



Supply Chain Management

Αναπλ. Καθηγήτρια Κλεοπάτρα Μπαρδάκη

cleobar@hua.gr

SUPPLY CHAIN PERFORMANCE DRIVERS

1. *Facilities*
2. *Inventory*
3. *Transportation*
4. **Information**: data and data analysis concerning facilities, inventory, transportation, costs, prices, and customers throughout the SC (consider Big Data, data analytics)
5. *Sourcing*
6. *Pricing*

ROLE OF INFORMATION

“In modern supply chains, information replaces inventory.”

- Helps reduce variability.
- Helps improve forecasts.
- Enables coordination of systems and strategies
- Improves supply chain visibility.
- Improves customer service.
- Facilitates lead time reductions.
- Enables firms to react more quickly to changing market conditions.

INFORMATION

the most critical SC driver

enables coordination and collaboration between SC partners

huge effect on SC decisions (consider data inaccuracies e.g. faulty demand forecasts)

Information -> Information technology -> **Information Systems**

The background features a light gray gradient with several realistic water droplets of various sizes scattered in the corners. The droplets have highlights and shadows, giving them a three-dimensional appearance.

INFORMATION **QUALITY** ->
EFFECTIVE? DECISION MAKING IN SUPPLY CHAIN
MANAGEMENT

BULLWHIP EFFECT

One of the key information in a SC is the quantity that is demanded at its various nodes. Every SC node tends to stock more items than actually needed because of uncertainties in the estimated quantity. The quantity of items magnifies upstream the supply chain and the effect is known as Bullwhip effect. (Gowda, A.B. and Subramanya, K.N., 2017. A Study of Bullwhip Effect and Its Impact on Information Flow in Cloud Supply Chain Network. *IUP Journal of Supply Chain Management*, 14(3), pp.49-65)

Describes the effect by which slow moving consumer demand creates large swings in production for the suppliers at the other end of the supply chain. (Wang, X. and Disney, S.M., 2016. The bullwhip effect: Progress, trends and directions. *European Journal of Operational Research*, 250(3), pp.691-701)

Sometimes referred to as 'demand amplification', 'variance amplification' or the 'Forrester effect'.

BULLWHIP EFFECT

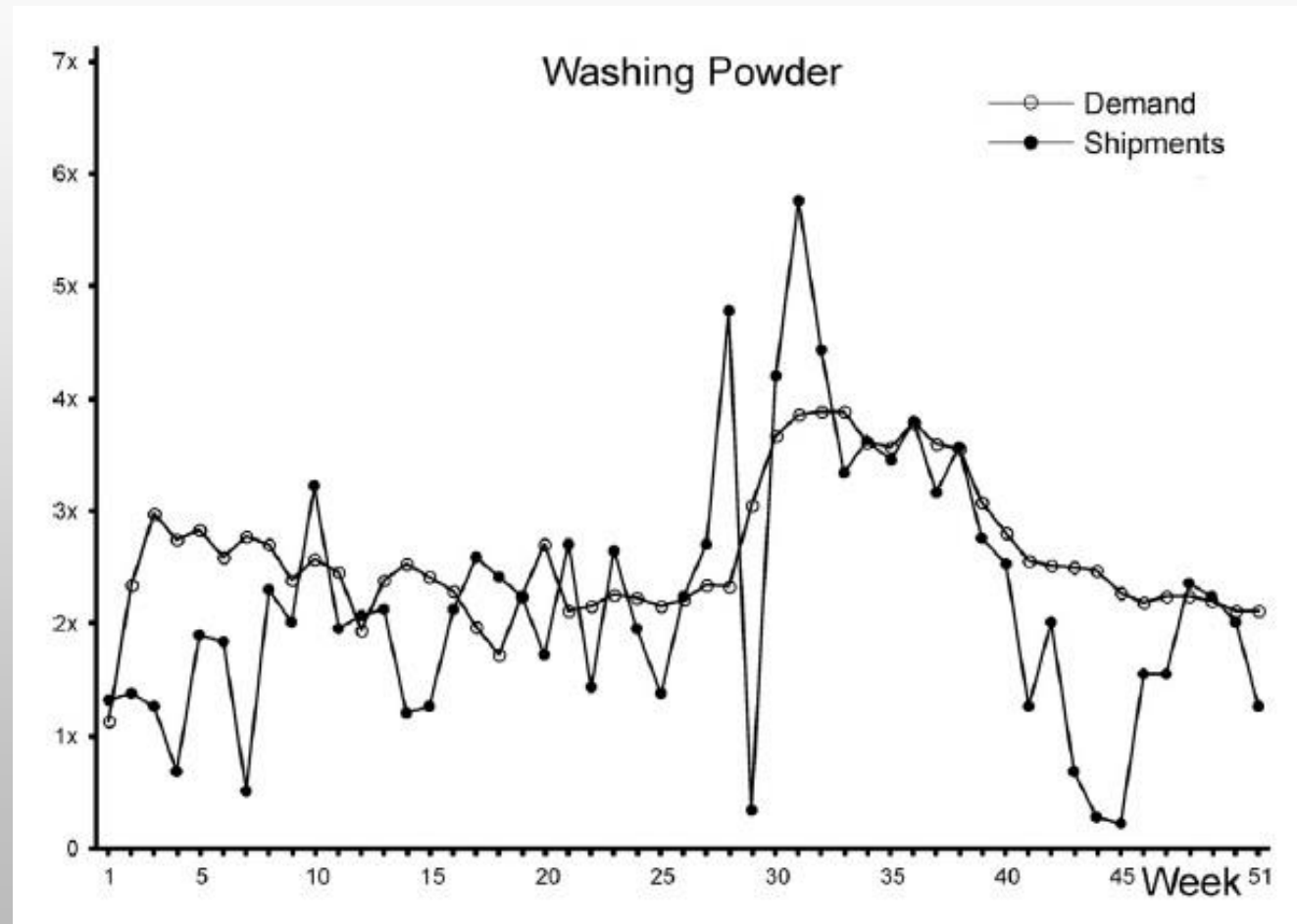
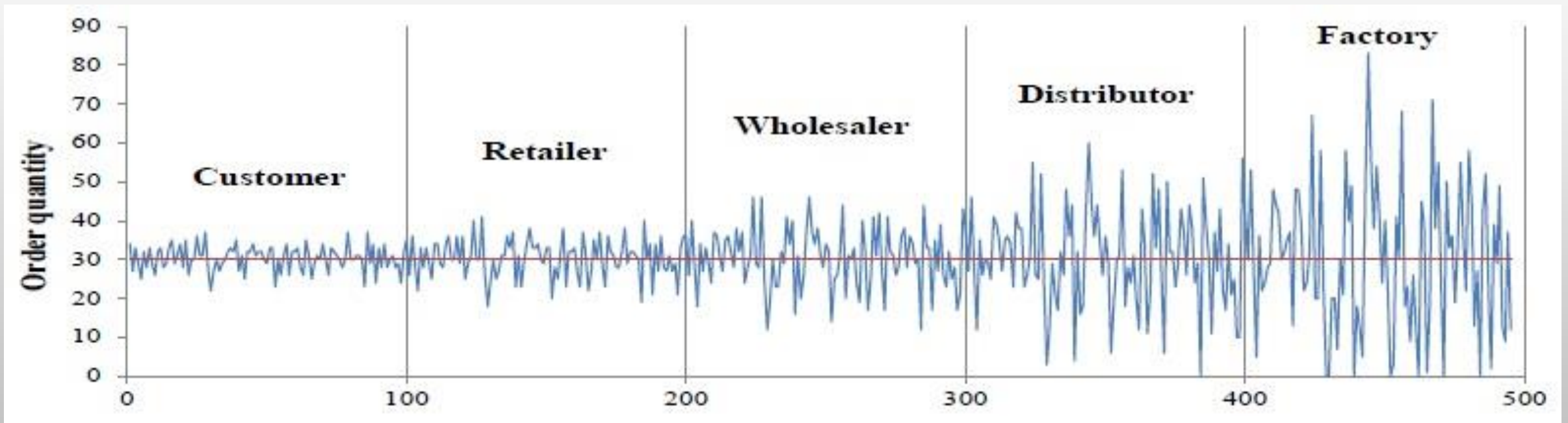
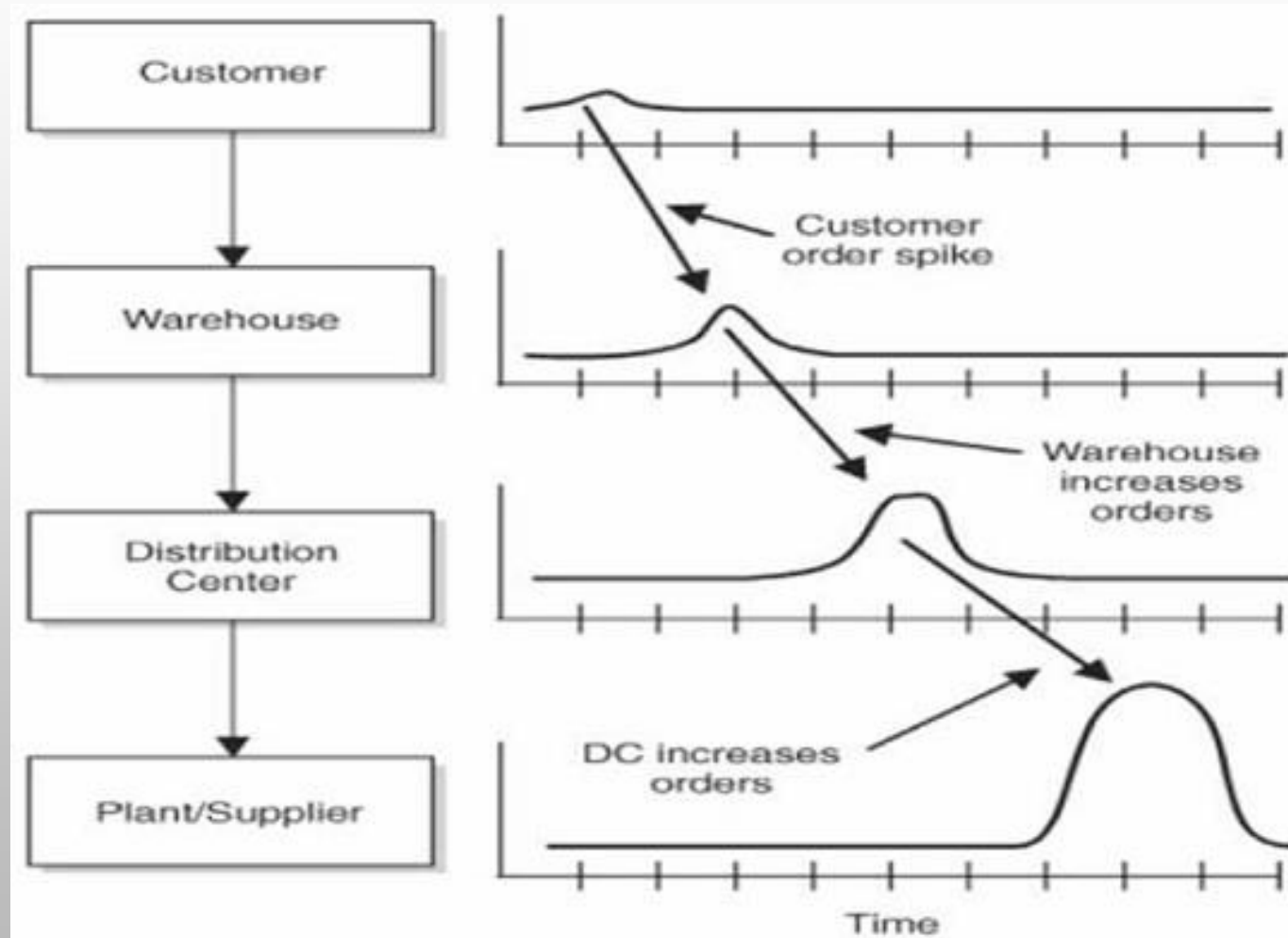


