



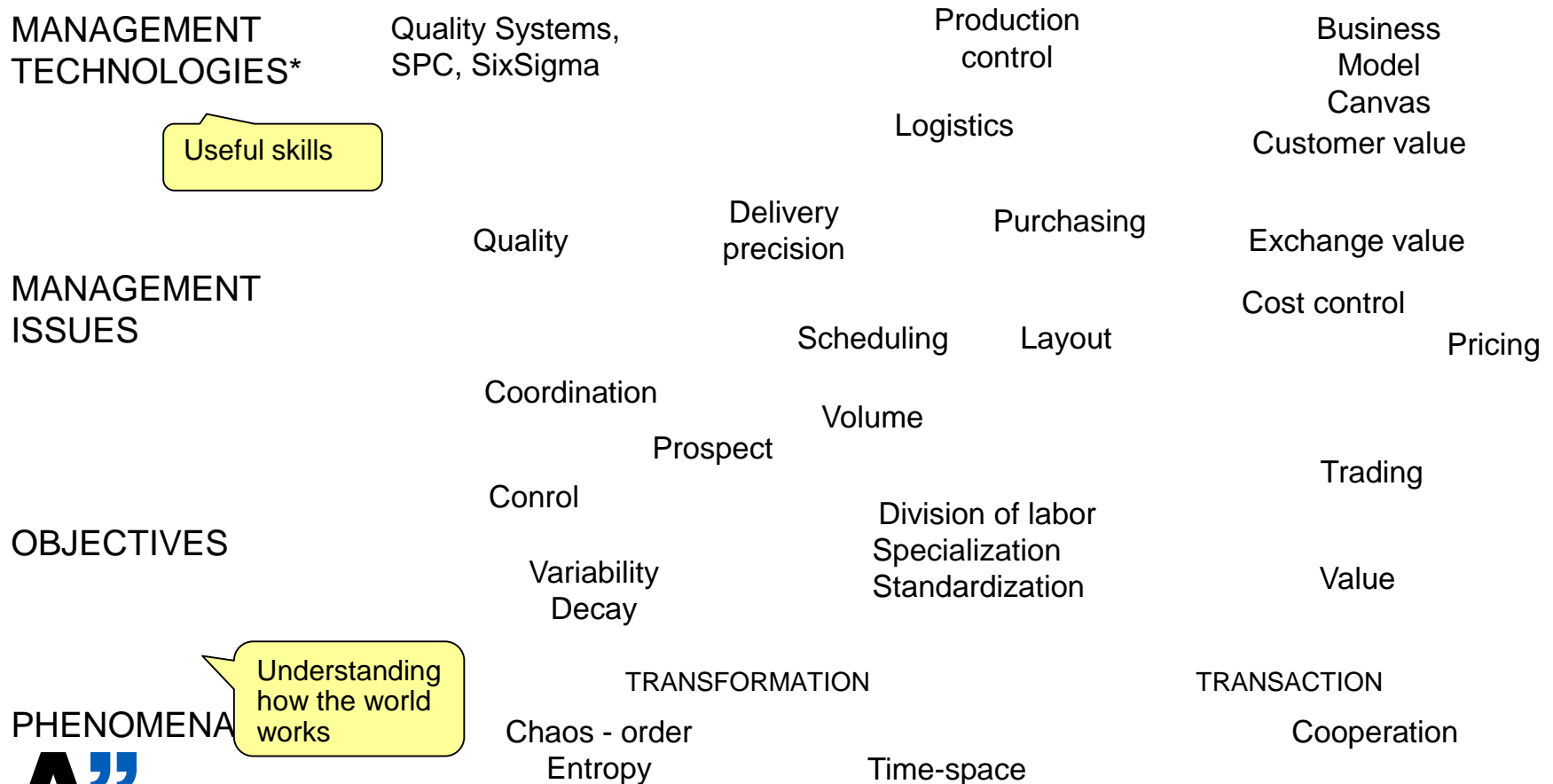
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# INTRODUCTION TO INDUSTRIAL ENGINEERING AND MANAGEMENT

TU-A1300

Paul Lillrank

# THE IDEA OF THE COURSE: FROM FUNDAMENTAL PHENOMENA TO MANAGEMENT TECHNOLOGIES



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\*) Technology here in the broad sense, see fig. #13.

# TUOTANTOTALOUS INDUSTRIAL ENGINEERING AND MANAGEMENT OPERATIONS MANAGEMENT

Produces knowledge about:

