ETH zürich

Discovering Management

Discovering Production and Operations Management (POM)

March 2020

Dr. Henrik Franke

Chair of Production and Operations Management

Dr. Henrik Franke

- Postdoc POM since 2019
  ETH Zürich, CH
- Doctorate (empirical OSCM)
  EBS Universität, DE
- M.Sc. Management
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- B.Sc. Industrial Engineering
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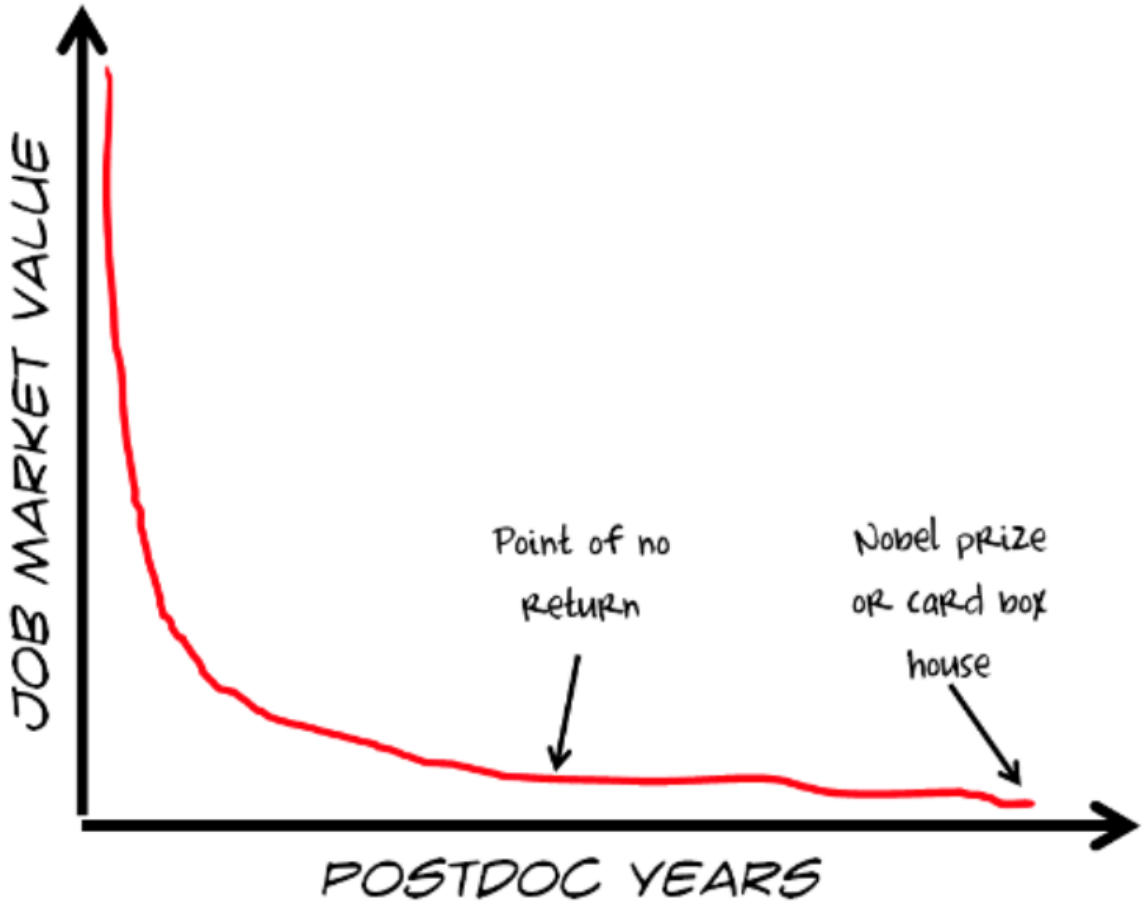


Learning outcomes

- Understand what drives productivity (the “EFFs”)
- Explain **operations strategy** and the process-view of operations
  - SIPOC, 4Ms
  - Competitive priorities
- Understand **capacity management** and Little’s law
- Explain **process types** and the CODP

- Optional: Know POM decision areas and connection to SCM
- Optional: Understand behavioral POM research

The Pig Factory
A warm-up

Photo: Chipotle Inc. (The Scarecrow, 2013)

Draw a pig

The situation

We operate a “pig farm,” a *Pig drawings Ltd.* factory

You are a worker

- Take a blank piece of paper and draw a pig
- Estimated production time is 1 minute.

- Don’t forget to write your first name with capital letters
- Hold it up when you are done.

Reflections

The 2 “Effs”

Effectiveness

The degree to which something is successful in producing a desired result

(Oxford Dictionaries)

“Doing the right things”

Efficiency

The state or quality of being efficient.

Efficient = achieving maximum productivity with minimum wasted effort or expense

(Oxford Dictionaries)

“Doing the things right”

The customer directly cares about effectiveness, and indirectly about efficiency

The Basic Goal of POM

It seeks to implement systems and processes that are

- **Repeatable** (i.e., can be done again)
- **Consistent** (i.e., produces the same result)
- **Reliable** (i.e., does not break down randomly)

Michael Schumacher. F1 champion 1994, 1995, 2000, 2001, 2002, 2003, 2004

Operations has **nothing** to do with strategy. Operations is the acting part of the organization. It is concerned with the operational and tactical levels

U.S. companies in the 60s

Manufacturing is the “missing link” in corporate strategy (1969). You **can** compete through manufacturing

C. Wickham Skinner

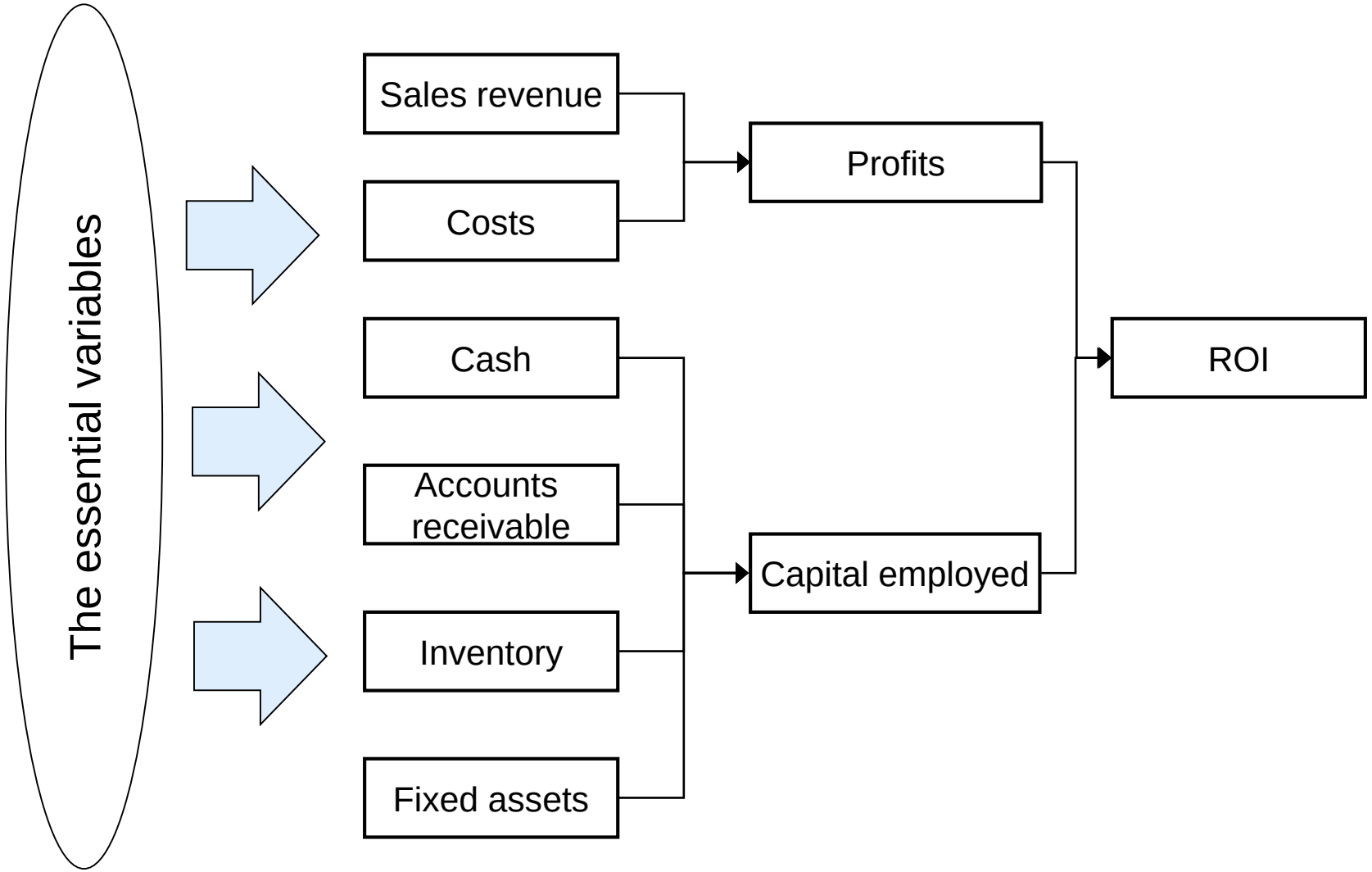
https://www.hbs.edu/news/releases/Pages/c-wickham-skinner-obituary.aspx

What is Production and Operations Management (POM)?

- POM is at the heart of any business
- POM covers the business processes that transform input into output and deliver products and services to customers
- POM is concerned with the productivity of technology, people, and processes
- POM is not only important in the manufacturing sector but also in the service sector