Fig. 1 - Wang, X. and Disney, S.M., 2016. The bullwhip effect: Progress, trends and directions. *European Journal of Operational Research*, 250(3), pp.691-701.

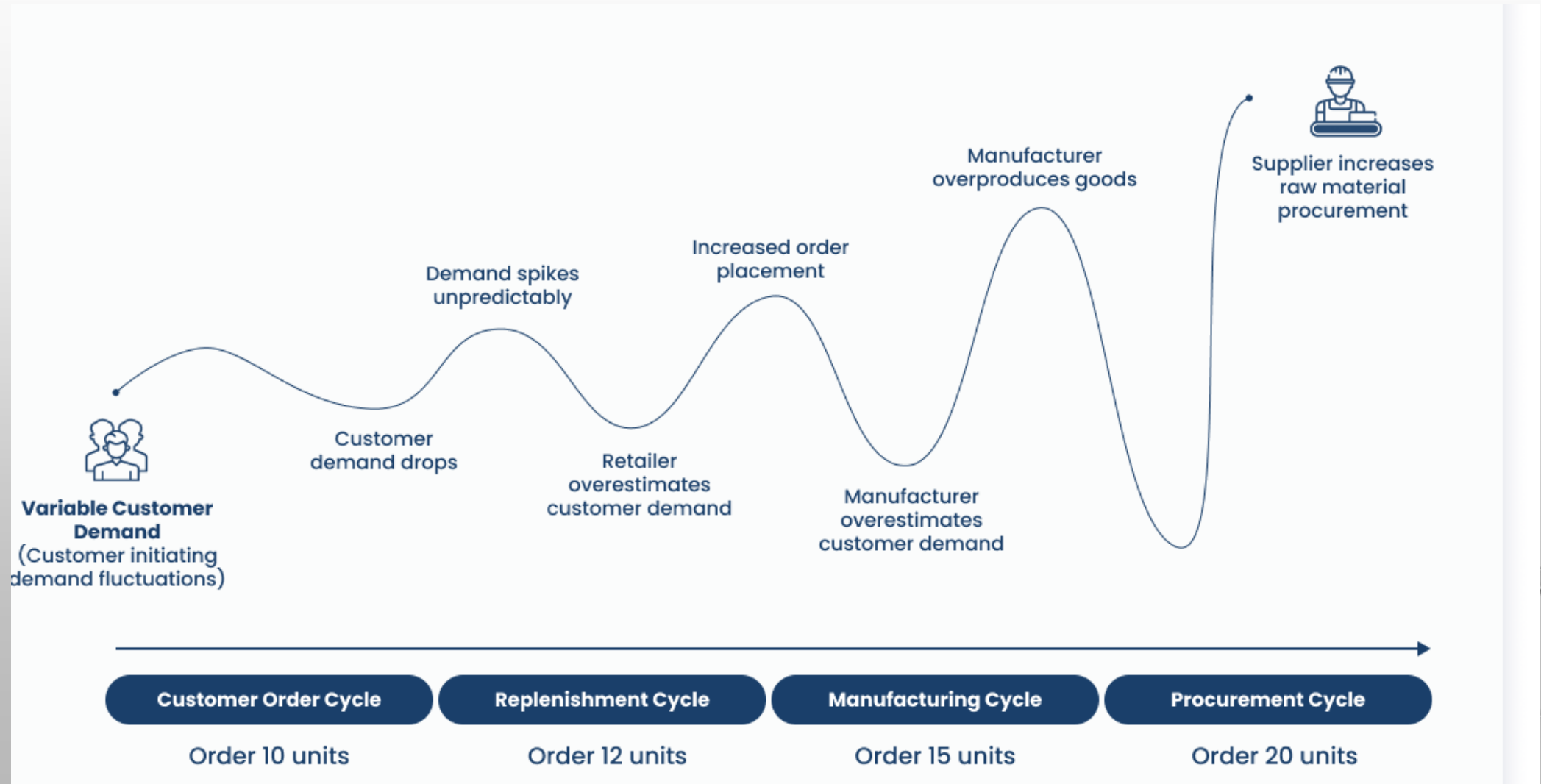
Order Variability Upstream the Supply Chain



Order Variability Upstream the Supply Chain



Order variability is amplified up the supply chain; upstream echelons face higher variability.



CAUSES OF BULLWHIP EFFECT



CONSEQUENCES

Increased safety stock

Reduced service level

Inefficient allocation of resources

Increased transportation costs

COPING WITH THE BULLWHIP EFFECT

Reduce uncertainty

- Sharing information
- Sharing forecasts and policies
- More effective forecasting


Reduce variability (e.g. eliminate promotions)

Reduce lead times

- Cross docking
- Distribution redesign

Strategic partnerships

- Data sharing
- CPFR




EXAMPLE: QUICK RESPONSE AT BENETTON

Quick Response - manufacturing, warehousing, sales and retailers are linked together

A Benetton retailer reorders a product through a direct link with Benetton's mainframe computer in Italy.

Using this strategy, Benetton is capable of shipping a new order in only four weeks, several week earlier than most of its competitors.



EXAMPLE: ZARA ORDERING

ZARA stores order twice a week based on existing sales and demands.

Each order will meet demands in the next few days and order quantity is not great.

Small, frequent orders eliminate the adverse impact of order batching.



Information Systems in SCM

Information System

Information system (IS)

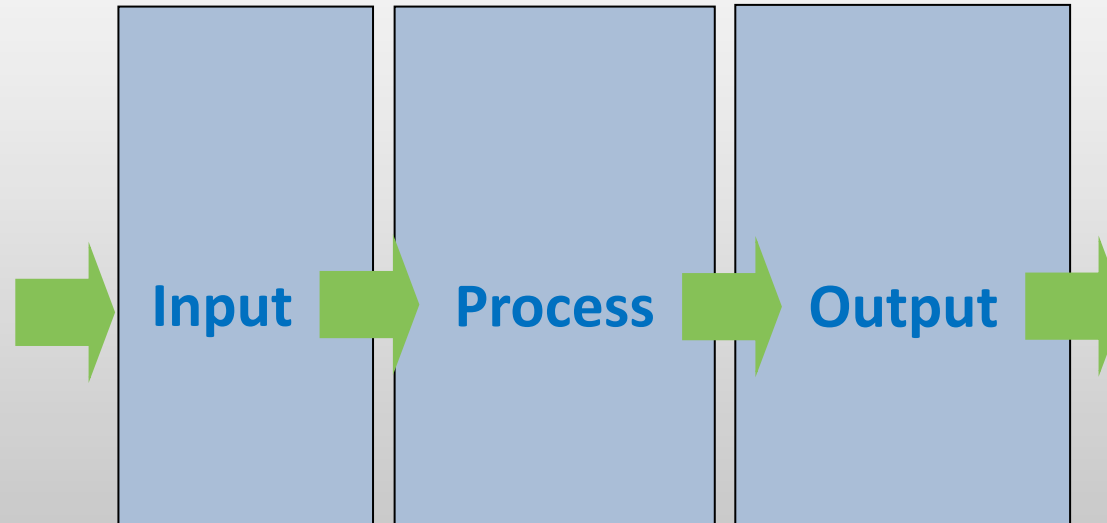
A set of interrelated components that collect (or retrieve), process and store data for providing information, knowledge and digital products to the users.