Production systems = Purposeful, value creating socio-techno-economic systems

Methods

- Empirical: mixed method: case, survey, simulation,...
- Theory: models

Results: managerial technologies for planning, management and improvement

Societal mission: Improve productivity: get more with less

# SUB-AREAS

Operations strategy: make or buy, locations, investments

Planning and control of production systems

Logistics: material- and information flows

Purchasing

Networks, partnering, and contracting

Quality and risk management

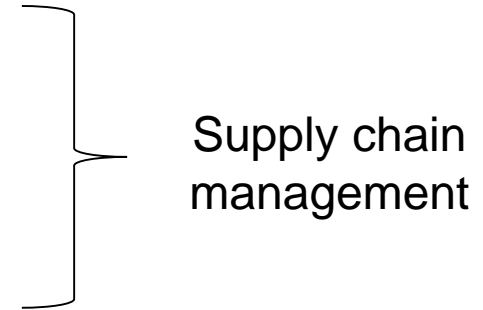
Project management

Continuous improvement

Management accounting

Human resources


Innovations



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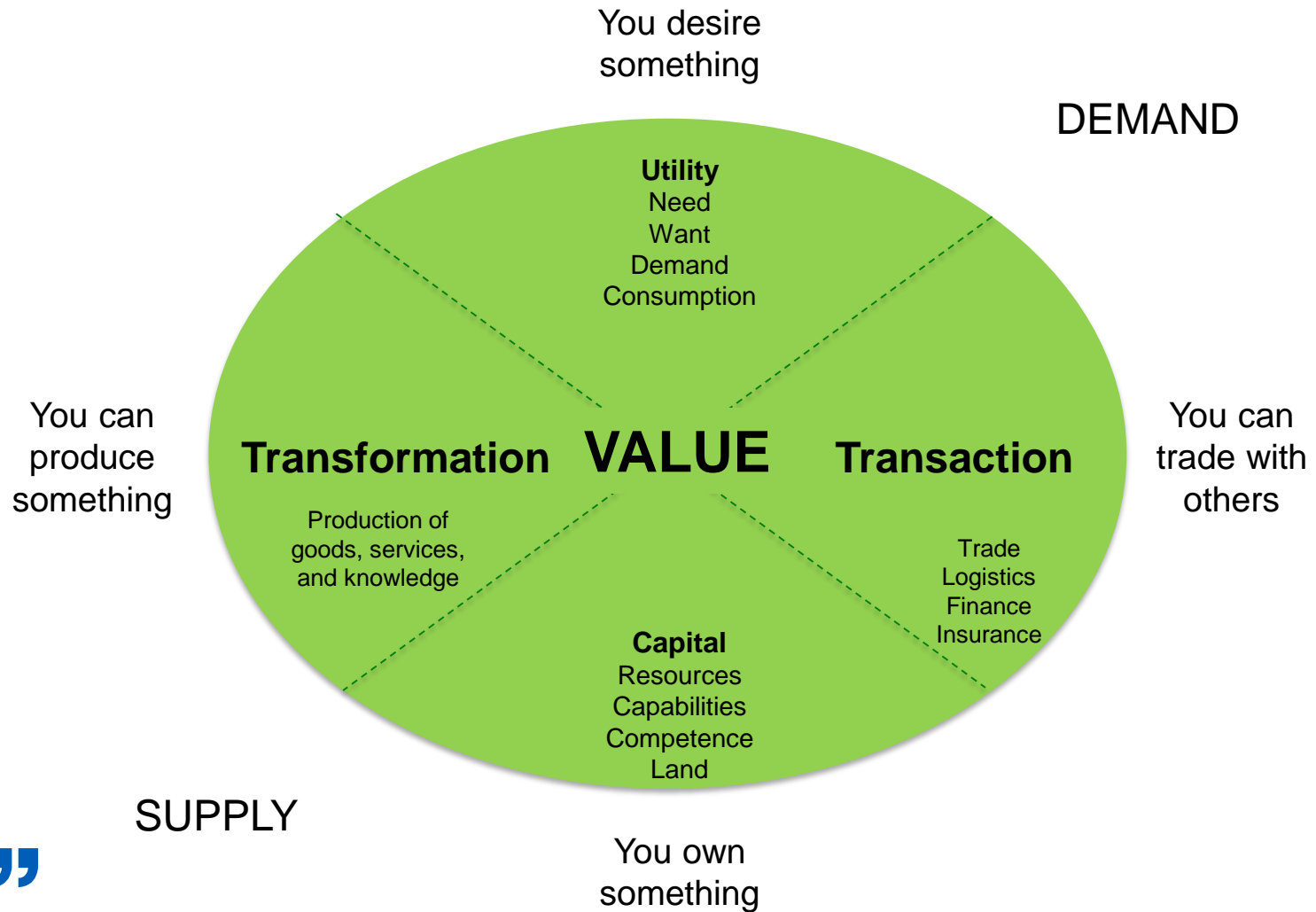
# THE NECESSARY INSTITUTIONS FOR ECONOMIC PROGRESS

1. Private ownership
  - Legal and legitimate protection of property and investment
  - Contracting
2. Scientific and technical thinking
  - Rationality: the world works in a way that can be known
  - Empiricism: observations and experimentation
3. Capital markets
  - Connect savers and investors
  - Spread risk
4. Logistics
  - Transport
  - Communication

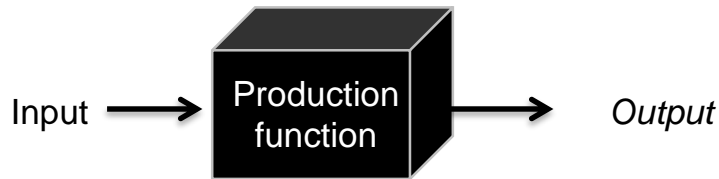


The world  
where  
Industrial  
Management  
can operate

# PURPOSEFUL ECONOMIC ACTIVITY



# PRODUCTION FUNCTIONS DO THE JOB



## Basic production functions

Extraction: Hunting & gathering, fishery, mining

Cultivation: Agriculture, animal husbandry, fermentation

Subtraction: Carving, machining

Forming: Molding, casting, pottery

Assembly: Construction, discrete manufacturing

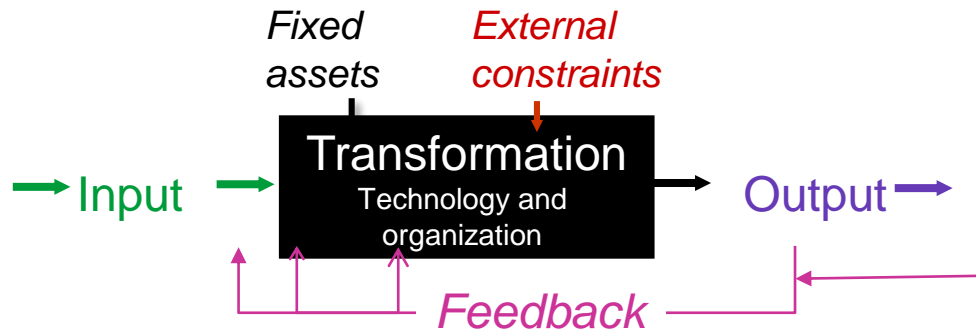
Chemical reaction: Process industries, petrochemicals

Addition: Candle-making, 3D-printing

*“Manufacturing is to apply controlled energy to matter in order to realize an idea.”*

Varnecke, H.J., The Fractal Company. Springer 1993.

# PRODUCTION FUNCTIONS ARE ORGANIZED INTO PROCESSES AND SYSTEMS



## Input

- orders
- material, energy, labor

Physical technologies and fixed assets

Cognitive technologies: capabilities and skills

Social technologies: organisation och processes

## External constraints

- regulation, trade barriers, availability of resources,...

## Output / throughput

- sellable goods

## Feedback

- control, learning



# TRANSACTIONS IN MARKETS

Economy: the science of rational management of scarcity

- *Oikonomie* (house) → housekeeping → economy

Self-sufficiency → exchange economy: social exchange, barter, pecuniary economy.

Trade: voluntary exchange of goods and services perceived to be beneficial to both parties

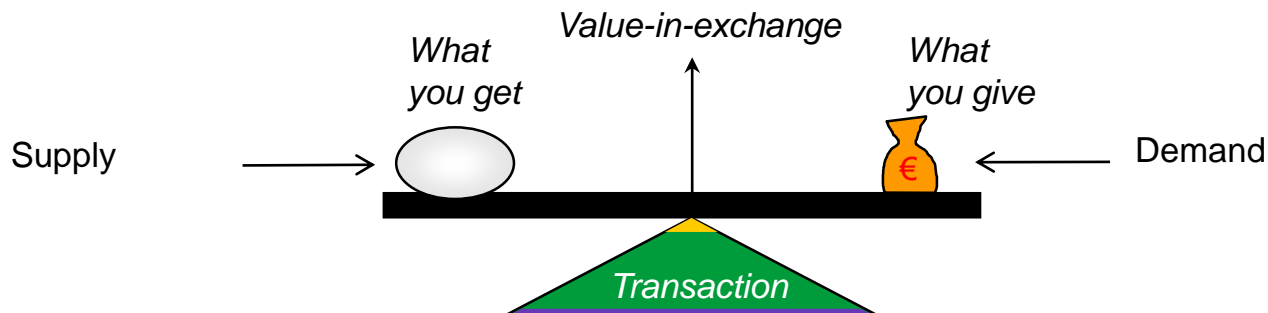
- Opposite: robbery, slavery, exploitation,