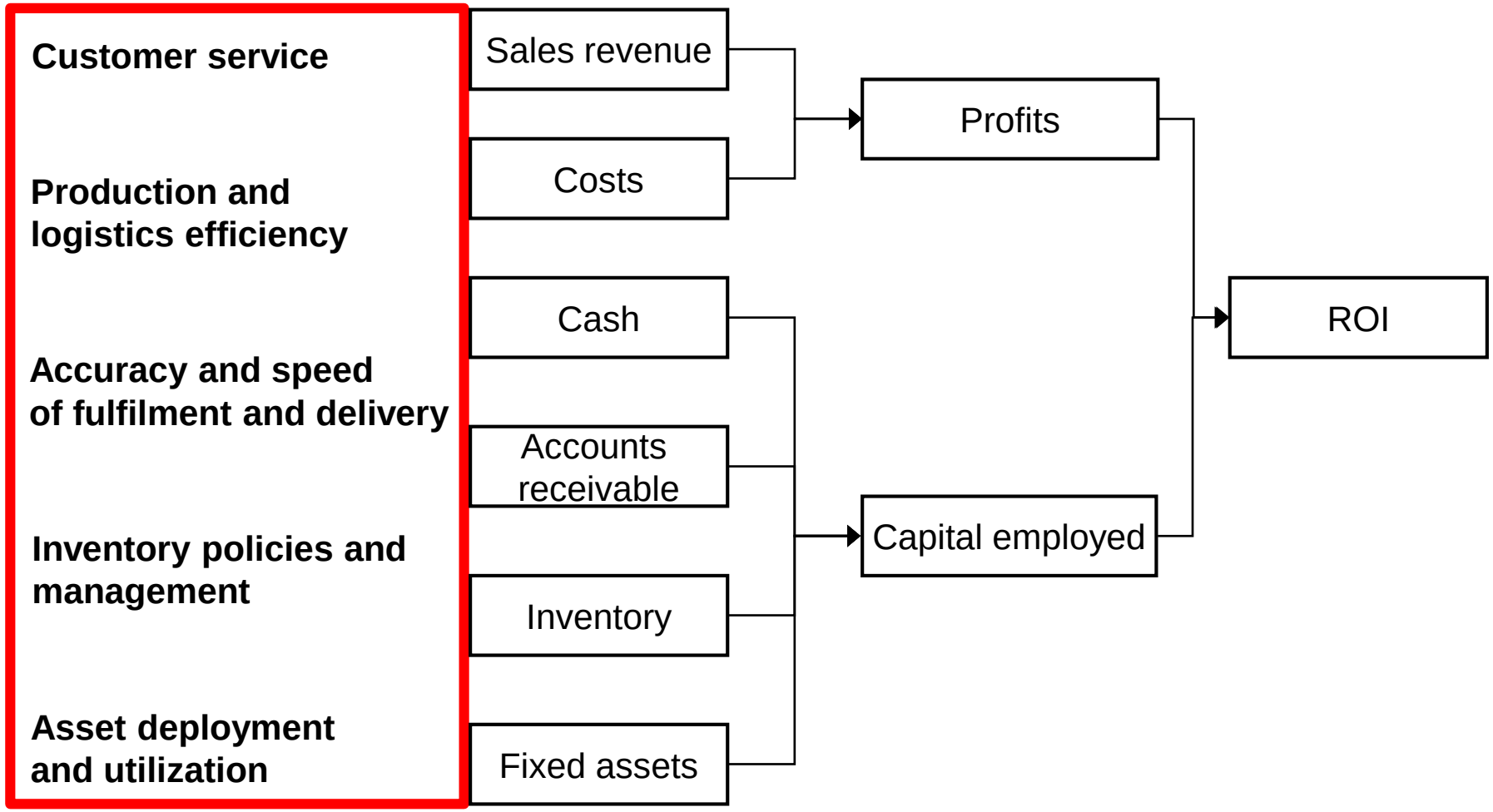
Did you know that the largest portion of assets and employees in most organizations are engaged in the operations function?

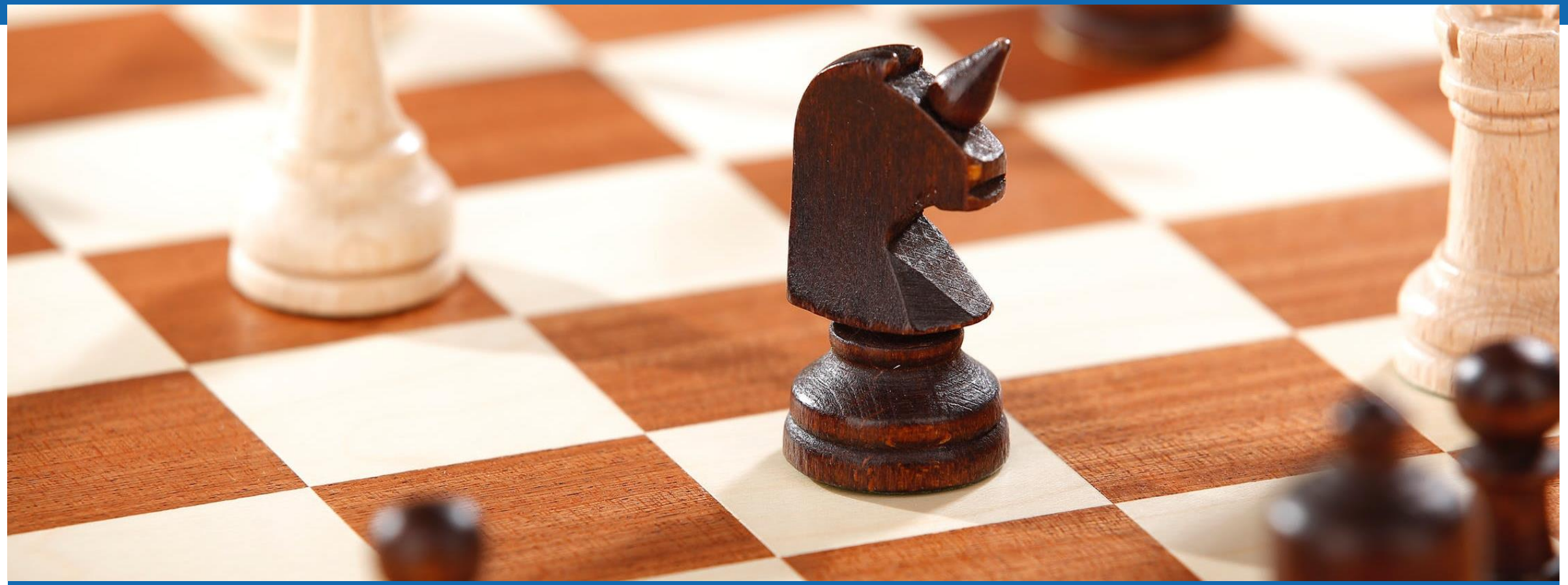
How operations contribute to financial results



How operations contribute to financial results

This is POM!

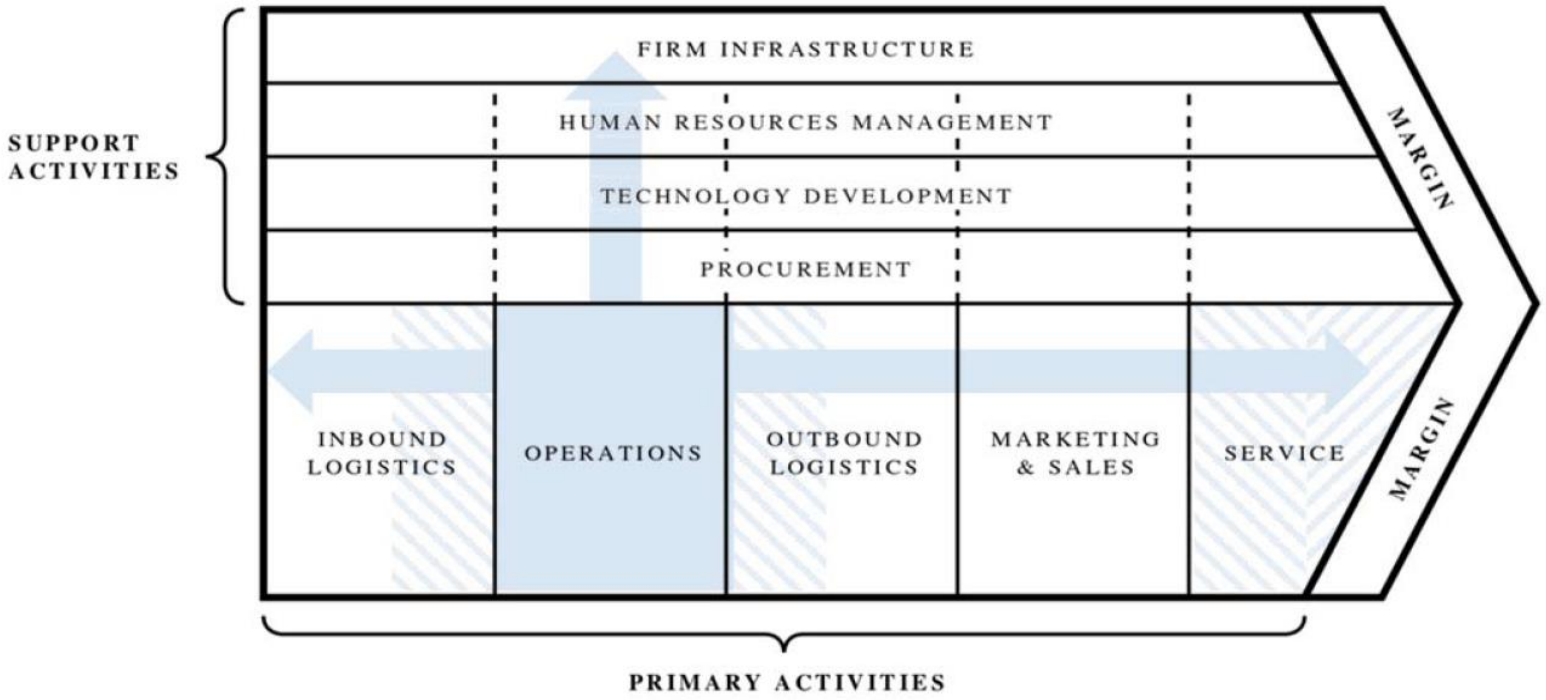




Operations and Strategy

What is Production and Operations Management (POM)?

The activity of managing resources of the organization that transform input into output, and delivers goods and services
(Paton, Clegg, Hsuan & Pilkington, 2011)



Porter, Michael E., 1985, “Competitive Advantage”. Ch.1, pp.11-15. The Free Press. NY.

What is an Operations Strategy?

"The total **pattern of decisions** which shape the long-term **capabilities** of any type of operation and their **contribution** to overall strategy, through the **reconciliation** of market requirements with operations resources" (Slack and Lewis, 2008)

Operations Strategy Key Elements

(1) Competitive priorities	(2) Production system	(3) Strategic decision areas
The **priorities/capabilities** to support the company's competitive advantage	The design of the manufacturing **process** (or production system)	The **structure** and **infrastructure** of the operations

Competitive priorities/capabilities

- **Cost**
- **Quality (conformity)**
- **Delivery**
- **Flexibility**
- Performance
- Uniqueness
- Speed-to-market
- Service
- Innovation
- Personalization
- Safety
- Social responsibility

The 4 original

Different priorities require different operations strategies!

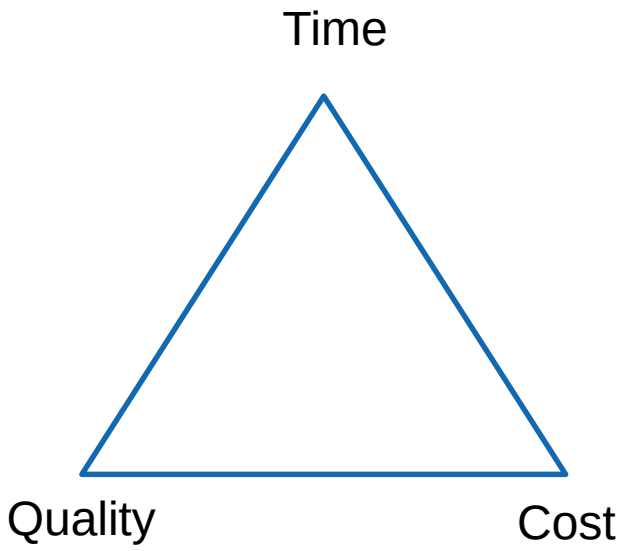
Trade-offs!

Trade-offs in competitive priorities/capabilities

In operations systems, there are potentially many *trade-offs*.