Businesses utilize IS to manage their supply chain/ operations, interact with their customers, collaborate with their suppliers and, ultimately, execute their competitive strategy.

ISystems Main Components

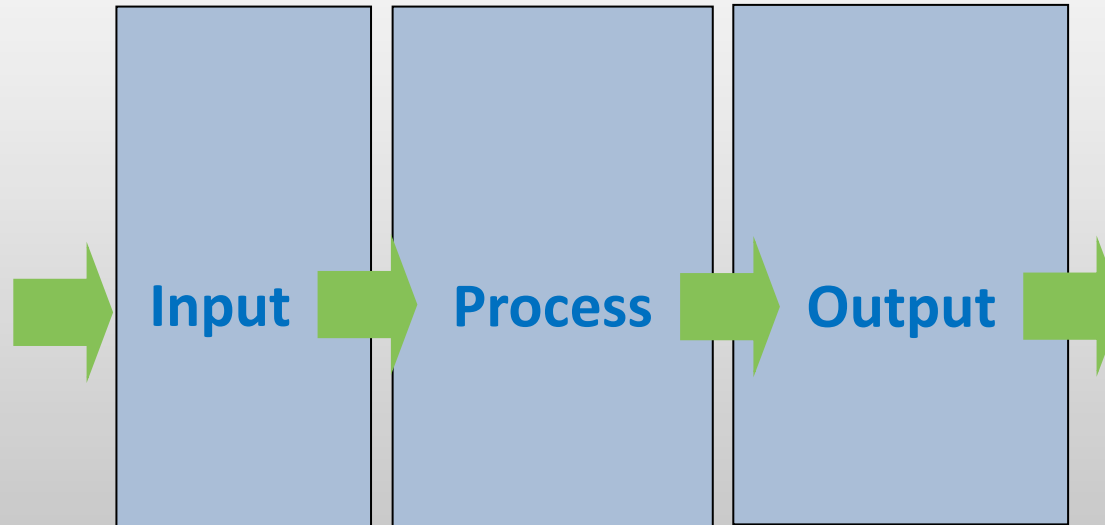
- Hardware
- Software
- Telecommunications
- Data
- **People**
- **Procedures/ Processes**

What ISystems Do



What ISystems Do in a Supply Chain

Employee data
Supplier data
Sales data
Product data
.....
Social Networks data
Sensors data
Material data
Competitors data
Market Segments
data
Regulation data



Employee payments
Supplier Contracts
Production Plan
Replenishment quantities
Picking quantities
Demand/ Sales Forecasting
.....
Inventory Strategy
Promotion campaigns
Customer loyalty programs
Outsourcing strategy
Management reports
Customer profiles

ERP

- Enterprise resource planning (ERP) is an IS that allows companies to (1) **automate and integrate many of their business processes**, (2) share a common, enterprise-wide database and business practices throughout the enterprise, and (3) produce information in real time.
- **Broad scale, modular IS** that integrates a firm's business processes and functions into a single IS that integrates the corresponding data and serves the requirements of the firms processes and functions.
- **IS for identifying and planning the enterprise-wide resources** needed to take, make, ship, and account for customer orders.

ERP ...

- Collects, processes, and provides information about a company's entire enterprise.
- Serves as an **organization's backbone** by integrating and optimizing all the various business processes across the entire firm.
- **Links all of the firm's areas of activity** into a network.
- **Replicates organizational processes in software**, guides employees through the processes step by step, and automates as many of them as possible.

Source: R. Daft, 2010. Organization theory and design. Cengage learning EMEA, ISBN-13: 978-0-324-59889-6, Chapter 8.

ERP ...

- packaged software
- Serves as **transactional processing system**, as well as **management information system (MIS)**, **decision support system (DSS)**, or **executive information system (EIS)**.
- In brief, ERP systems implement functions of all these systems -> They provide to the users (personnel & managers) the big picture quickly and **support quick, effective decisions and actions**.
- Adopts and implements **best practices** in a firm's business processes.
- Facilitates the coordination, collaboration and exchange of information between the various departments of a firm.

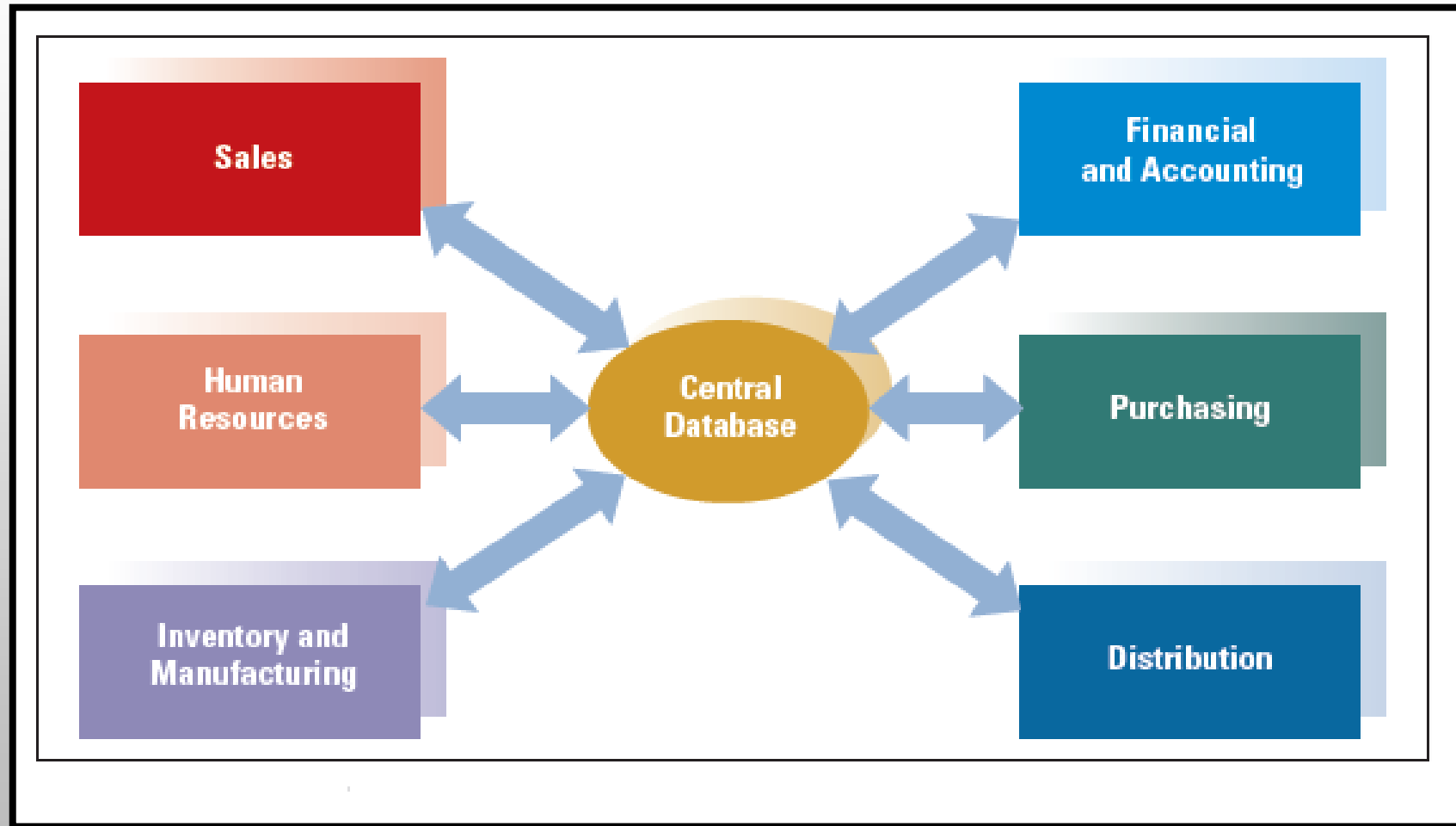
ERP Main Objective

Objective of ERP systems

Coordination of a firm's entire business, from supplier evaluation to customer invoicing.