Exchange requires a common conception of value

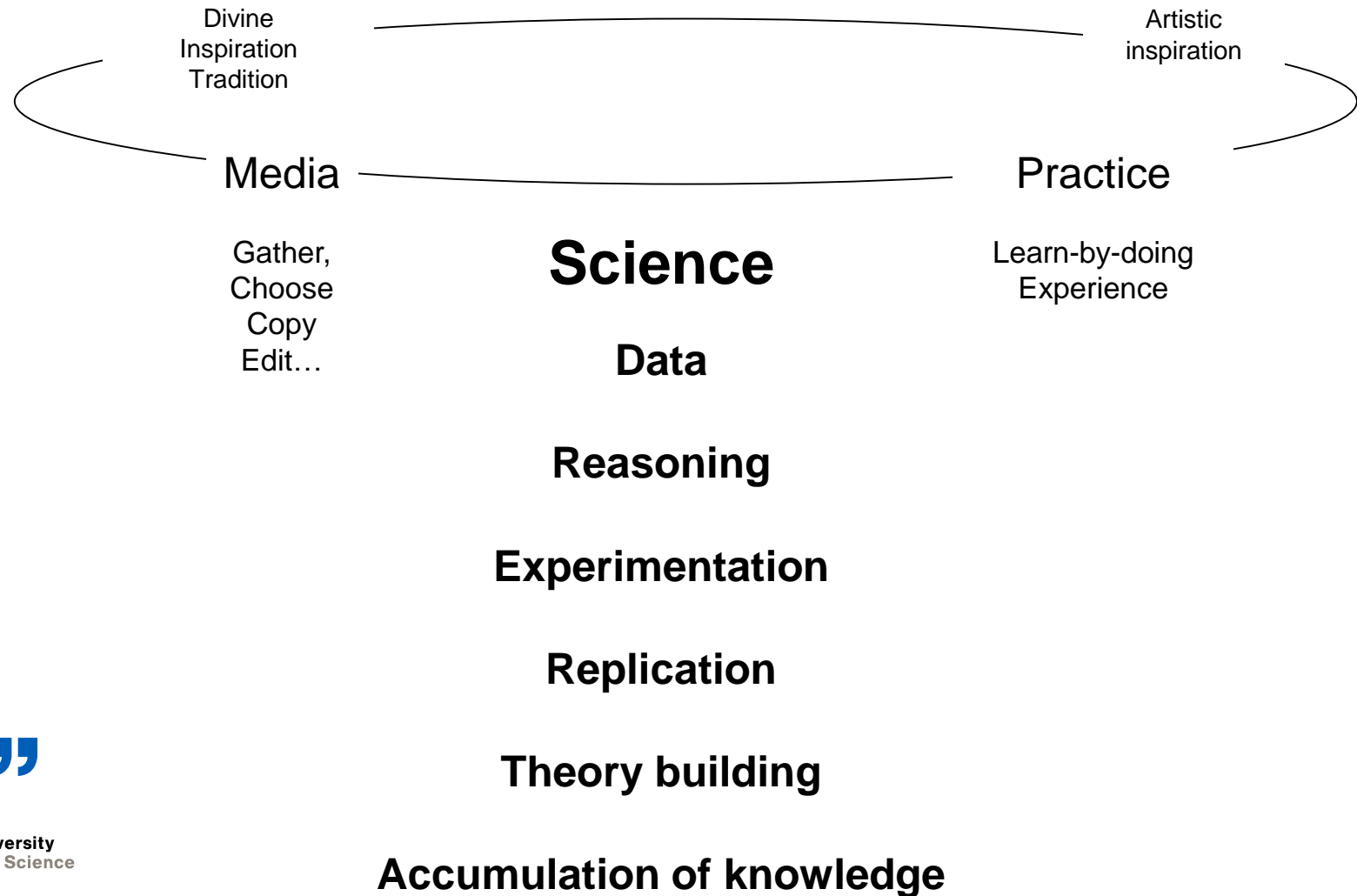
- Value-in-exchange – Market value
- Value-in-use - Utility
- Show-off –value - Status

Value is a property of transaction and use (not product)