Some examples are:

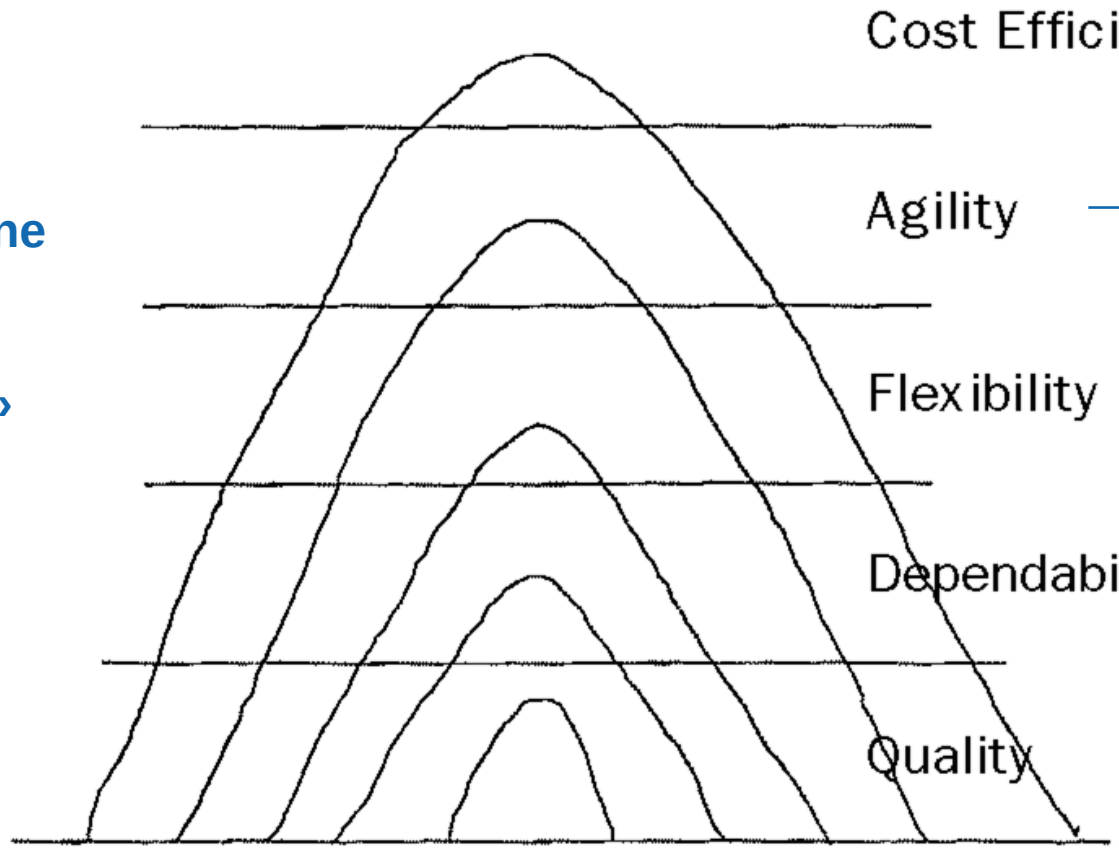
- Low price against quality
- Quick delivery against quality
- Low price against available variety
- Speed against flexibility
- Personalized attention against volume of customers



You need to carefully choose your competitive priorities and consider potential trade-offs

Trade-offs or cumulative capabilities?

«The Sandcone Model of competitive capabilities»



Speed of new product development

Delivery speed
On-time delivery

Ferdows, K. & De Meyer, A., Lasting Improvements in Manufacturing Performance: In Search of a New Theory. Journal of Operations Management, 1990, Vol. 9, No. 2, pp 168-184.

From Competitive Priorities to Key Performance Indicators (KPI)

Cost

- Reduce inventory
- Increase capacity utilization
- Reduce production costs
- Increase labor productivity

Quality

- Improve customer satisfaction
- Reduce the number of complaints
- Reduce variability (offer consistent, reliable quality)
- Reduce quality defects (scrap/rework) in manufacturing processes

Delivery

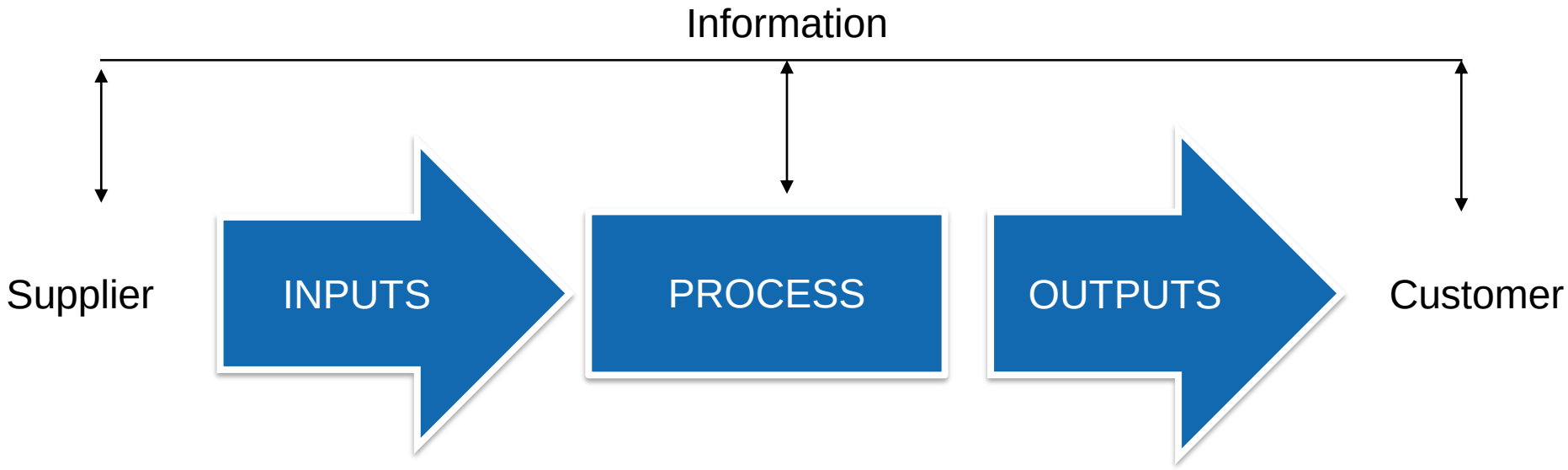
- Provide fast deliveries
- Meet delivery promises
- Reduce production lead time

Flexibility

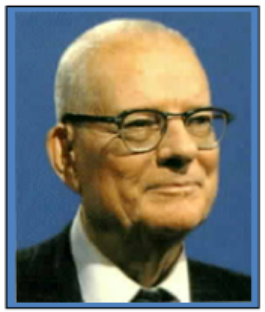
- Adjust capacity quickly
- Make rapid volume changes
- Make rapid design changes
- Offer a large number of product features
- Offer a large degree of product variety

Boyer & McDermott (1999) Strategic consensus in operations strategy. *Journal of Operations Management,* 17 (3), pp. 289-305.

Process View of Operations: SIPOC and 4M



Resources (4Ms)
Man
Machine
Material
Method
(Money)

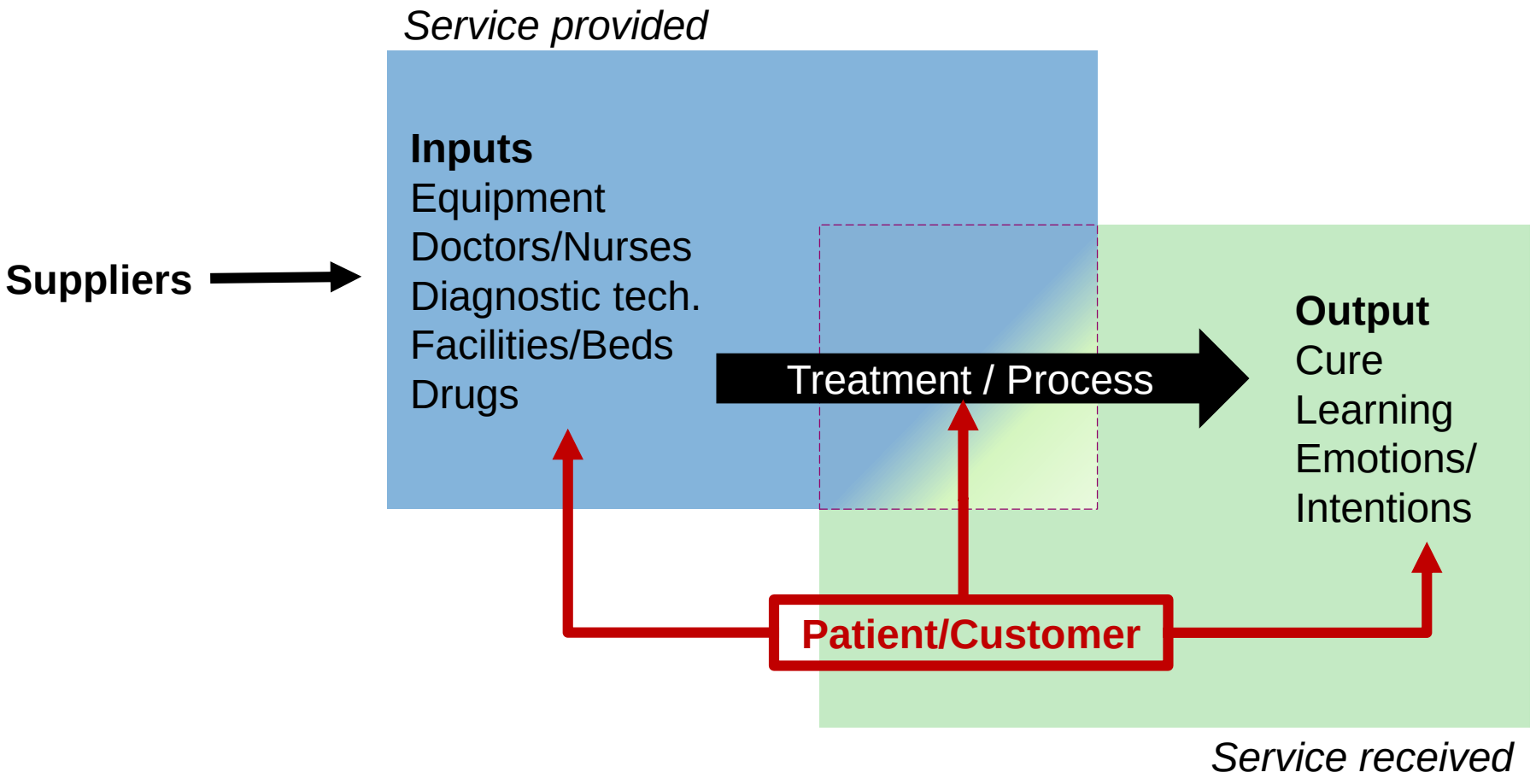


1900-1993

"If you can't describe what you are doing as a process, you don't know what you're doing."

- W. Edwards Deming

The operations perspective: SIPOC for medical services?