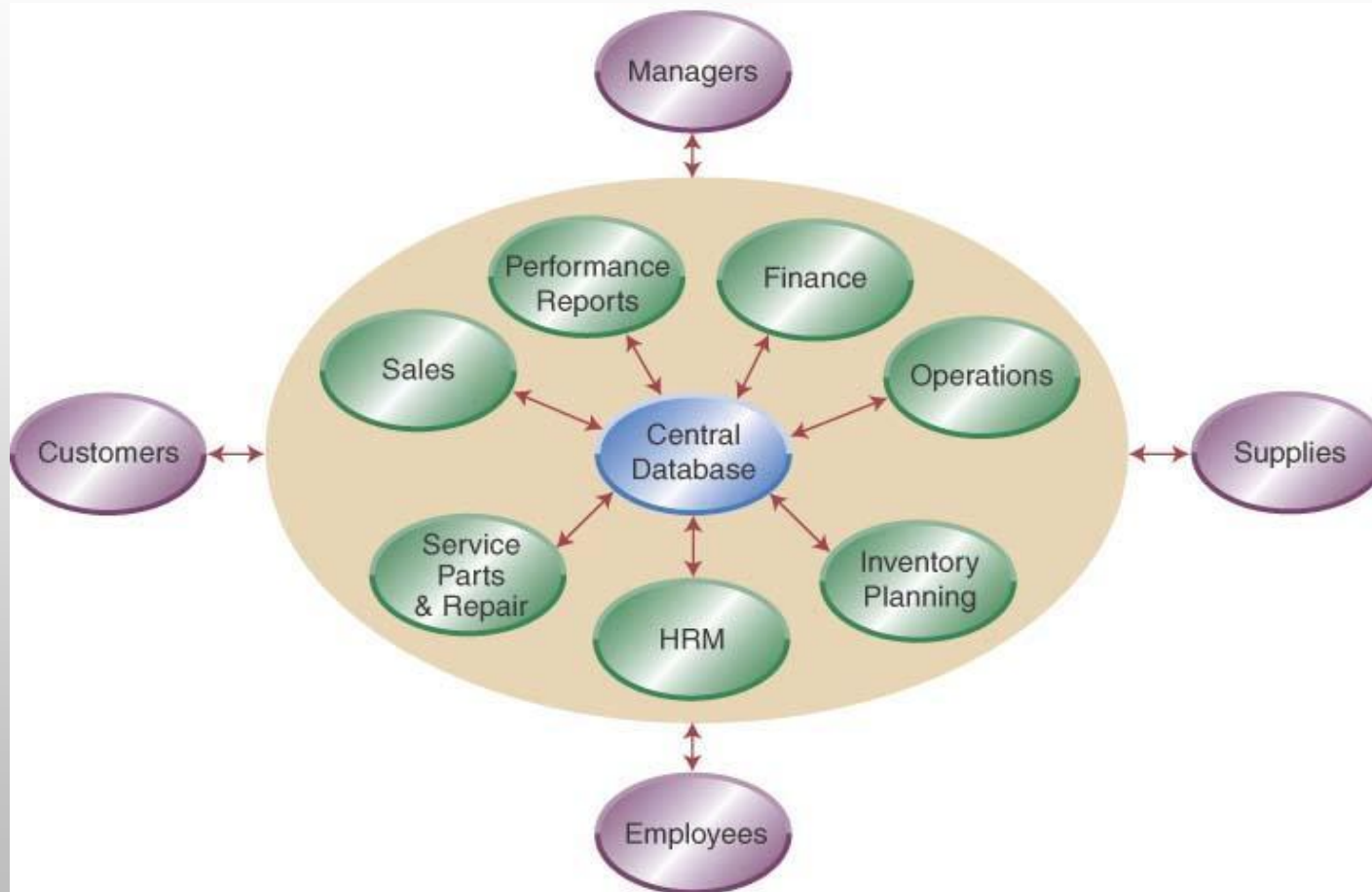
This objective is seldom achieved, but ERP systems are umbrella systems that tie together a variety of specialized systems.

ERP Integrates



Source: R. Daft, 2010. Organization theory and design. Cengage learning EMEA, ISBN-13: 978-0-324-59889-6, Chapter 8.

ERP Integrates



ERP Benefits

- Supply chain information visibility
- Improved data quality and security
- Improved visibility across all business operations (holistic view of a business)
- Improved reporting and planning -> improved decision making
- Improved alignment of competitive strategy and SC strategies
- Increased flexibility
- Sustained involvement of top management

ERP Benefits

- Enhanced/ new business processes (best practices implementation, standardization)
- Business processes automation -> reduced operating costs (e.g. labour costs), reduced errors
- Increased integration, communication and collaboration between business units
- Reduced Costs and stock
- Improved customer service
- Efficient coordination of demand, supply and production

ERP Disadvantages/ Risks

- Expensive
- Complex
- May require major business process reengineering
- Very time-consuming
 - ✓ adoption/ implementation process
 - ✓ adjustment of business
- Risk for a business
- Acceptance risk by the employees/ users (Resistance to change)
- Transition cost (e.g. training cost)

ERP Modules

- Material Requirements Planning (MRP)
- Finance and Accounting (capital, investments, performance reports etc.)
- Human Resources Management (workforce planning, payroll & benefits etc.)
- **Supply-chain management (SCM) software** for sophisticated vendor communication, e-commerce, and the activities necessary for efficient warehousing and logistics.
- **Customer relationship management (CRM) software** for analysis of sales, targeting the most profitable customers, and managing the sales force.
- **Sustainability software** for sustainable workforce issues, transparency for supply-chain sustainability issues, as well as monitoring health and safety activities, energy use and efficiency and environmental compliance.

ERP Implementation Case

Cadbury, a British multinational 123 year-old confectionery company owned by Mondelez Int.

- 2nd largest confectionery brand in the world after Wrigley's.
- Cadbury is headquartered in Uxbridge, London, and operates in >50 countries worldwide.
- Why ERP
 - ✓ Problems concerning production and distribution.
 - ✓ Firm was on a fast paced growth, but its systems could not serve its needs.
- Solution: SAP-based ERP adoption
 - ✓ 5-year IT transformation project, called "Probe"
 - ✓ Aim: integration of Cadbury' supply chain, purchasing, manufacturing, distribution, sales and marketing systems in a global ERP platform.



ERP Implementation Case

- Far from smooth transition to the new ERP
- Challenging implementation and very time-consuming
- Overall, the ERP implementation resulted in significant operating cost savings and increase in efficiency.
 - multi-node resources-management extended throughout its supply-chain
 - significantly better production efficiencies throughout the manufacturing chain
 - complete reengineering of existing warehouse and warehouse management system, and distribution processes.
- The system is also deployed to Cadbury's vendors. A portal called "vendor connect" enables the users to monitor the inventory movement and plan accordingly.



Top ERP Vendors

- 1 Oracle
- 2 SAP
- 3 Microsoft
- 4 Infor
- 5 Sage
- 6 Epicor
- 7 IFS
- 8 QAD/Plex/Deltek/Unit4
- 9 Acumatica
- 10 Odoo

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MRP

MRP is a system designed to plan manufacturing production. It identifies necessary materials, estimates quantities, determines when materials will be required to meet the production schedule, and manages delivery timing—with the goal of meeting demands and improving overall productivity.

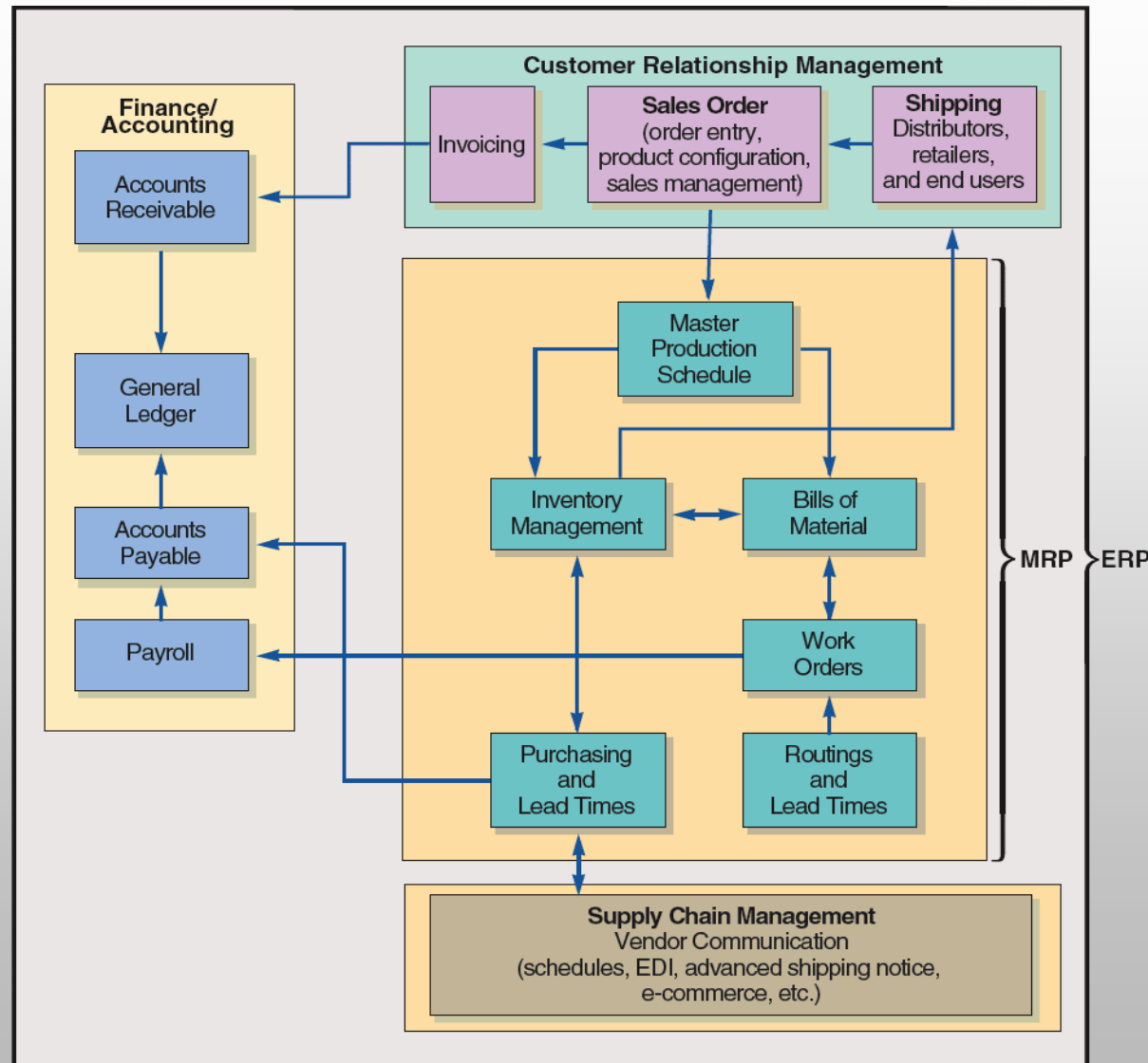
- considers inventory levels + sales forecasts -> analyzes and plans > to deliver asap while keeping your inventory low
- looks sales orders + bills of material + routings + rules for replenishing and replacing inventory
- purchases and production orders are entered into the system allowing it to predict what you will have and when.

