Sistem Produksi

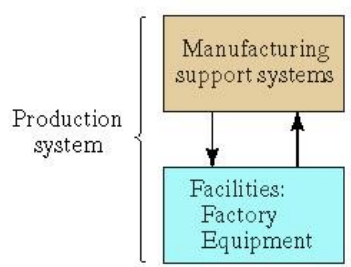
Kode Mata kuliah	TID 4033
Nama Mata kuliah	SISTEM PRODUKSI
Beban SKS	3
Sifat	Wajib
Mata kuliah Prasyarat	Rekayasa Lingkungan; Praktikum Terintegrasi I
Mata kuliah Kosyarat	Perencanaan dan Pengendalian Produksi
Praktikum	-
Capaian Pembelajaran Mata kuliah	1. Mampu membuat rencana kebutuhan material dan kapasitas 2. Mampu membuat jadwal operasi dan pengendalian lantai pabrik 3. Mampu membuat lintasan perakitan 4. Mampu menggunakan sistem tarik dan menentukan jumlah kanban 5. Mampu menentukan bottle neck dan menggunakan pendekatan Theory of Constraints 6. Mengikuti perkembangan teknologi terkait dengan keteknik-industrian seperti teknologi manufaktur maju, pemakaian teknologi informasi untuk mengelola perusahaan, green manufacturing, dll
Pokok Bahasan	1. Tinjauan sistem produksi: manufaktur dan jasa 2. Operasi manufaktur dan fasilitas sistem produksi 3. Sistem Pemindahan dan Penyimpanan Material 4. Single Station Manufacturing Cells 5. Group Technology dan Cellular Manufacturing 6. Keseimbangan Lintas Perakitan: Konsep, Metode, dan Performansi 7. Pengendalian Lantai Pabrik dan Pengendalian Pembelian: Sistem Dorong 8. Konsep Sistem Tepat Waktu, Penentuan Jumlah Kanban dan Production Smoothing, Konsep Lean Manufacturing: Sistem Tarik 9. Theory of Constraints dan Teknik Drum-Buffer-Rope
Pustaka Utama	1. Groover, MP. *Automation, Production Systems, and Computer Aided Manufacturing*. 2nd Edition. London: Prentice-Hall Inc. 2001. 2. Fogarty, D., Blackstone Jr, J. H., & Hoffmann, T. R. *Production & Inventory Management*. Cincinnati: South-Western Publishing Co. 1991.
Pustaka Pendukung	1. Askin, RG, & Goldberg, JB. *Design and Analysis of Lean Production Systems*. New York: John Wiley & Sons. 2001. 2. Askin, RG, & Standridge, CR. *Modeling and Analysis of Manufacturing Systems*, John Wiley & Sons, 1993. 3. Bedworth, D, et al. *Integrated Production, Control Systems: Management, Analysis, And Design*. New York: John Wiley & Sons. 2001. 4. Kusiak, A. *Computational Intelligent in Design and Manufacturing*. New York: John Wiley & Sons. 2000. 5. Regh, JA & Kraebber, HW. *Computer Integrated Manufacturing*. 2nd Edition. New Jersey: Prentice Hall. 2001.

Production System

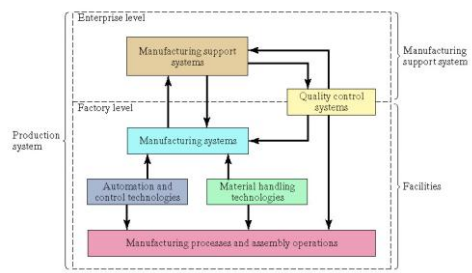
Production System

- The production system is the collection of people, equipment, and procedures organized to accomplish the manufacturing operations of a company (or other organization).
- The production system consists of facilities and manufacturing support systems.
  - The facilities of the production system consist of the factory, the equipment in the factory, and the way the equipment is organized.
  - The manufacturing support systems is the set of procedures used by the company to manage production and to solve the technical and logistics problems encountered in ordering materials, moving work through the factory, and ensuring that products meet quality standards. Product design and certain business functions are included among the manufacturing support systems.

