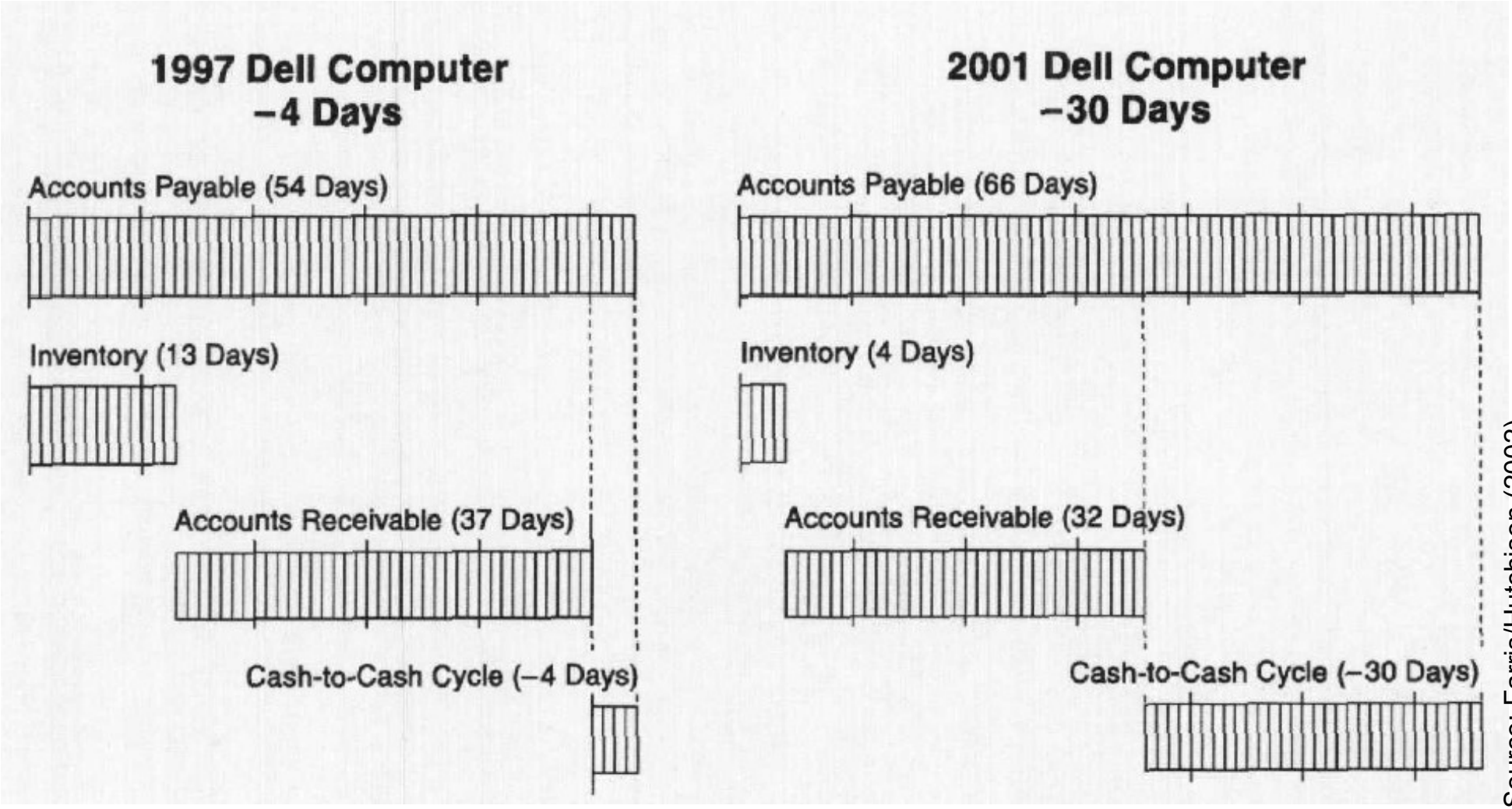
- To improve **Inventory C2C (DIH),** the company may identify actions to decrease turns, reduce or eliminate slow-moving inventory, and/or review systems in place for planning/stocking inventory levels, demand planning, or procurement strategies (which may be leading to excess inventories).
- To improve **Receivables C2C (DSO),** the company may implement strategies such as speeding up the invoicing process, reducing billing errors, quick identification of slow-paying customers, improving the credit approval process, or any number of effective techniques.
- To improve **Payables C2C (DPO),** the company may take actions such as review /negotiation of payment terms with key suppliers, matching payment of key purchases to related revenue buckets, vendor managed inventory and more.