It recommends production and purchase plans.

ERP and MRP

Most true ERP systems incorporate at a minimum MRP and Financials into one integrated software platform.

MRP requires that all purchases and sales are entered completely and accurately in the database. That means the same data that is entered into the finance system needs to be in the MRP.



ERP and MRP



ERP and MRP

MRP vs. ERP: Major Differences

MRP

- ✓ Works as a standalone system
- ✓ Typically less expensive
- ✓ Has limited users

ERP

- ✓ Works as an integrated system
- ✓ Typically more expensive
- ✓ Can have many users

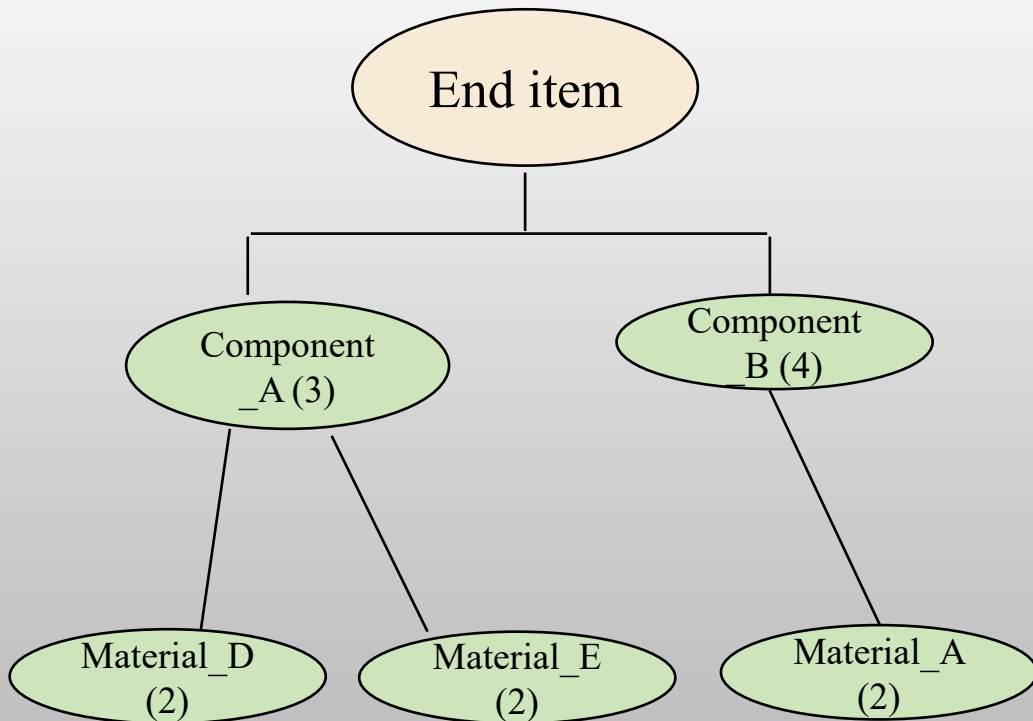
MRP usage

- Warehouses that package products or assemble collections of items into “kits” or combinations for resale as a unit
- Warehouses that assemble custom configurations to order (stocking major units and optional add-ons and then putting the customized product together for shipment)
- Service providers that assemble packages of documentation, devices, consumables, or other physical items they provide to customers/clients/patients
- Office building management, hospitals, government building managers, apartment managers—for managing supplies and equipment based on forecasted use
- Restaurants that use a form of MRP to manage ingredient and supplies inventory and replenishment

Material Requirements Planning (MRP)

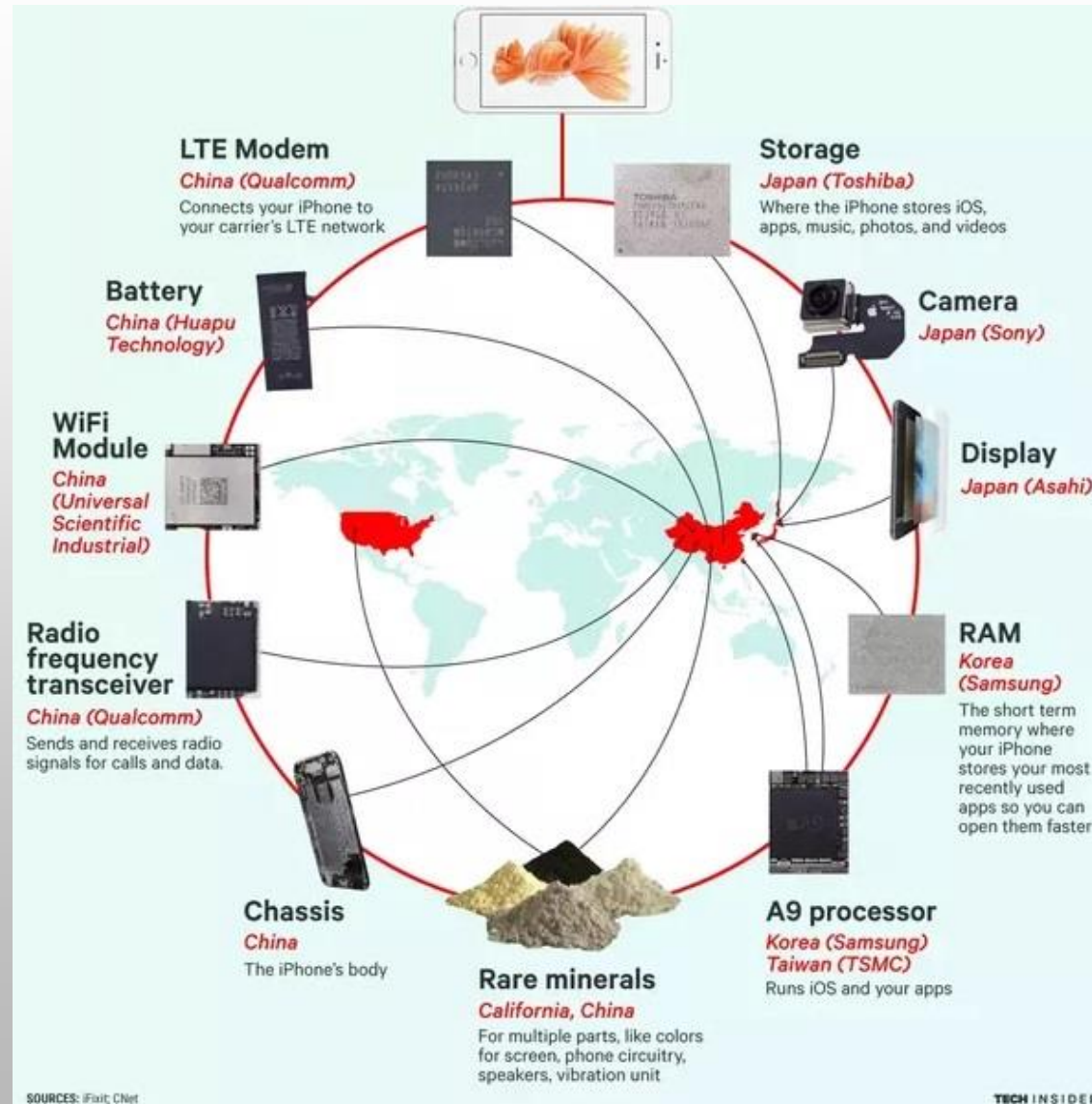
- MRP: A **dependent demand technique** that uses a bill-of-material, inventory, expected receipts, and a master production schedule to determine material requirements of end items.
- MRP system: An IS that translates master schedule requirements for end items into time-phased requirements for subassemblies, components, and raw materials.
- MRP systems support production managers in scheduling and placing orders for items of dependent demand in order to produce the end items.

Dependent Demand



- Dependent demand means that **demand for one item is related to the demand for another item.**
- A firm receives an order for final products -> the components, materials are dependent demand items.
- If we have an order quantity for the end item, the dependent demand for all parts and components can be calculated (**MRP is used**).

Dependent Demand of iPhone 6s



The parts (dependent demand) of the final product come from 4 countries -> very important to schedule the orders of the parts and consider the lead times -> MRP is necessary.

Source:
<http://www.businessinsider.com/where-iphone-parts-come-from-2016-4>

MRP key functionalities

Accurately define what needs to be produced.

- creating and managing the bill of materials (BOM) for all final products and sub-assemblies.
- BOM describes the order in which the material will be needed, what parts are dependent on other parts, and how many of each will be required.