Source: Johnston, Clark & Shulver (2012)

SIPOC

Think about the elements of SIPOC for a pizzeria

www.wooclap.com/PCYGQJ

Suppliers	Inputs	Process	Outputs	Customers

Capacity Management

38% of US consumers would not buy Corona under any circumstances (n=737, BusinessInsider.com, Feb 28 2020)

Capacity Management

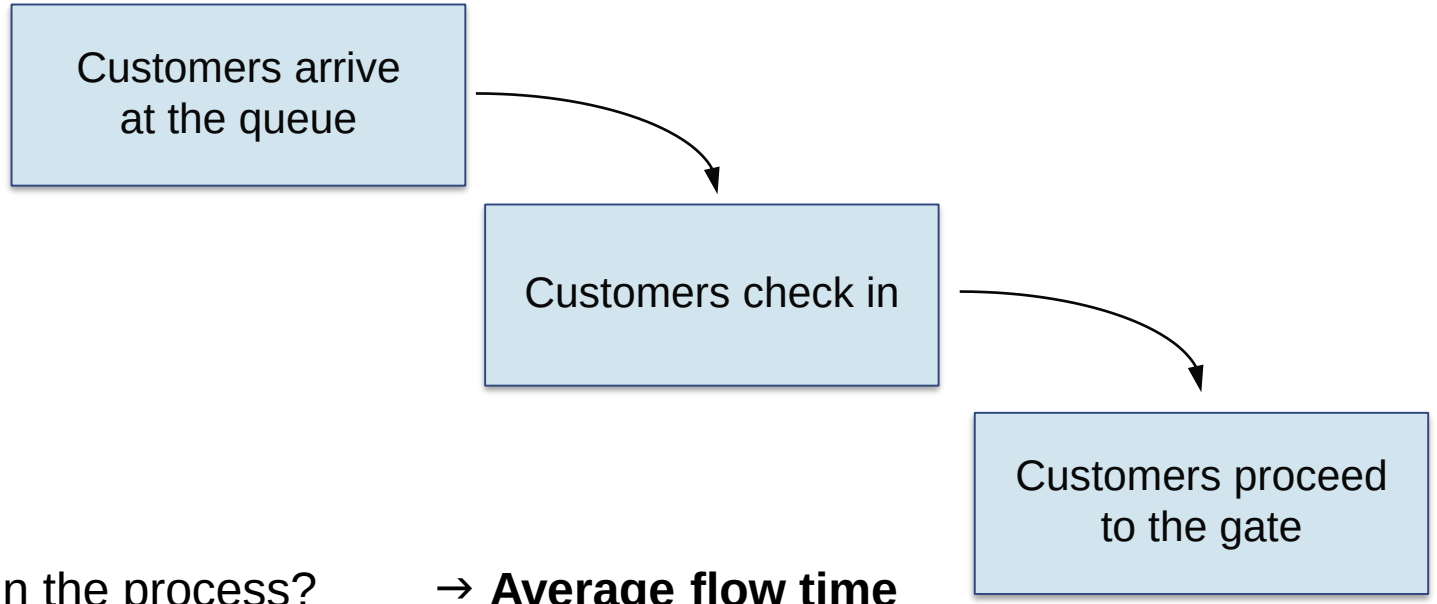
What is capacity?

- An organization's capability to provide certain products or services in a specific time period
- Typically, capacity is measured relative to time (i.e., units/hour)

Why does capacity matter?

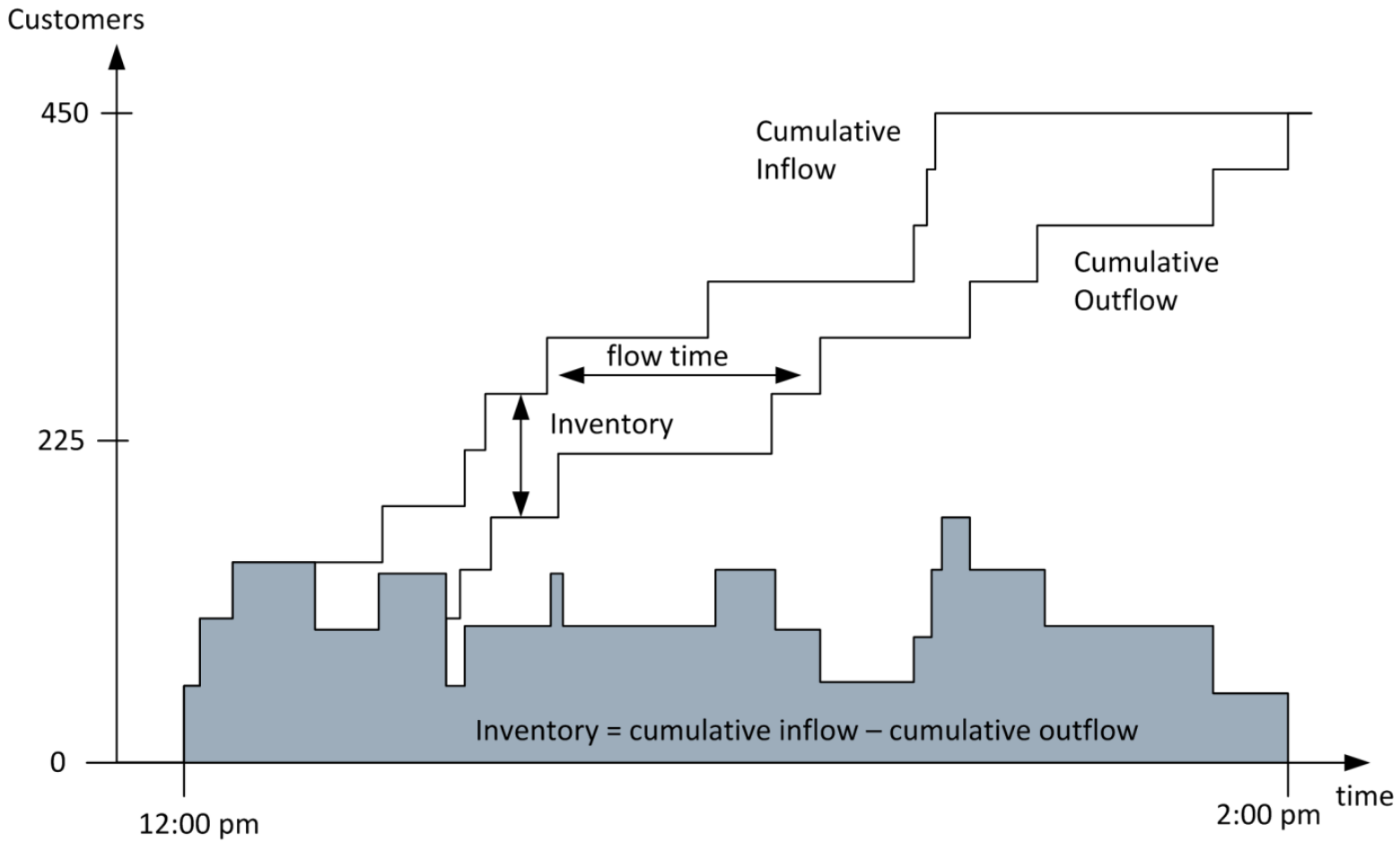
- Level of appropriate capacity to meet current and future demand
- In most industries, capacity planning has a large impact on performance
- Challenge to determine the "right" amount of capacity

1-Stage Check-in Process



- How long do flow units (people) spend in the process? → **Average flow time**
- How many people are in the process? → **Average inventory**
- How many people leave the system within 1 hour? → **Average flow rate**

Flow Time, Inventory, and Flow Rate



How long do customers spend in the process?

→ **Average flow time**

How many people are in the process?

→ **Average inventory**

How many people leave the system within 1 hour?

→ **Average flow rate**

Adapted from: Cachon, Terwiesch, Matching supply with demand

Little‘s Law

- **THEOREM (LITTLE’S LAW):**
  Average inventory = (Average flow time) x (Average flow rate)

- **Why is Little‘s Law cool?**
  - This law holds always
  - Sequencing does not matter (FIFO, LIFO, etc.)
  - Variability does not matter
  - Is a mathematical, not natural law → we don’t need empirical evidence
  - Helps to simplify things substantially

Further applications of Little's Law

Little's Law can be applied to a multitude of processes

	U.S. Immigration	Champagne Industry	MBA Program	Large PC Manufacturer
Flow unit	Application for immigration benefit	Bottle of champagne	MBA student	Computer
Flow rate/ throughput	Approved or rejected visa cases: 6.3 million per year	260 million bottles per year	600 students per year	5,000 units per day
Flow time	Average processing time: 7.6 months	Average time in cellar: 3.46 years	2 years	10 days
Inventory	Pending cases: 4.0 million cases	900 million bottles	1,200 students	50,000 computers

Source: Cachon, Terwiesch, Matching supply with demand

The larger picture: Little's Law and firms as black boxes

Financial statements include several indications on a firm's operational efficiency. Inventory is usually measured in monetary units. Little's Law helps us to estimate and interpret some key performance indicators.

Capacity, in this example, refers to the possibility to keep inventories. But, in general, lower inventory does not imply better operations management. Further KPIs are required, such as the average flow time.

Applying Little's Law in Kmart's and Wal-Mart's balance sheets

	January 28, 1998	January 27, 1999	January 26, 2000	January 31, 2001	January 29, 2002
Kmart Corp.					
Inventory	$ 6,367	$ 6,536	$ 6,350	$ 5,796	$ 4,825
Income					
Total operating revenue	$ 33,674	$ 35,925	$ 37,028	$ 36,151	$ 30,762
Cost of goods sold	$ 26,319	$ 28,161	$ 29,732	$ 29,853	$ 26,258
Net income	$ 518	$ 364	($268)	($2,446)	($3,219)
Wal-Mart Stores Inc.					
Inventory	$ 16,497	$ 17,076	$ 19,793	$ 21,644	$ 22,749
Income					
Total operating revenue	$119,299	$139,208	$166,809	$193,295	$219,812
Cost of goods sold	$ 93,438	$108,725	$129,664	$150,255	$171,562
Net income	$ 3,526	$ 4,430	$ 5,377	$ 6,295	$ 6,671

$$\text{Flow time} = \frac{\text{Inventory}}{\text{Flow rate}}$$

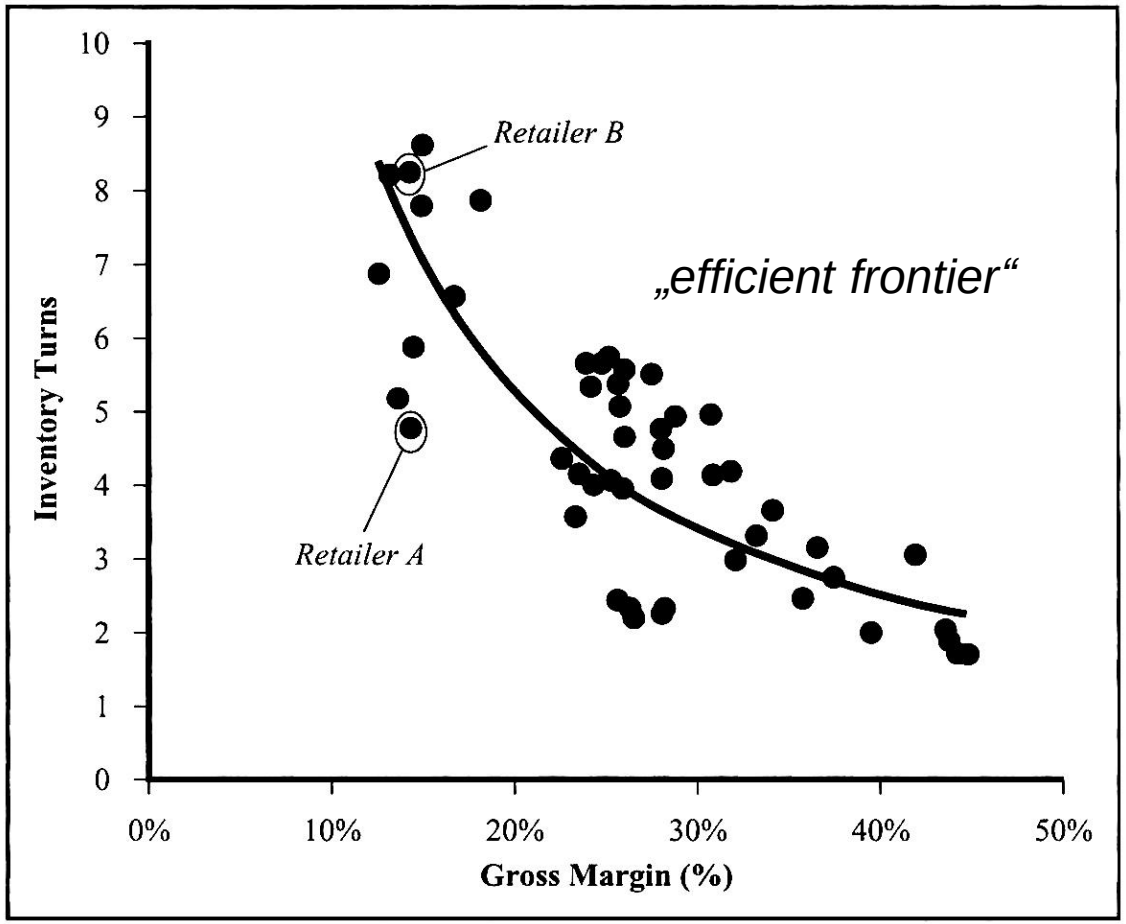
Source: Cachon, Terwiesch, Matching supply with demand

Reflection on Inventory Turns

Caution: Inventory turns are important, yet they are not everything!