Product attributes: functionality, grade, style, quality



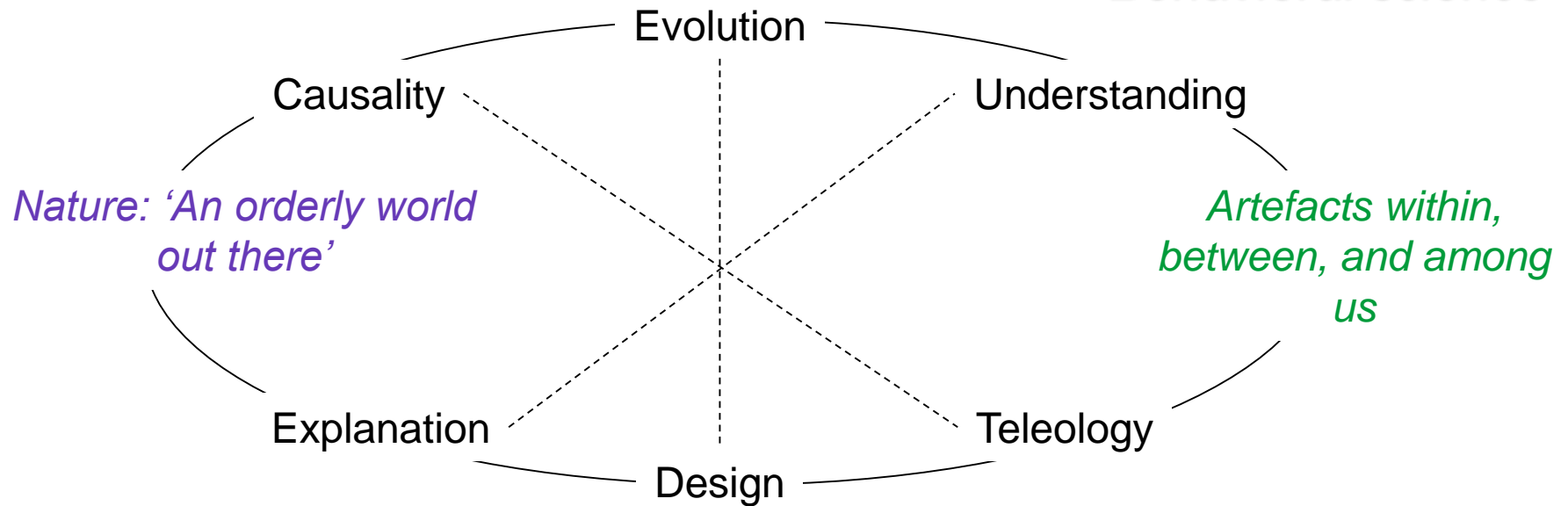
# RESEARCH UNIVERSITIES PRODUCE KNOWLEDGE



# THE WORLDS OF SCIENCE

*Sciences of the  
natural world*

*Sciences of the  
artificial world:  
Behavioral science*



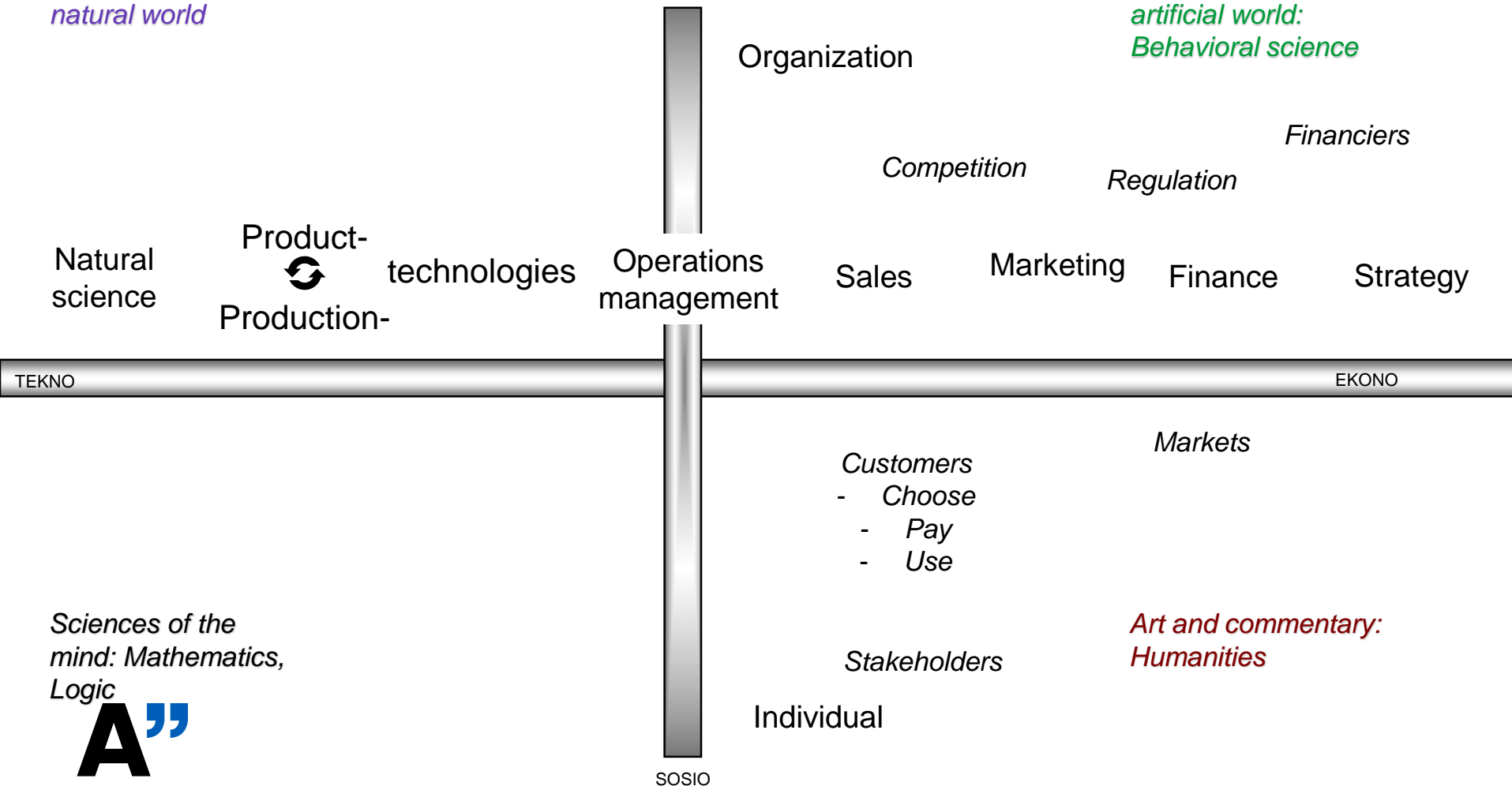
*Sciences of the  
mind: Mathematics,  
Logic*

*Art and  
commentary:  
Humanities*

# THE OPERATIONS MANAGEMENT PLAYING FIELD

*Sciences of the  
natural world*

*Sciences of the  
artificial world:  
Behavioral science*



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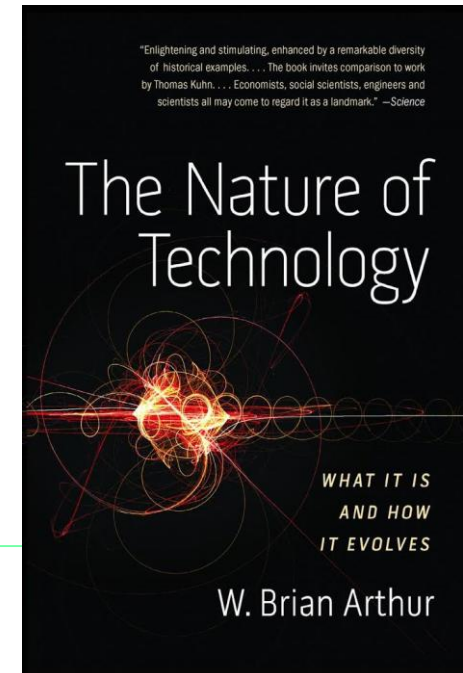
# TECHNOLOGY IS TO MANIPULATE A PHENOMENON FOR A PURPOSE

*A technology is built upon some principle, “some method of the thing”, that constitutes the base of idea of its working.*

*A technology is a phenomenon captured and put to use.*

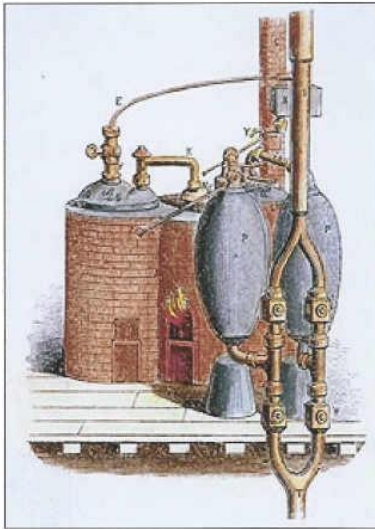
*A technology is a programming of phenomena to our purposes.*

Physics, Chemistry	→	Engineering
Biology	→	Clinical medicine
Psychology	→	Behavioral technologies
Social science	→	Management