Example: JC Penney vs. Dell



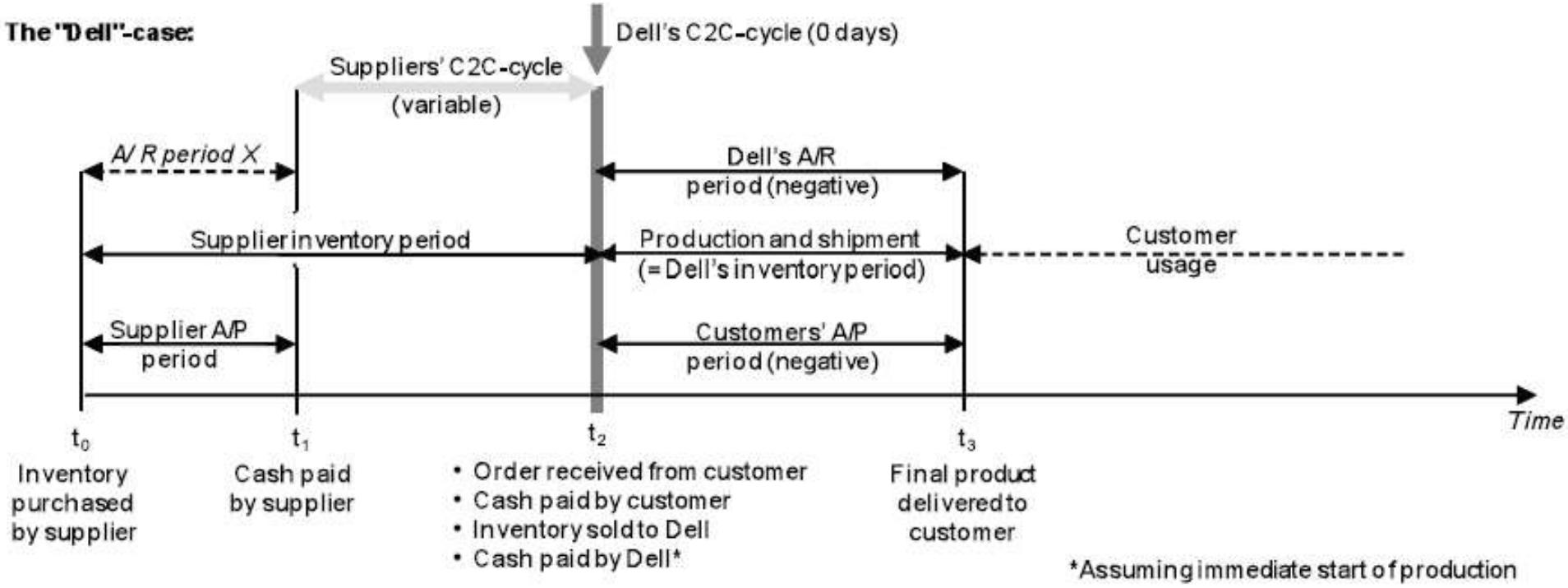
Source: Farris/Hutchison (2002)

Dell Computer or How to Work with other People‘s Money



Source: Farris/Hutchison (2002)