It is natural that some products turn faster than others.

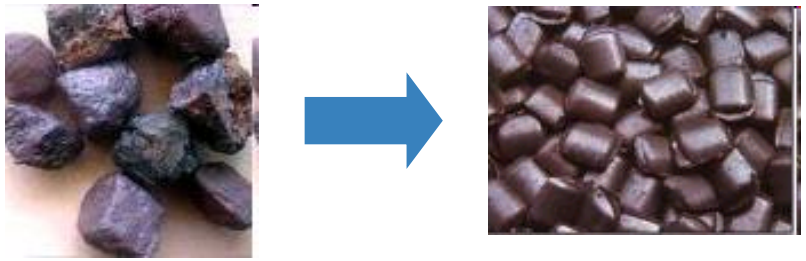
$$\text{Inventory turns} = \frac{1}{\text{Flow time}}$$



Source: Cachon, Terwiesch, Matching supply with demand

More Complex Production: Iron Ore Plant

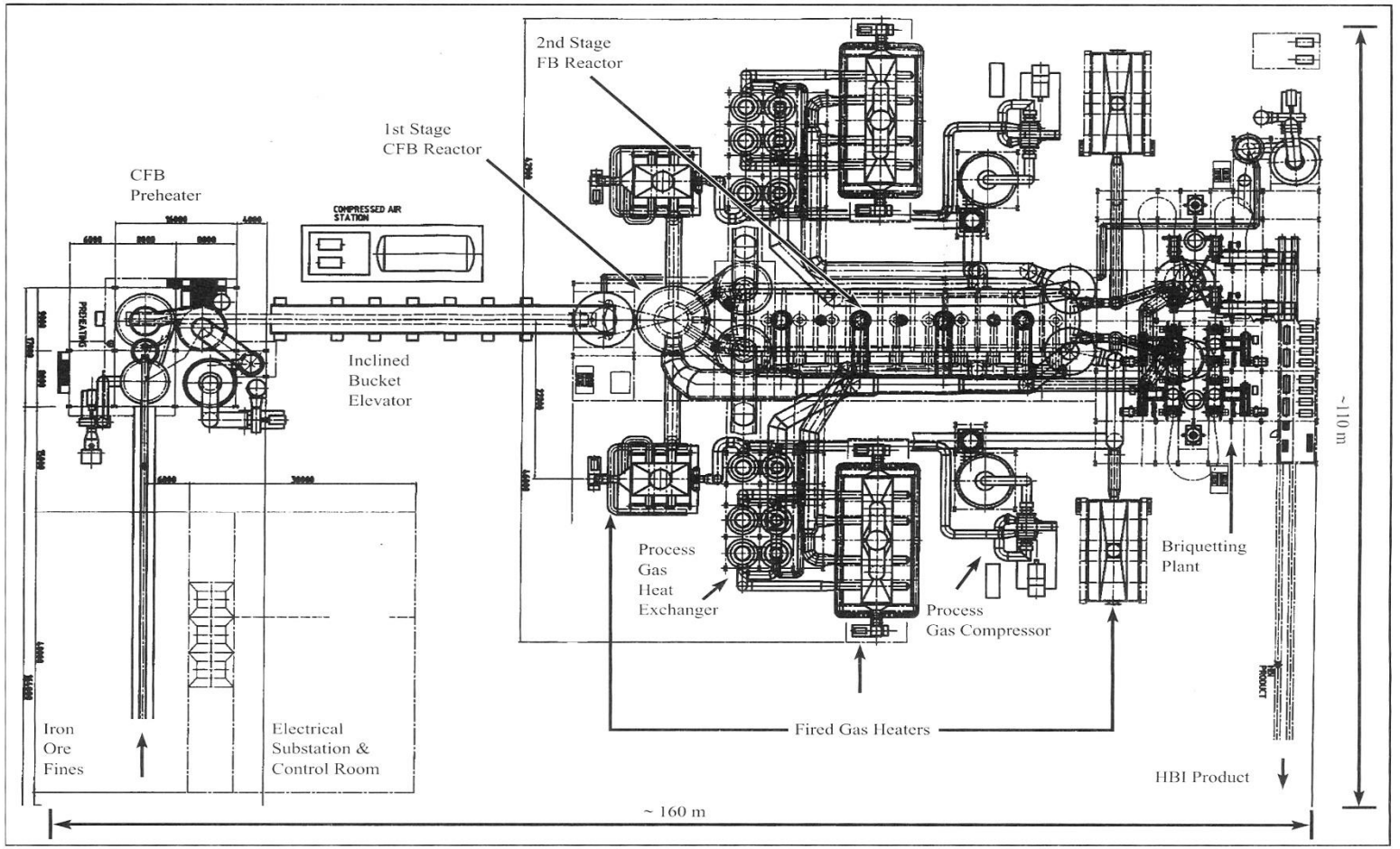
- The plant converts **iron ore** (in the form of iron ore fines) into **direct reduced iron** (DRI) **briquettes**



Source: Cachon, Terwiesch, Matching supply with demand

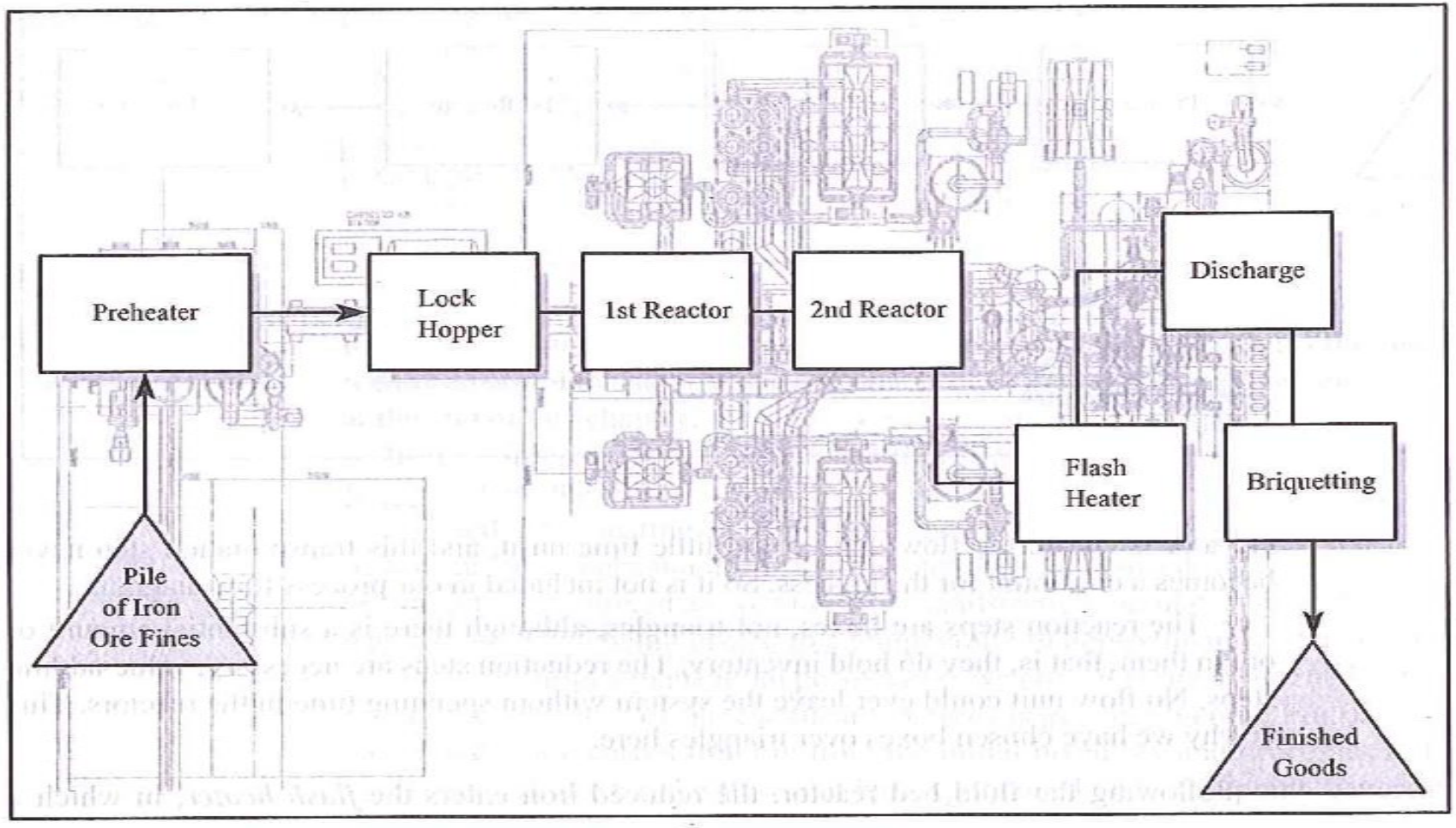
A Detailed Plan of the Plant

Source: Terwiesch and Loch 2002.