# FIRST THERE WAS TECHNOLOGY

## Steam engine



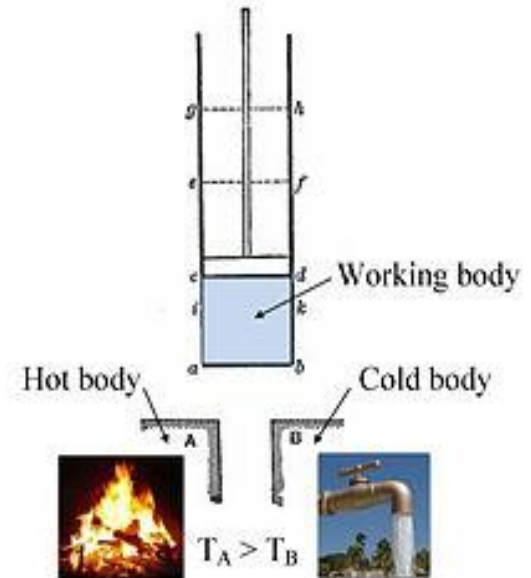
Thomas Savery 1678

Thomas Newcomen 1711

**A** James Watts 1765

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## Thermodynamics



Sadi Carnot 1824

Lord Kelvin 1854

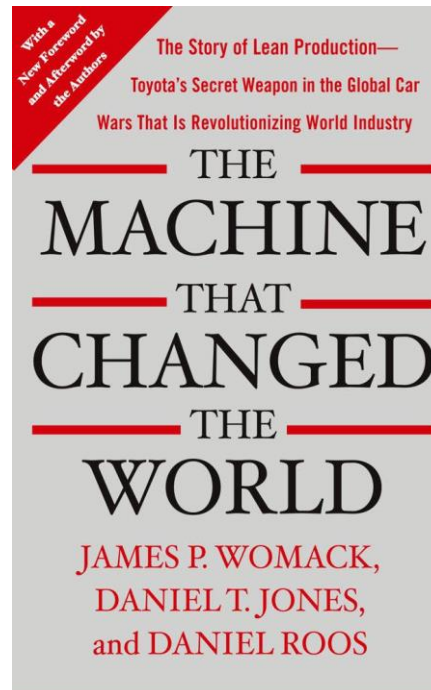
# FIRST IT WORKED IN PRACTICE, THEN IN THEORY

Toyota  
production  
system,  
1955→

Export-  
success  
1975→

Theoretical explanation:  
Lean Production 1990

Successful application  
in different nations and  
industries

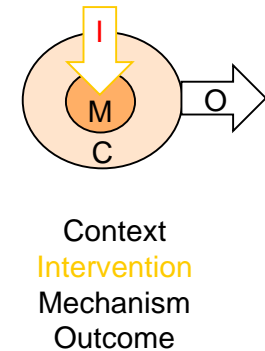
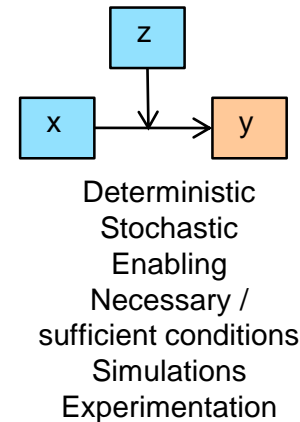
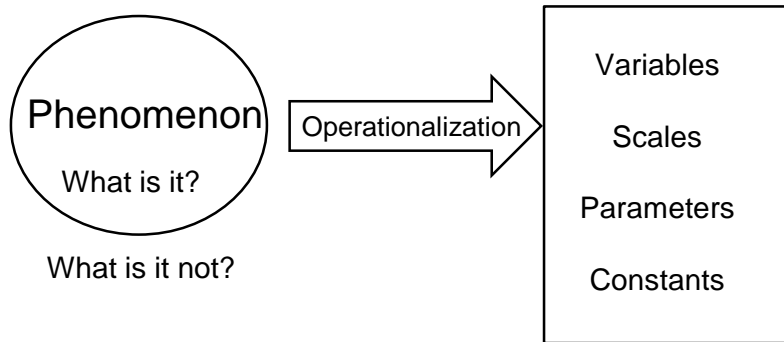


Lean healthcare



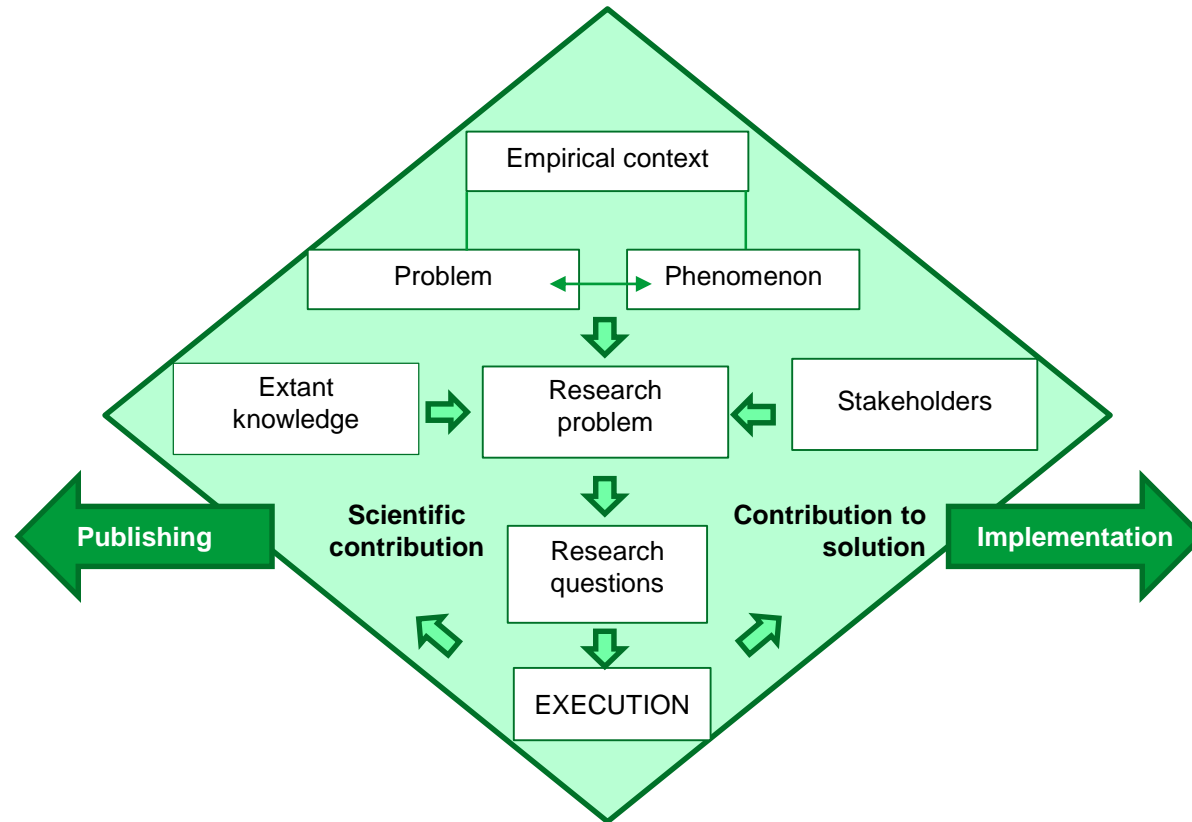
# DEVELOP TECHNOLOGIES

What is it? <i>Ontology</i>	What can be known? <i>Epistemology</i>	How does it work? <i>Dynamics</i>	What can be done? <i>Technology</i>
<b>Conceptual model</b>	<b>Measures</b>	<b>Dynamic model</b>	<b>Interventions</b>