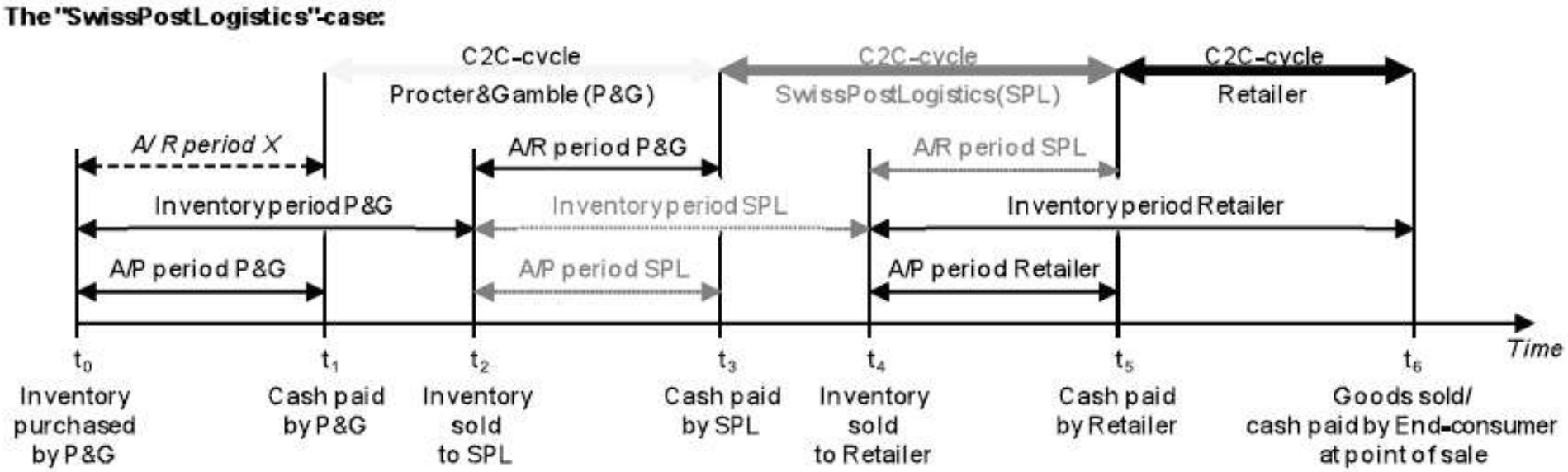
Example for Self-Oriented Cash-to-Cash Cycle Approach



Dell has a zero C2C cycle while transfering risk and financing to its suppliers!
Similiar approach in the Case of WalMart, Aldi, Lidl&Schwarz…

Source: Hofmann and Kotzab (2010)

Example for Collaborative Cash-to-Cash Cycle Approach



SwissPostLogistics as the service logistic provider takes some risk as well as ownership of the goods. May be a solution if:
(1) refinancing rate of the LSP is lower than that of the other players in the supply chain; (2) the LSP possesses extensive information about sales forecasts and flows of goods in the supply chain; (3) the LSP has capabilities of inventory financing and know-how to evaluate risks; and (4) an equal distribution of power between the involved supply chain parties is given.

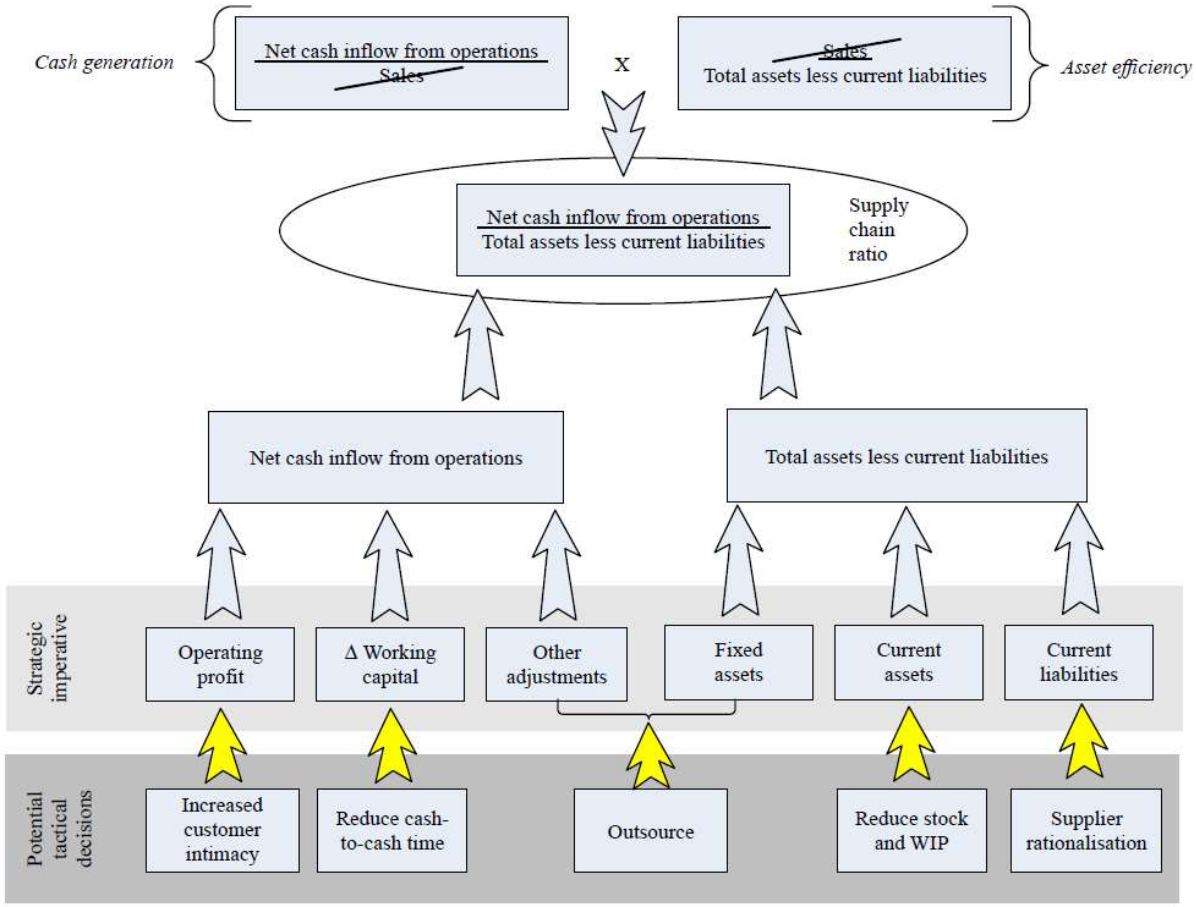
Source: Hofmann and Kotzab (2010)