Source: Cachon, Terwiesch, Matching supply with demand

In POM, a higher level of abstraction is necessary

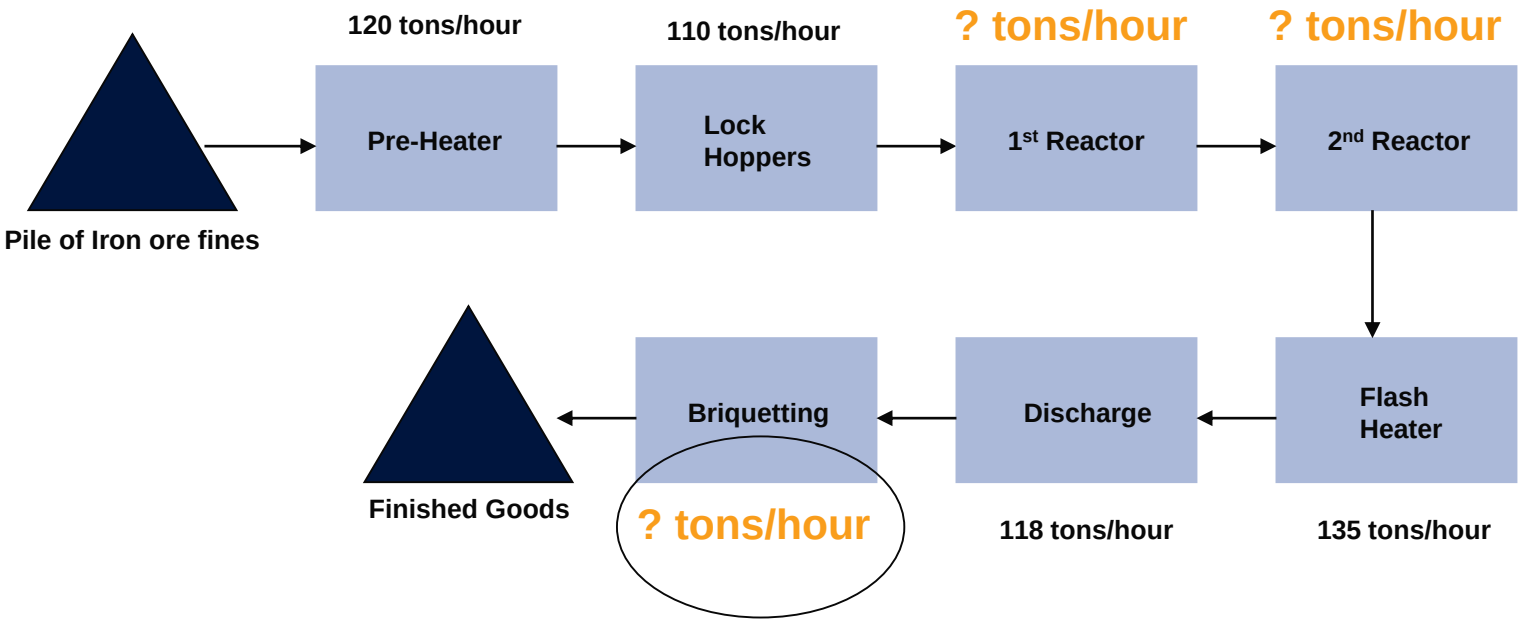


Buffers/ Inventories

Process Activities

Source: Cachon, Terwiesch, Matching supply with demand

Finding the „Bottleneck“



There are three briquetting machines which process parallel.
Each has a capacity of 55 tons/hour.

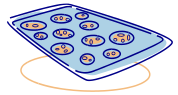
What is the overall flow rate of the process stage?

Campus Muffin Company

1. Place all ingredients in a mixing bowl and mix them

- your mixer can hold up to 2 dozen of muffins and it takes you 6 minutes for this step

2. Spoon the dough onto a tray



- spoon the dough onto a tray: your tray can hold 1 dozen of muffins and it takes you 2 minutes per tray to spoon the dough

3. Put the muffins into the oven and bake them

- your oven is small and can hold only 1 tray per time with negligible time to place the muffins in the oven. total baking time is 10 minutes.

4. Let them cool

- It takes 5 minutes for the muffins to cool.

5. Take a tray and carefully pack them in a box

- 2 more minutes to pack each dozen

Source: Bohn, Kristen's Cookie Company

Common Process Types

Engineer-to-Order (ETO)

- Create products and services from the drawing board to meet customer requirements

Make-to-Order (MTO)

- Make each order is to a particular customer specification after identification of an individual order

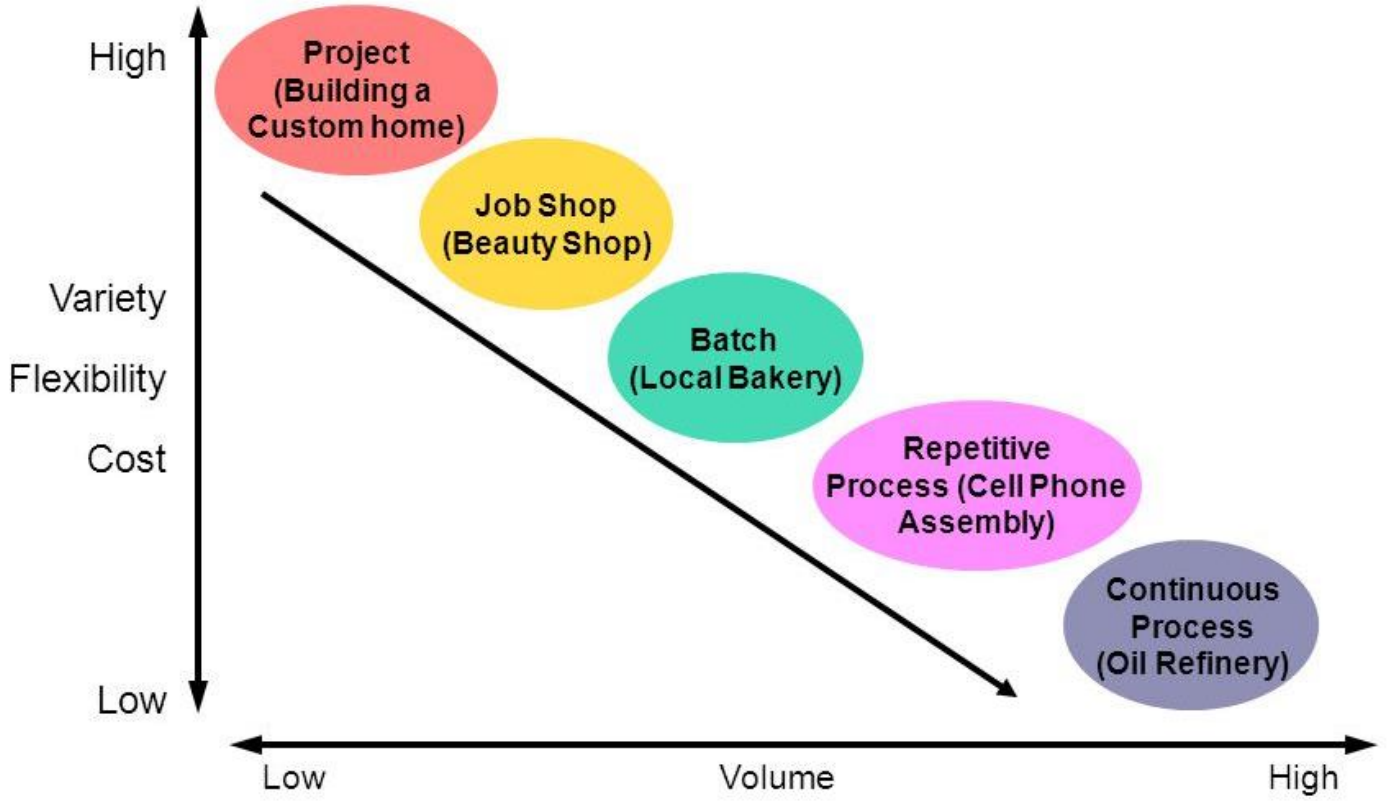
Assemble-to-order (ATO)

- Build sub-assemblies in advance of demand and assemble them to make the final product for a specific customer order

Make-to-Stock (MTS)

- Make standard items that are put into inventory, which can then be used immediately to fulfil customer demand

The Product-Process-Matrix

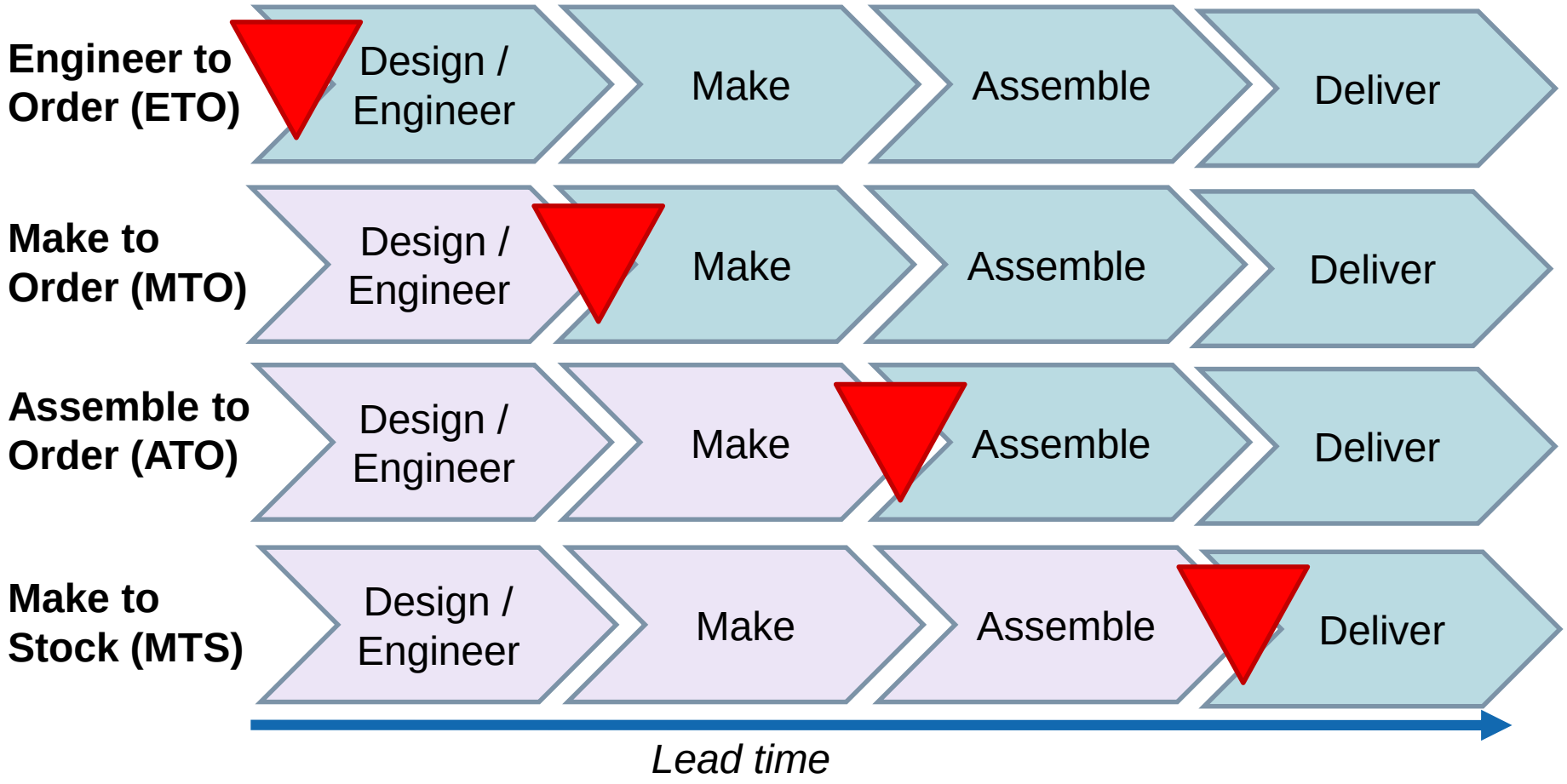


Source: Pearson Education, 2014

Customer Order Decoupling Point (CODP)