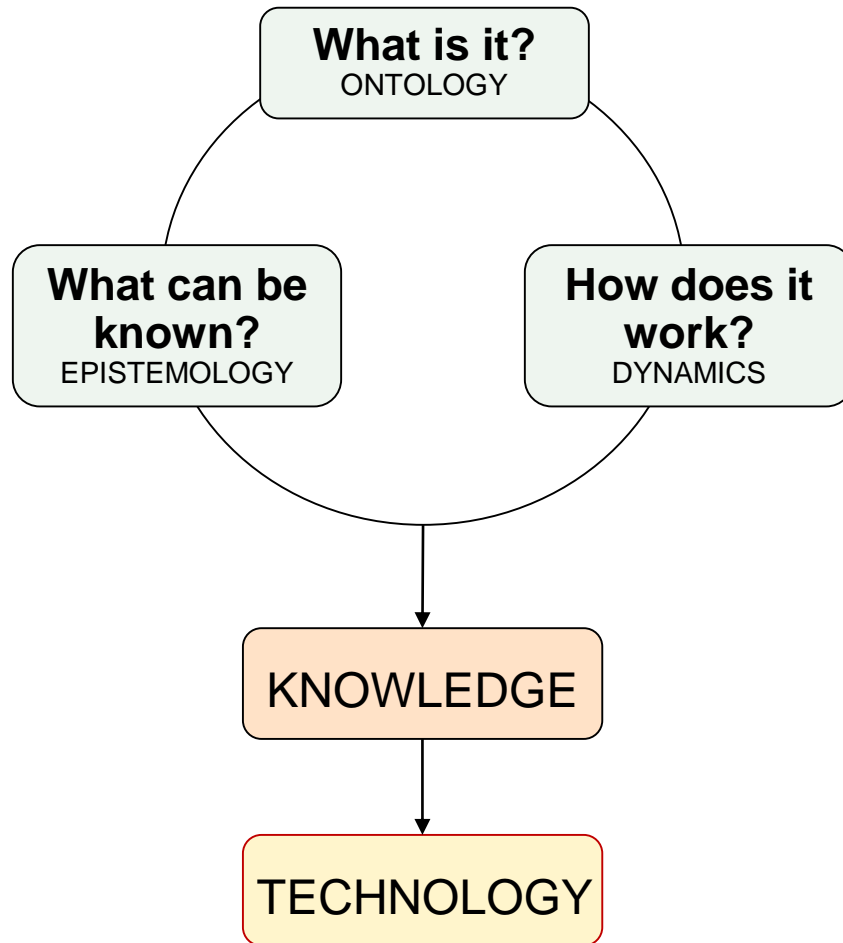




# THE STRUCTURE OF A DISSERTATION



# HOW TO CREATE KNOWLEDGE?

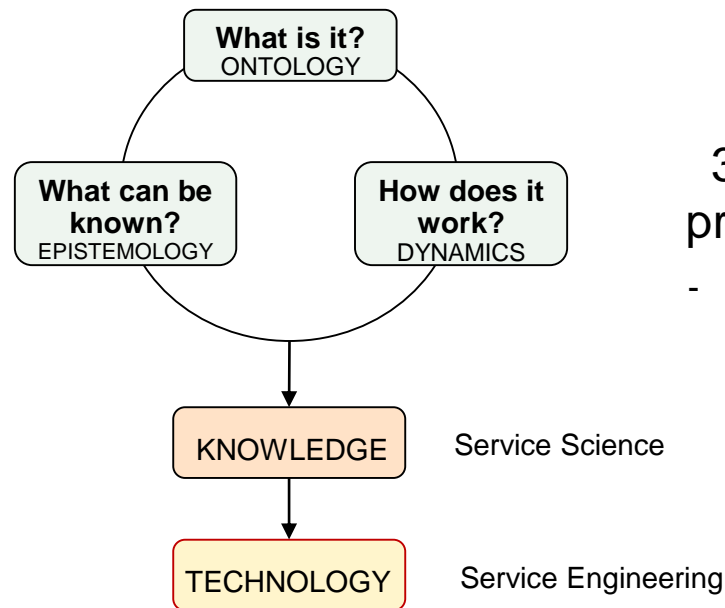


# SERVICE DEFINITIONS

## 1. Immaterial but tradable good

- Immaterial, Heterogeneous, Inseparable, Perishable (IHIP)

## 2. State change



## 3. Customers participate: production in open systems

- Co-creation of value; Service –dominant logic (SDL)
- Resource Integration (RI)

# THE IHIP -DEFINITION OF SERVICES

**Intangible:** Services provide value in forms that are intangible and can't be owned  
→ agreement about delivery criteria prior to service production;  
a *promise* of service is marketed

**Heterogeneous:** Services are complex bundles of activities

**Inseparable:** Services exist only the moment they are produced and consumed  
→ customer affects the service process to varying degree  
→ services cannot be owned

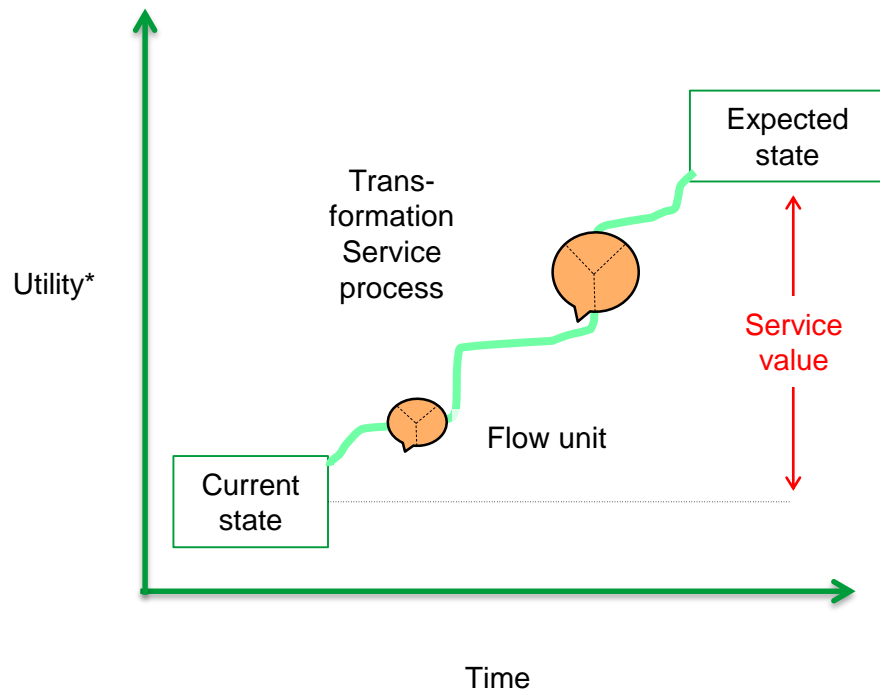
**Perishable:** services cannot be stored  
→ capacity management, demand management