Quantify the demand

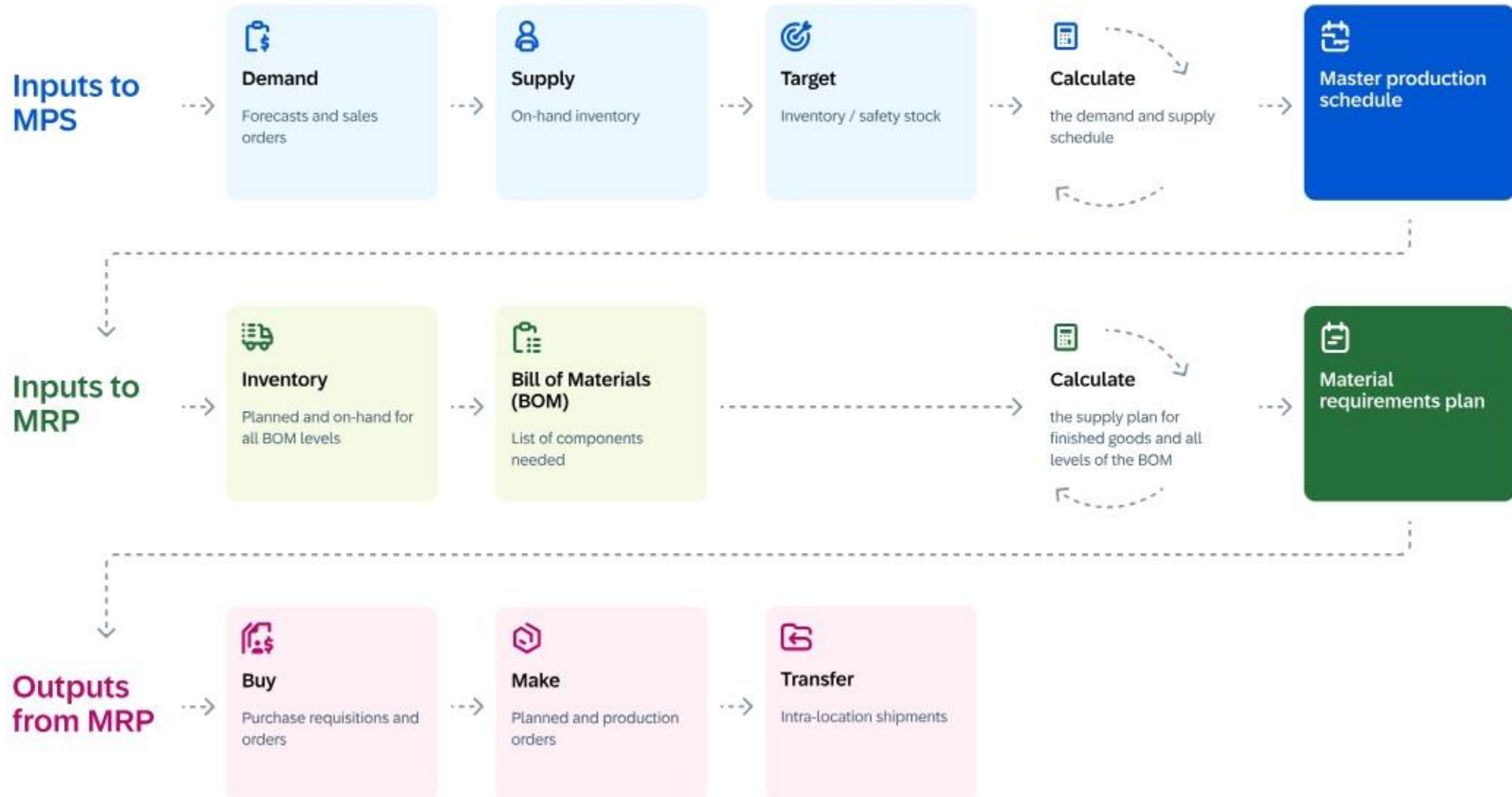
- calculates the required quantity and date for final products needed to meet demand.
- calculation = sales department's customer orders + forecasts, - expected on-hand inventory.
- **build-to-order** manufacturers will primarily focus on customer orders.
- **Make-to-stock** companies emphasize forecasts
- -> feed the master production schedule (MPS), which is the agreement between all the stakeholders on what will be produced – such as given capacity, inventory, and profitability.

Determine the supply

- BOM + MPS for all the products -> MRP runs step-by-step, calculate the assemblies, components, and materials that must be produced or purchased over the planning period.
- it checks the needed quantities against available inventory, called netting, to identify net shortages for each component.
- Using predefined parameters, such as lot sizing, it determines the proper “make or buy” quantity for each item.
- Finally, it calculates the proper start date for the acquisition, using either the purchase or production lead time as appropriate and sends this information to the purchasing department or production control.

MRP process flow

MRP and MPS schedule flow chart



MRP Requires

- Master production schedule (what is to be made and when)
- Product specifications (i.e. Bill of Materials = materials and parts of the product)
- Inventory availability (what is already in stock)
- Purchase orders outstanding (what is on order, also called expected receipts)
- Lead times (how long it takes to get various components)

MRP key functionalities

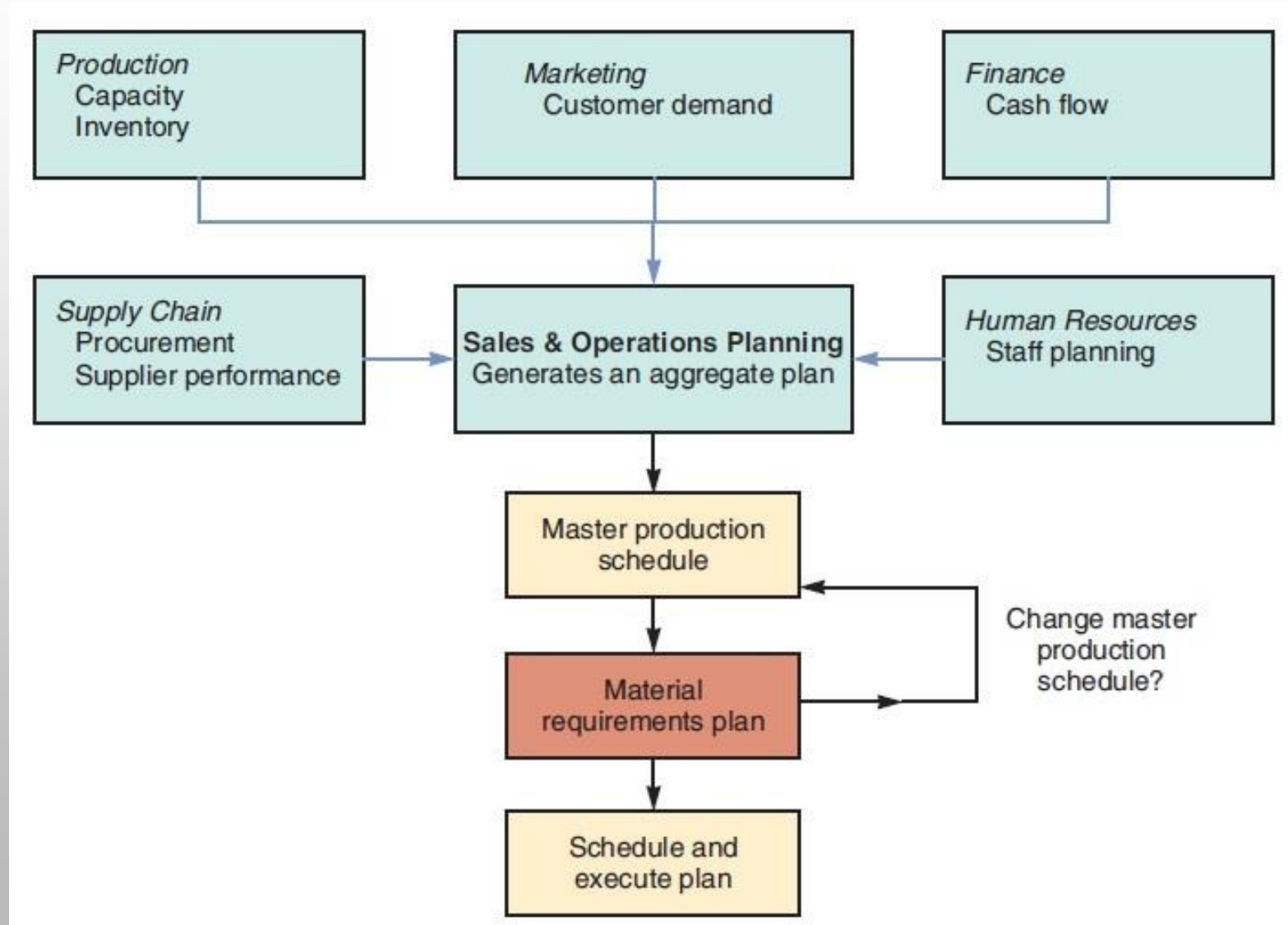
3 principal inputs

- BOM (Bill of Materials)
- “master schedule”, outlining the desired quantum of finished products and
- “inventory record file”, tells the existing inventory on hand and pending orders

Master Production Schedule (MPS)

- A timetable that specifies what is to be made (usually finished goods) and when. It specifies how many end items will be produced within specified periods of time.
 - ✓ What to produce
 - ✓ How many
 - ✓ When
- It determines precisely the feasibility of a schedule within aggregate capacity constraints.
- *MPS disaggregates the aggregate plan. The aggregate production plan refers to families of products while MPS refers to specific products.*
- The aggregate production plan sets the upper and lower bounds of the MPS.