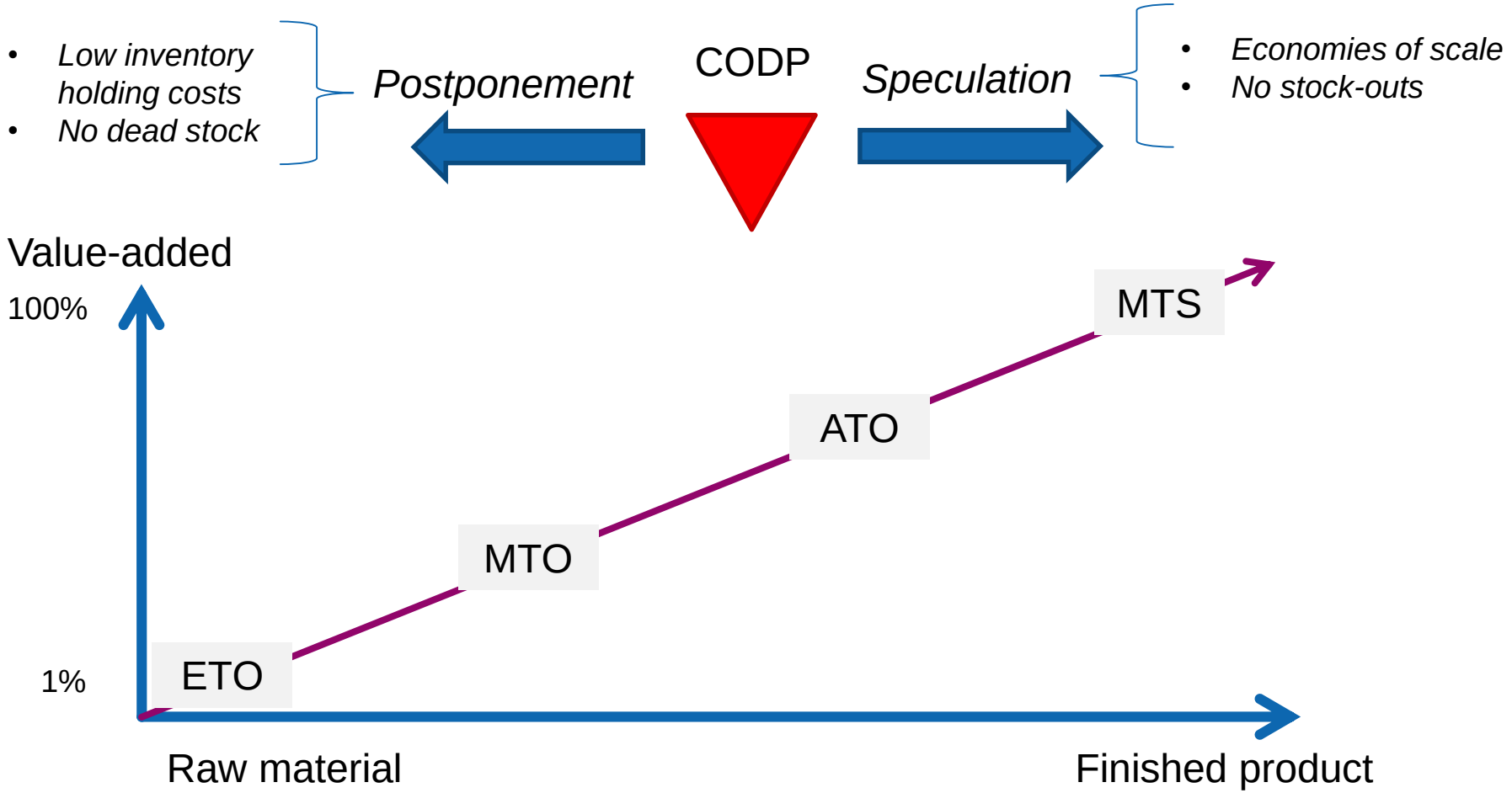
The CODP separates order-driven activities from forecast-driven activities

Customer Order Decoupling Point (CODP)

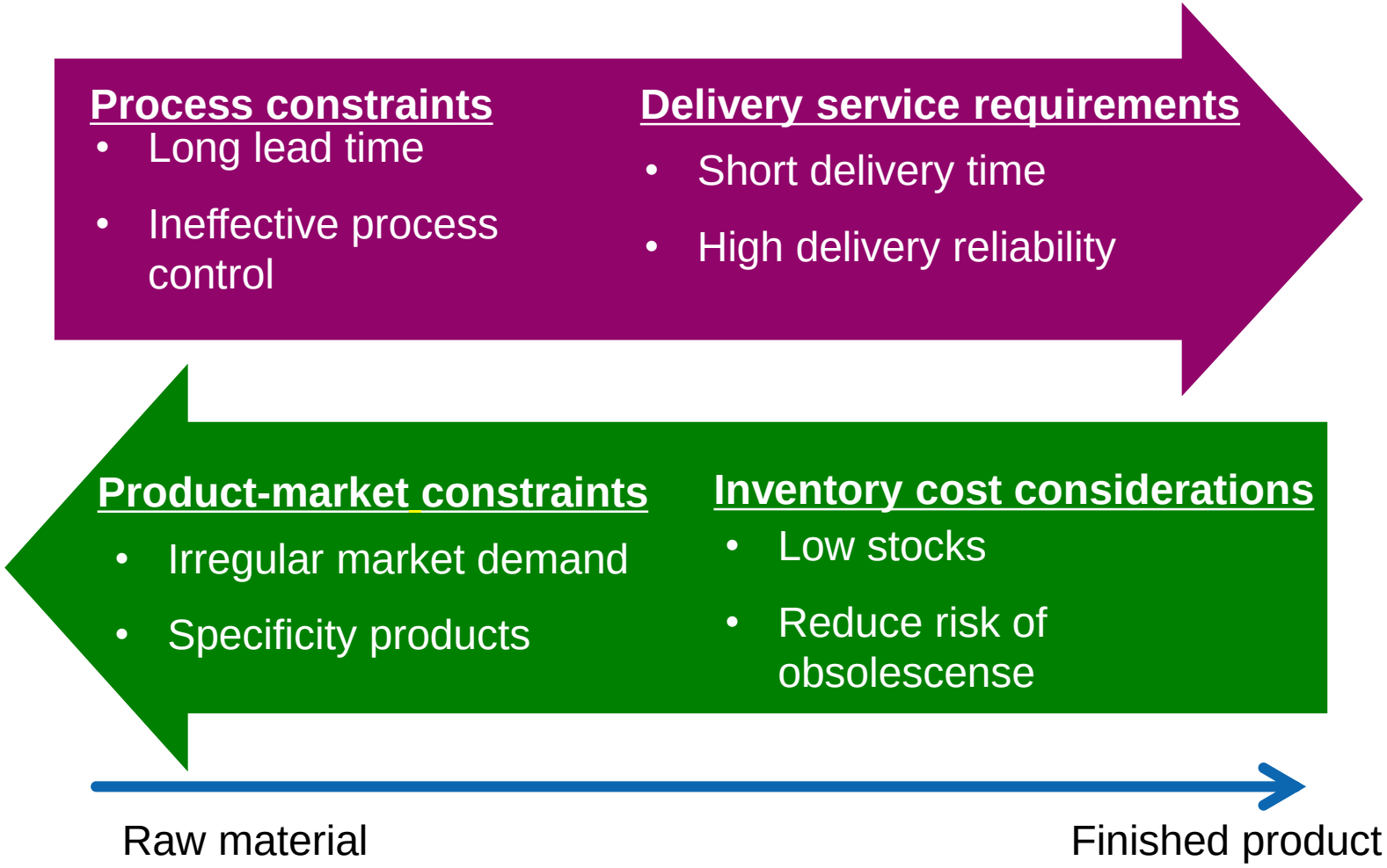


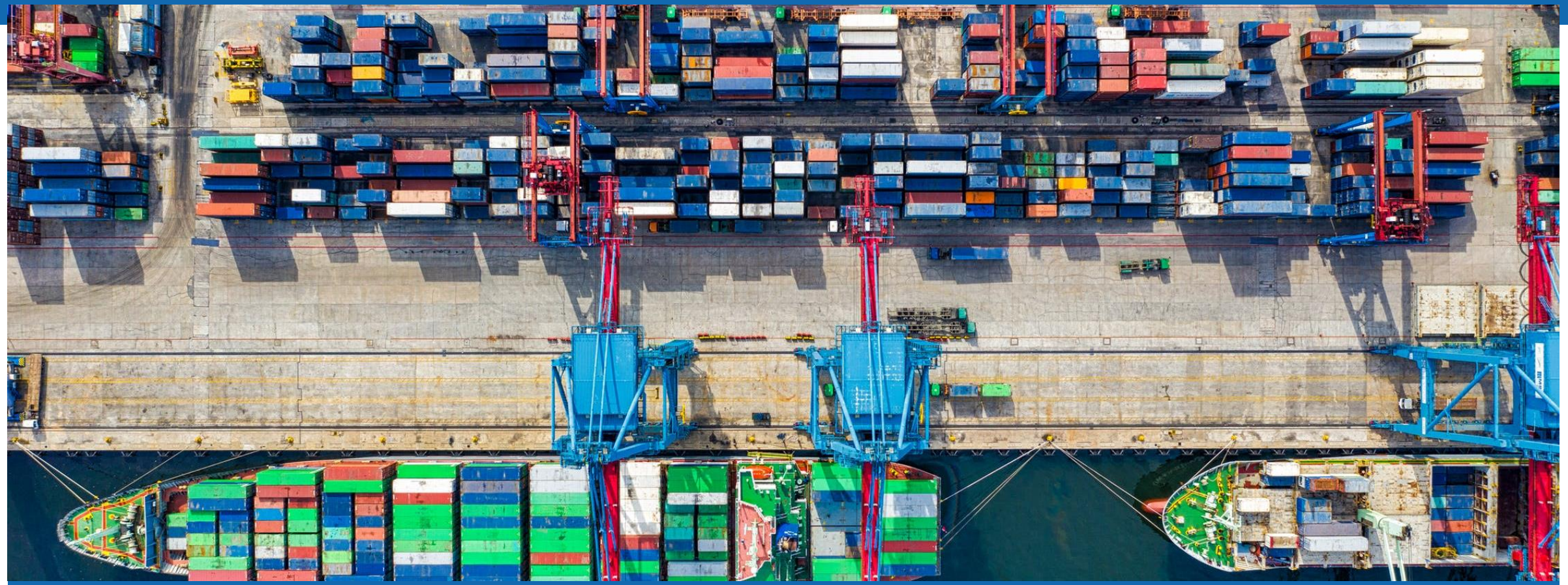
Customer not involved Customer involved CODP

Postponement vs speculation



What influences the position of the CODP?