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Source: mainstream service literature; e.g. Parasuraman et al. 1985, Grönroos 2000

# SERVICES APPEAR AS STATE CHANGES



Flow unit is:

	Material	Immaterial
New (Unique or copy)	<i>Goods</i>	<i>Intellectual property Content</i>
Existing	<i>Maintenance Repair Upgrade</i>	<i>Knowledge Experience Behavior Location</i>

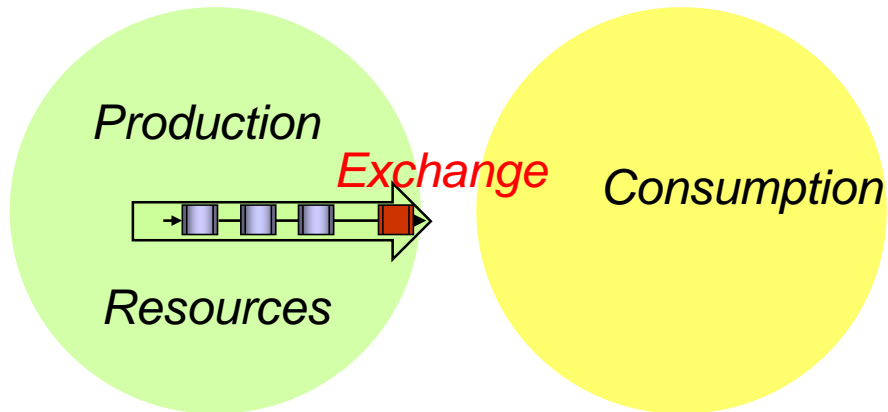
Flow unit is:

# THE GOODS AND THE SERVICE DOMINANT LOGICS

## GOODS –DOMINANT LOGIC GDL

PRODUCTION  
SYSTEM

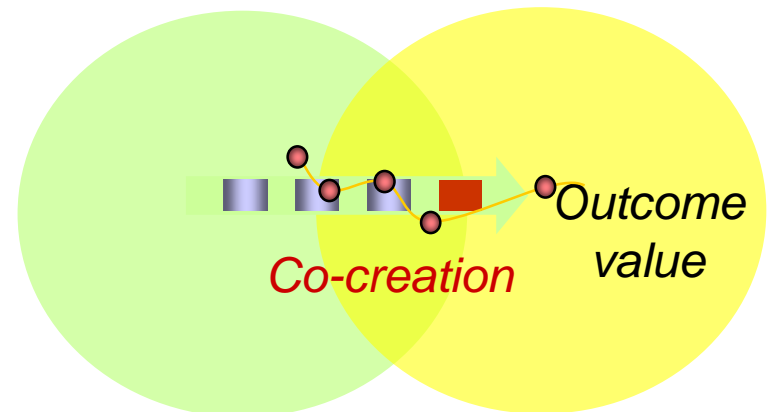
CONSUMPTION  
SYSTEM



## SERVICE –DOMINANT LOGIC SDL

PRODUCTION  
SYSTEM

CONSUMPTION  
SYSTEM



# RESOURCE INTEGRATION AND IHIP

## Producer resources & capabilities: **PERISHABLE**

- Customer requests activate resources
- Unused resource perishes
- Capacity & demand management

## Service contract: **IMMATERIAL**

- No change of ownership
- Promises
- Roles, rights, and responsibilities – compliance to agreements

## Service production: **INSEPARABLE**

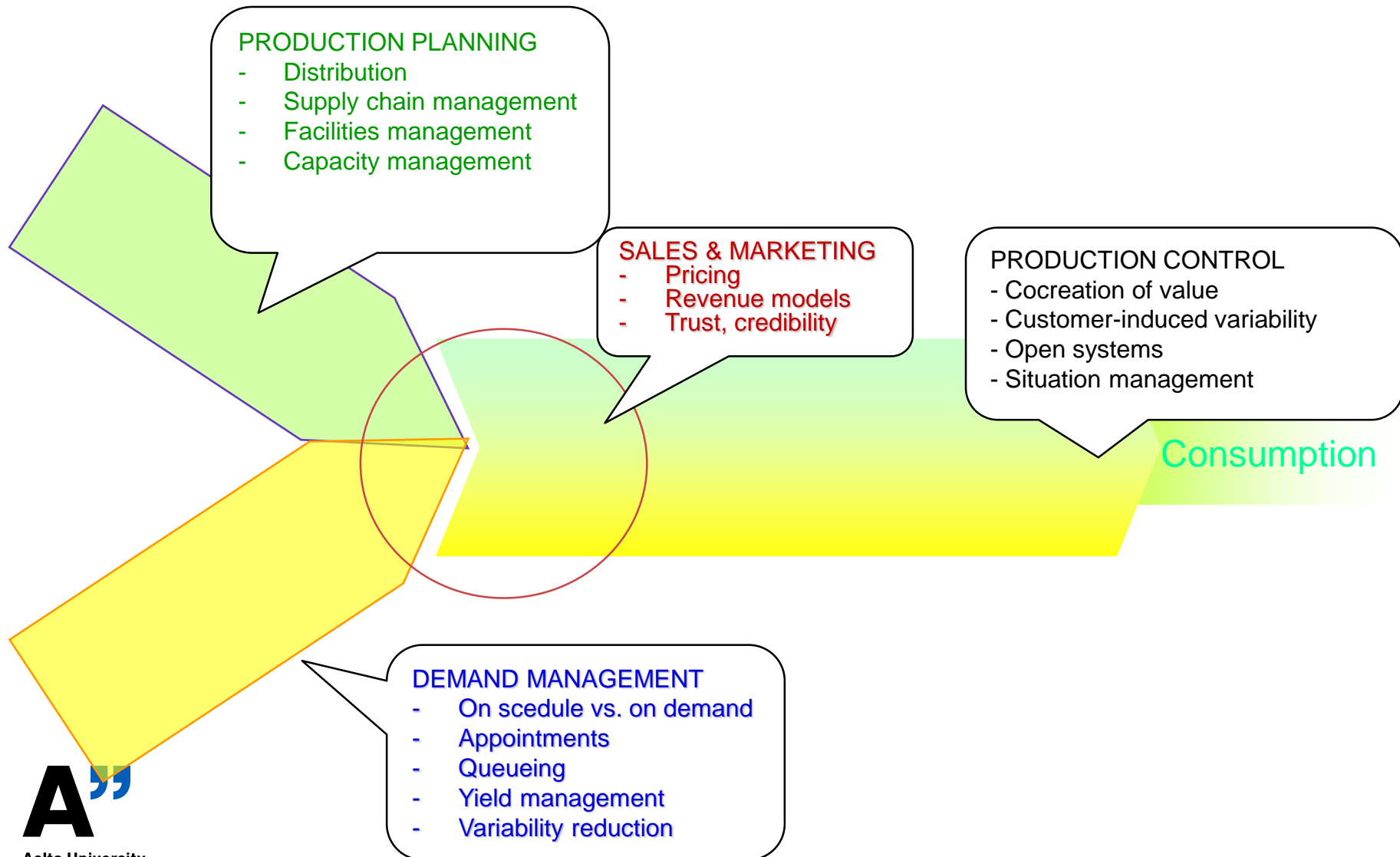
- Customer participates through person, possession or information
- Production in open systems
- Customer-introduced variability