Production Planning



MPS Example

Products	Dec 2017				Jan 2018			
Week	1	2	3	4	1	2	3	4
Master Production Plan								
Dark chocolate Easter eggs			150	100		100		200
White chocolate Easter eggs			100	100	50	50	100	150
Milk Chocolate Easter eggs	300	250		250	350	250	450	400
Aggregate production plan of Easter eggs	1250				2100			

Bill Of Materials (BOM)

- List of components, ingredients, and materials, their description and the quantities needed to produce a final product item.
- **A food recipe is also a BOM.**
- BOM = Product tree structure + quantities per component
 - Product tree Level 0 refers to the final product.
 - Items above any level are called parents
 - Items below any level are called children or components.

What's included in a Bill of Materials?



BOM of Airpods

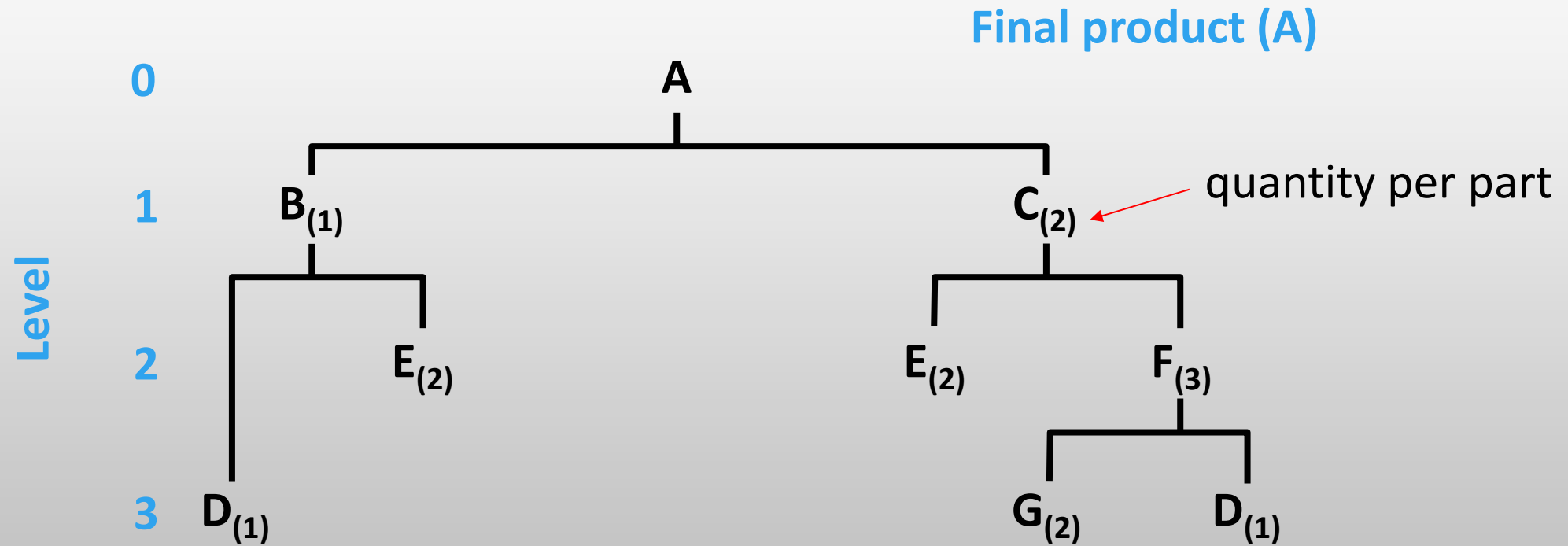
Bill of Materials (BOM)

Product Name : AirPods™ Pro
 Assembly Name : A1722
 Author: John Doe
 Assembly Revision : 21
 Approval Date : 17-Dec-18



Part ID	Part Na	Categ	Description	Critical	Qty	Jnit	Phase	Proces	ocureme	endo	MOQ	Lead Time	Fixed Cost	Jnit Cos	Cost
98835688	VL53LO	Periphera	Optical Sensor	N	2	each	RTS		OTS						\$ 1.18
98838466	DBF002B	Periphera	Dual Beam-Forming Microphone	Y	2	each	In Production		MTS	STMicro	10,000	10		\$ 0.59	\$ 1.98
10030	PIFA00320	Periphera	Bluetooth Antenna	Y	1	each	In Production		OTS	Foxconn	50,000	25		\$ 0.99	\$ 0.85
2771	BIS1	Consuma	Industrial Two-Component Adhesive	N	0.5	mL	RTS		OTS	Pegatro	5,000	70		\$ 0.85	\$ 0.03
										TAPIR		2		\$ 0.06	

BOM – Product Tree Example (1)



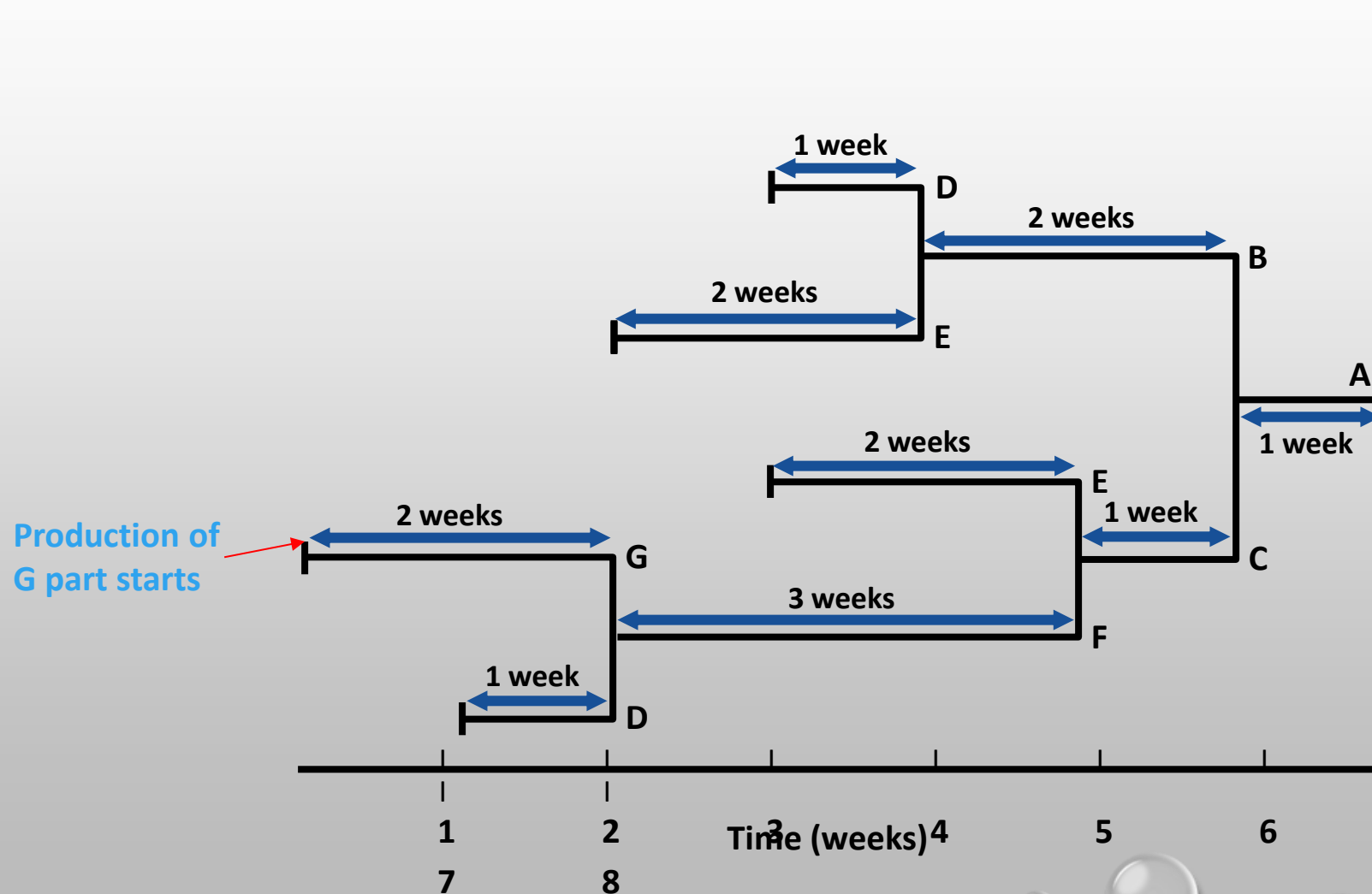
BOM – Product Tree Example (2)

Order of Final Product A	30 items
We need	
Part B	$1 \times \#A = 1 \times 30 = 30$
Part C	$2 \times \#A = 2 \times 30 = 60$
Part D	$1 \times \#B + 1 \times \#F = 1 \times 30 + 1 \times 180 = 210$
Part E	$2 \times \#B + 2 \times \#C = 2 \times 30 + 2 \times 60 = 180$
Part F	$3 \times \#C = 3 \times 60 = 180$
Part G	$2 \times \#F = 2 \times 180 = 360$