Supply Chain Ratio (SCR) as an Alternative Measure

SCR is a proxy that comprised measures of cash generation and asset efficiency based on readily available financial data from companies published accounts.

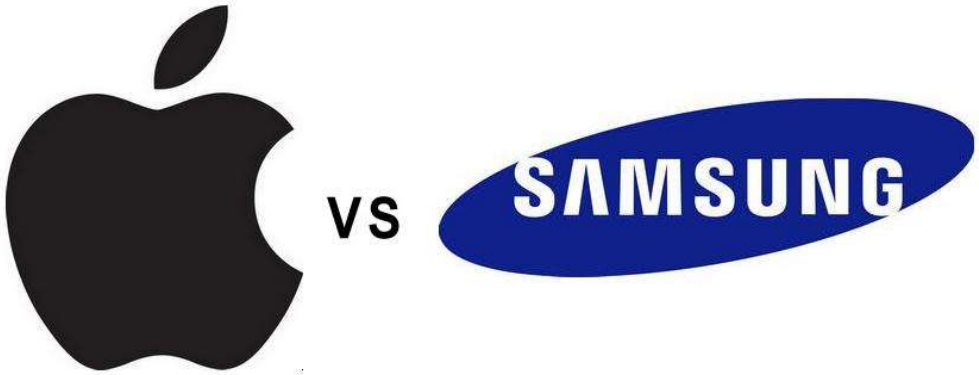
Increase of SCR comes long with an increase in ROCE and a improvement of CSC measures.

This in turn is indicative for good supply chain management practice.



Source: Johnson and Templar (2011)

Discussion Topic
Apple Inc. vs. Samsung Electronics



As a business analyst, it is now your task to answer the following questions:

a) Please suggest and calculate some key performance indicators that enable a comparison of the mobile phone business of Apple Inc with that of Samsung Electronics from a supply chain management point of view!
b) According to the given figures, which of the two companies performs better and why?
c) What could the other company do to get better?

Outlook to Lesson 10

Topics are
Transport Services and Logistics Service Providers

Please have a look at the Case Study *Missing Boxes in Central Europe* and try to fill in associated slides posted on CANVAS!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MISSING BOXES IN CENTRAL EUROPE

This case was written by Associate Professor Günter Prockl and Student Assistant Kirsten Weibrecht Kristensen from the Department of Operations Management at the Copenhagen Business School. This case is intended to be used as a basis for class discussion rather than to illustrate the effective or ineffective handling of a management situation.

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