Consumption

## Customer resources: Purchasing power **HETEROGENEOUS**

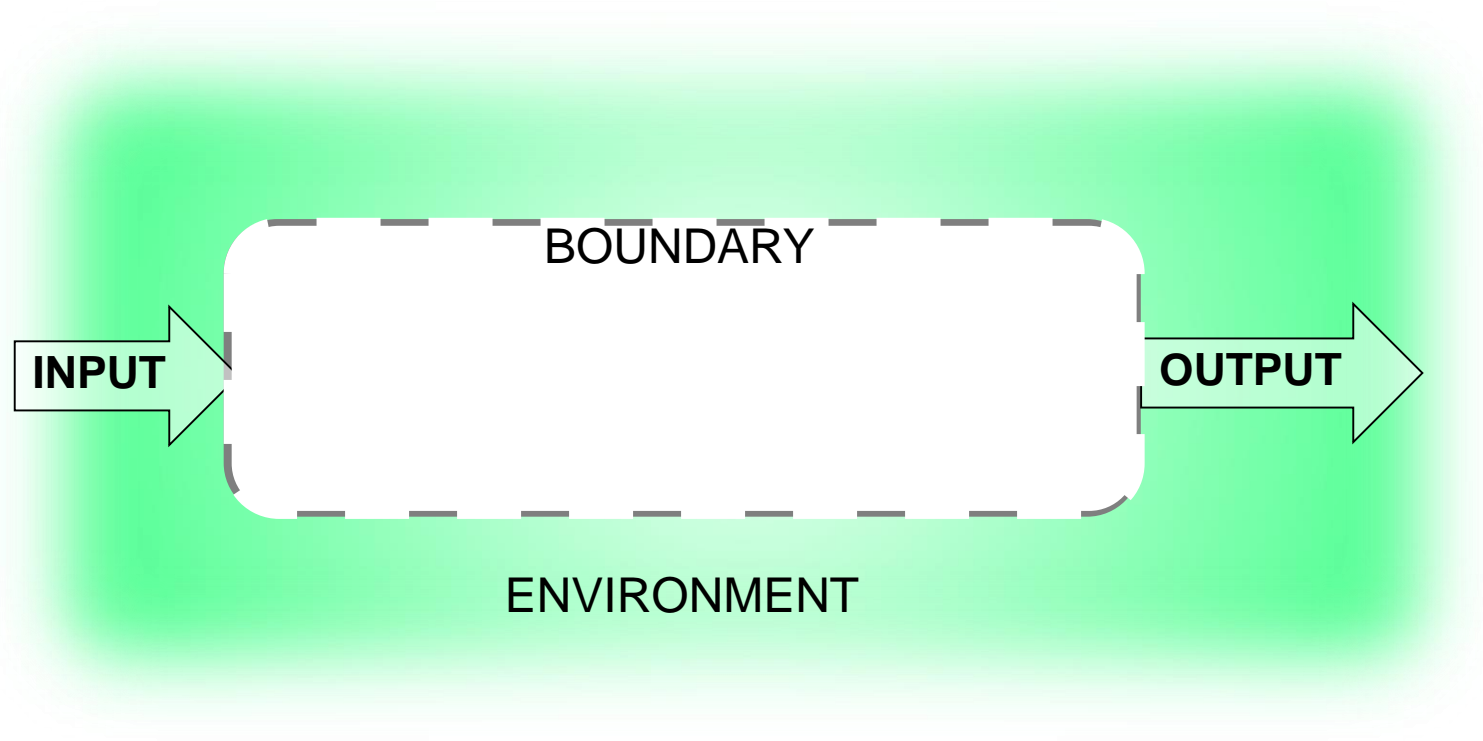
- Individual and situational preferences

# THE TASKS OF SERVICE OPERATIONS MANAGEMENT





# SYSTEMS HAVE BOUNDARIES



# PRODUCTION IN CLOSED OR OPEN SYSTEMS?



CLOSED SYSTEM	OPEN SYSTEM
Goods –dominant logic	Service –dominant logic
Standard / formatted processes	Routine / explorative processes
Identical copies of prototype	Each unit is designed
Inventory management	Capacity management
Value stream additive	Value stream includes multiples
Value resides in product	Value resides in process
Property rights, ownership	Rights and responsibilities
Demand on schedule	Drop-in demand
Variability minimized	Variability absorbed

# INDUSTRIAL MANAGEMENT MILESTONES

Early concepts 1776 →

- Division of labor and specialization (*Smith, Babbage*)
- Interchangeable parts, standardization (*Whitney*)

Scientific management 1880 →

- Time & Motion studies (*Gilbreth*)
- One best way (*Taylor*)
- Queuing theory (*Erlang*)

Mass production 1910 →

- Moving assembly line (*Ford*)
- Statistical process control (*Shewhart*)
- Economic order quantity (*Harris*)
- Linear programming PERT (*DuPont*)
- MRP

Lean production 1980 →

- JIT, TQM, Six Sigma
- CAD/CAM, EDI
- Cross-functional processes

Mass Customization 1995 →

- Globalization & Internet
- Demand-supply chain management
- ERP

Service Engineering and Management 2004 →

- Servitization
- KIBS, PSTS
- SOA, SaS
- Outcome –based business models
- Platforms, P2C

VOLUME

COST

QUALITY

FLEXIBILITY

SOLUTIONS



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