Lead Times for Dependent Demand

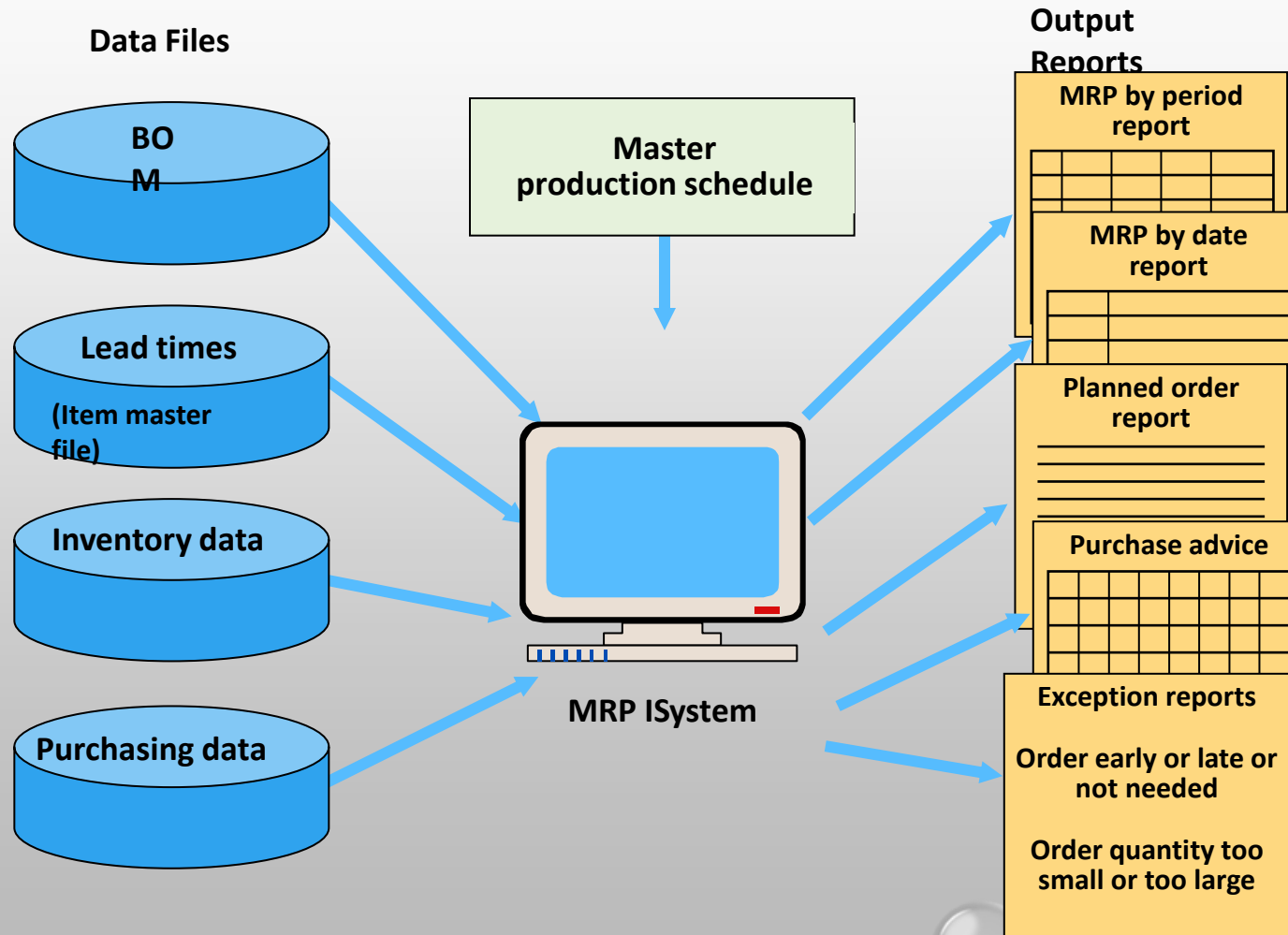
- The time required to purchase, produce, or assemble an item.
 - ✓ Manufactured item: sum of order, wait, move, queue, setup and run times for each component.
 - ✓ Purchased item: the time between recognition of need for an order and when it is available for production.
 - ✓ Lead times -> *Time-phased production* of final product

Time-Phased Production of Product A



Lead time (in weeks)	
Part B	2
Part C	1
Part D	1
Part E	2
Part F	3
Part G	2
A	1

MRP System



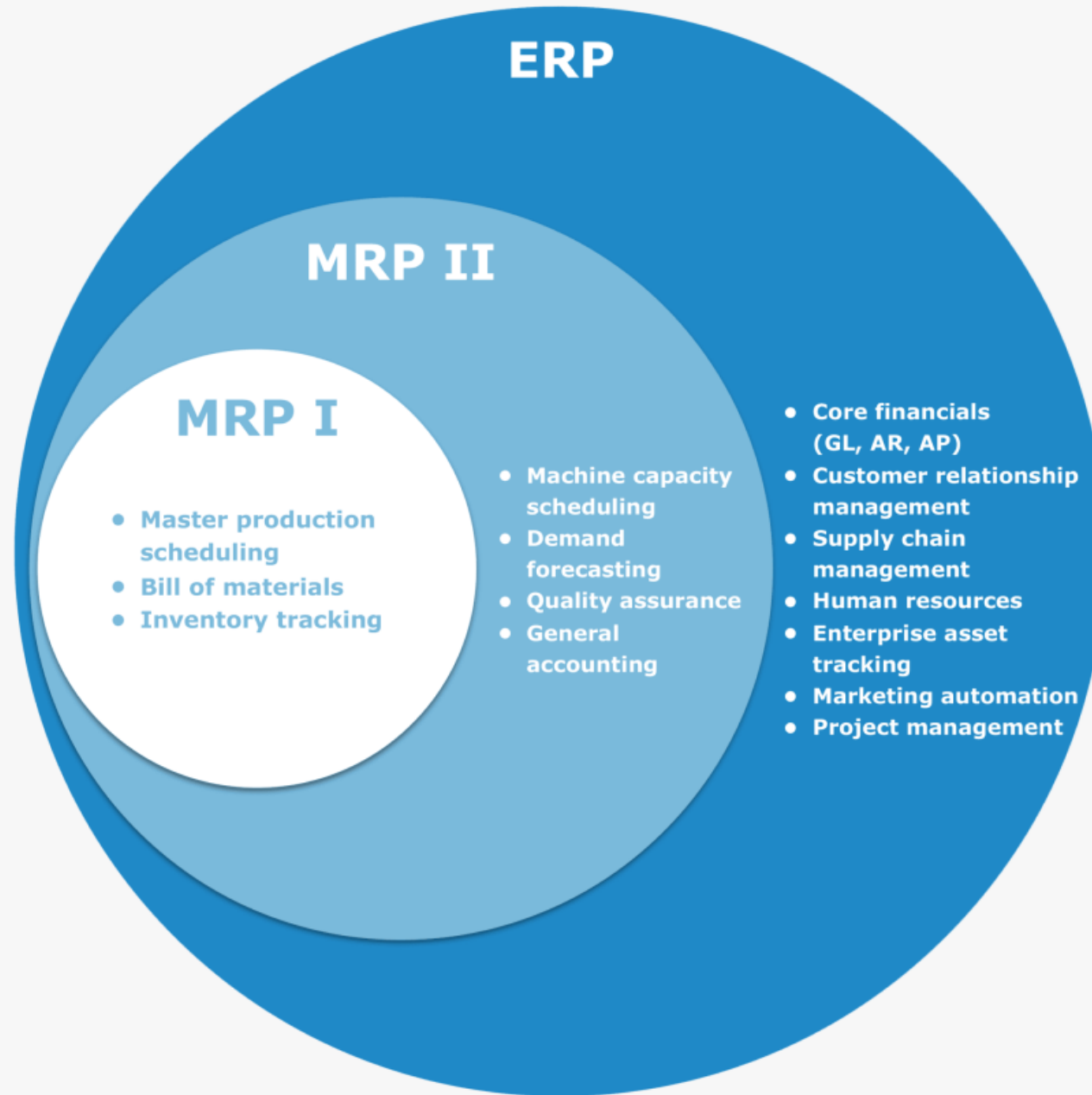
MRP Benefits

- Timely and accurate re-planning
- Low levels of in-process inventories
- Tracking material requirements
- Automatic allocation of production time
- Automatic determination of inventory usage
- Improved inventory planning and scheduling
- **Faster response to market changes and shifts**

MRP II

- MRP II : Manufacturing Resources Planning
- MRP is expanded.
- MRP II concerns not only the planning of materials but the planning and scheduling of all the resources involved in production e.g. costs, labor-hours, machine-hours, capacities etc.

MRP II



MRP Software

Software	Starting Price	Deployment	Implementation	Best For
Brahmin Solutions	\$199/month	Cloud (SaaS)	3–6 weeks	Growing manufacturers (\$500K–\$50M revenue)
MRPeasy	~\$49/user/month	Cloud (SaaS)	1–4 weeks	Very small shops (<50 employees)
Katana	~\$199/month	Cloud (SaaS)	2–6 weeks	Make-to-order / Shopify-based manufacturers
Fishbowl	~\$329/month	On-premise / Cloud	4–8 weeks	QuickBooks-centric manufacturers needing on-premise control
Cin7	~\$349/month	Cloud (SaaS)	4–10 weeks	Manufacturers with B2B distribution
Odoo	Free / ~\$31/user/month	Cloud / Self-hosted	4–16 weeks	Tech-savvy teams needing customization
NetSuite	~\$2,000+/month (quote-based)	Cloud (SaaS)	3–6 months	Large manufacturers (\$50M+), full ERP needs
Craftybase	~\$41/month	Cloud (SaaS)	1–2 weeks	Small artisan / craft manufacturers
Wherefour	Custom pricing	Cloud (SaaS)	Varies	Food, beverage, and regulated industries
inFlow	~\$186/month	Cloud + Desktop ↓	1–3 weeks	Small businesses with light manufacturing



Καλή συνέχεια!

cleobar@hua.gr