Operations Decision Areas and SCM

Classification of Strategic Decision Areas

Infrastructural Decision Areas

1. Planning and control
2. Quality
3. Work organization
4. Human resources
5. New product development
6. Performance measurement

Structural Decision Areas

1. Facilities
2. Capacity
3. Process technology
4. Supply network

These are 10 areas where operations managers make decisions (i.e. «decision areas»)…according to many OM text books

Infrastructural Decision Areas

Infrastructural Decision Areas

1. Planning and control
2. Quality
3. Work organization
4. Human resources
5. New product development
6. Performance measurement

- Planning & control systems, centralization, tools,…
- Maintenance planning
- Stock levels
- Quality management policies and procedures
- Quality leadership
- Hierarchical structure
- Worker empowerment (giving workers a broader range of tasks, more planning/inspection responsibility)
- Recruitment, training, management style
- Use of small teams to solve problems
- Systems and procedures to introduce new products
- Recognition and reward systems

Structural Decision Areas

Structural Decision Areas

1. Facilities
2. Capacity
3. Process technology
4. Supply network

- Location, size, focus, layout
- Capacity planning: shifts, working hours, staffing levels
- Type and maturity of technology: Cimputer-Aided Design(CAD), Robotics, Computrized Numerical Control machines (CNC), knowledge-based systems, Material Requirements Planning (MRP), etc.
- Technology development internally or externally
- Technology for reducing costs or improving outcomes?
- Number of suppliers, distributors, and their capabilities
- Supplier relationships (partnership, integration, sharing, responsibilities)
- Make or buy
- Network configuration

A Global Supply Chain at Boeing

787 Dreamliner

https://www.huffingtonpost.com/2011/01/20/a-wing-and-a-prayer-outso_n_811498.html

HERSHEY'S

Hershey, PA

Canada
Mississauga, ON

United States
Ashland, OR
Hazleton, PA
Lancasster, PA
Memphis, TN
Robinson, IL
Stuarts Draft, VA

Mexico
El Salto
Monterrey

Brazil
Sao Roque

Greater China
Shanghai
Yudong
Zhoukou
Inner Mongolia

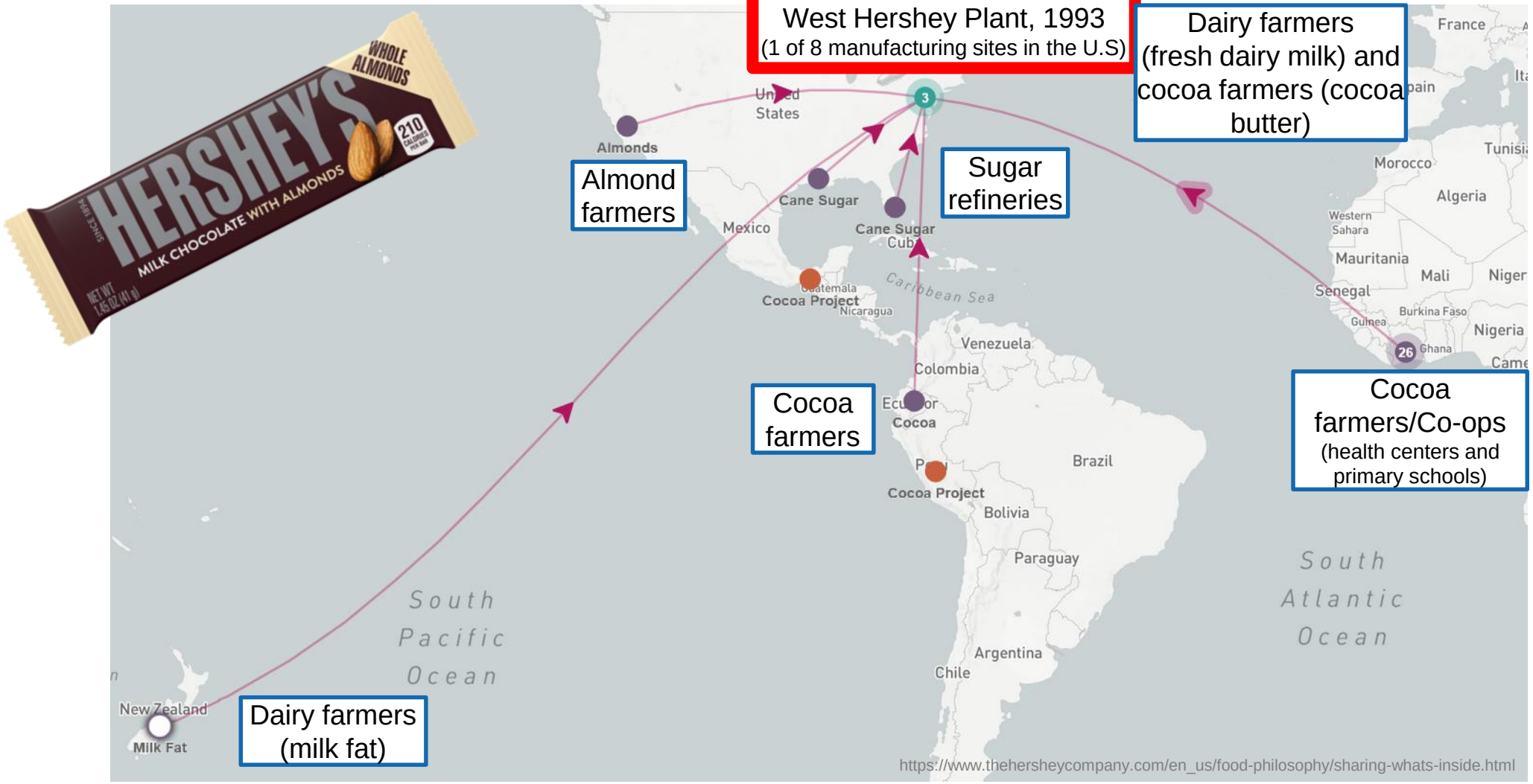
India
Mandideep, Madhya Pradesh

Malasya
Johor (2nd largest)

United Arab Emirates
Dubai

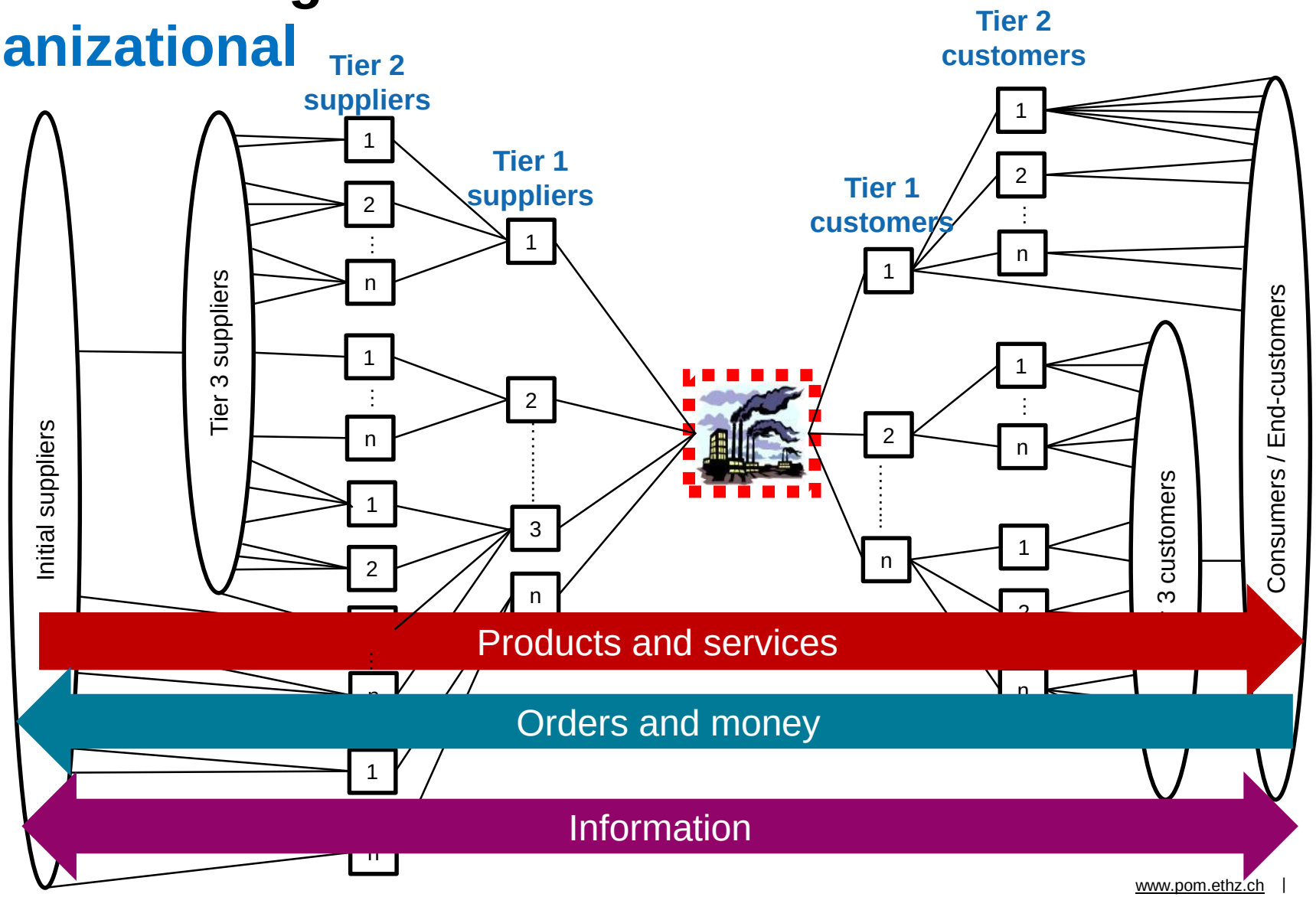
https://www.thehersheycompany.com/en_us/this-is-hershey/global-locations.html#top

Global Supply Chain at HERSHEY: Milk chocolate with almond bars



Supply chain management

Inter-organizational



Lamber, Cooper & Pagh, 1998, Supply Chain Management. Int. J. Log. Mngt.

Thank you!

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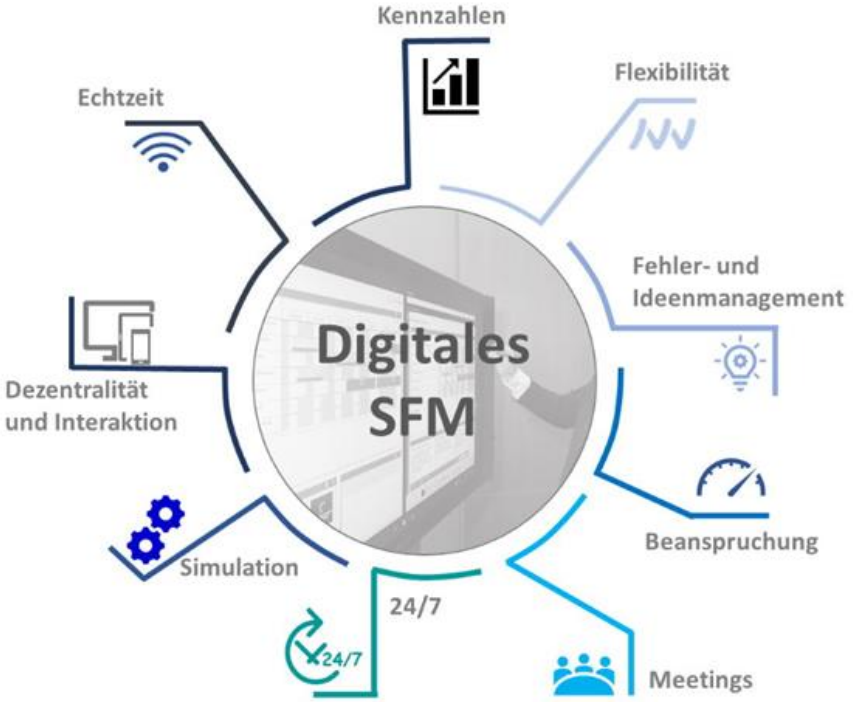
- ***Global Operations.*** Configuration, coordination, and improvement of global production networks.
- ***Behavioral Operations.*** The role of the human in POM.

➢ *pom.ethz.ch/the-chair/open-positions*

➢ *pom.ethz.ch/education/theses.html*

Master Thesis: Digital Shop Floor Management

This research shall shed light on the ***potentials and drawbacks*** *of digital SFM* by analyzing its application within different ***case study*** companies.



Chair of Production and Operations Management

Prof. Dr. Torbjörn Netland

Our **purpose** is to deliver **research that matters** and **teaching that inspires** with the determination of developing **better operations** in industry and society.

Recent research collaboration

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