Production System



Production System



Production System Facilities

Production System Facilities

Facilities include the factory, production machines and tooling, material handling equipment, inspection equipment, and computer systems that control the manufacturing operations

- *Plant layout* – the way the equipment is physically arranged in the factory
- *Manufacturing systems* – logical groupings of equipment and workers in the factory
  - Production line
  - Stand-alone workstation and worker

Production Facilities

- A manufacturing company attempts to organize its facilities in the most efficient way to serve the particular mission of the plant
- Certain types of plants are recognized as the most appropriate way to organize for a given type of manufacturing
- The most appropriate type depends on:
  - Types of products made
  - Production quantity
  - Product variety

Manufacturing System Defined

"A collection of integrated equipment and human resources, whose function is to perform one or more processing and/or assembly operations on a starting raw material, part, or set of parts"

- Equipment includes
  - Production machines and tools
  - Material handling and work positioning devices
  - Computer systems
- Human resources are required either full-time or periodically to keep the system running

Examples of Manufacturing Systems

- Single-station cells
- Machine clusters
- Machine cells (cellular manufacturing)
- Manual assembly lines
- Automated transfer lines
- Automated assembly systems

Components of a Manufacturing System

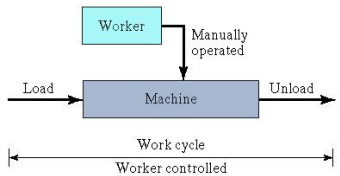
1. Production machines
2. Material handling system
3. Computer system to coordinate and/or control the preceding components
4. Human workers to operate and manage the system

Production Machines

- In virtually all modern manufacturing systems, most of the actual processing or assembly work is accomplished by machines or with the aid of tools
- Classification of production machines:
  1. Manually operated machines are controlled or supervised by a human worker
  2. Semi-automated machines perform a portion of the work cycle under some form of program control, and a worker tends the machine the rest of the cycle
  3. Fully automated machines operate for extended periods of time with no human attention

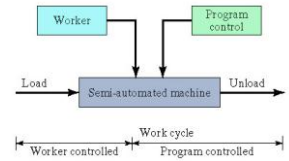
Manually Operated Machine

- Manually operated machines are controlled or supervised by a human worker. The machine provides the power for the operation and the worker provides the control. The entire work cycle is operator controlled.



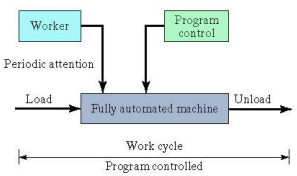
Semi-Automated Machine

- A semi-automated machine performs a portion of the work cycle under some form of program control, and a worker tends to the machine for the remainder of the cycle. Typical worker tasks include loading and unloading parts



Fully-Automated Machine

Machine operates for extended periods (longer than one work cycle) without worker attention (periodic tending may be needed).



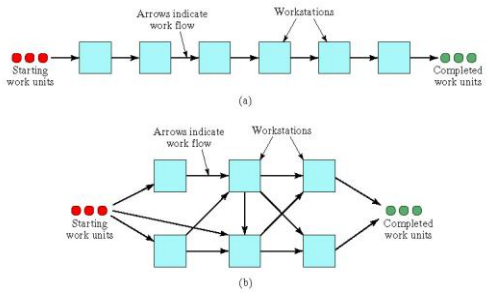
Material Handling System

- In most manufacturing systems that process or assemble discrete parts and products, the following material handling functions must be provided:
  1. Loading work units at each station
  2. Positioning work units at each station
  3. Unloading work units at each station
  4. Transporting work units between stations in multi-station systems
  5. Temporary storage of work units

Work Transport Between Stations

- Two general categories of work transport in multi-station manufacturing systems:
  1. Fixed routing
     - Work units always flow through the same sequence of workstations
     - Most production lines exemplify this category
  2. Variable routing
     - Work units are moved through a variety of different station sequences
     - Most job shops exemplify this category

(a) Fixed Routing and (b) Variable Routing



Computer Control System

- Typical computer functions in a manufacturing system:
  - Communicate instructions to workers (receive processing or assembly instructions for the specific work unit)
  - Download part programs to computer-controlled machines
  - Control material handling system
  - Schedule production
  - Failure diagnosis when malfunctions occur and preventive maintenance
  - Safety monitoring (protect both the human worker and equipment)
  - Quality control (detect and reject defective work units produced by the system)
  - Operations management (manage overall operations)

Classification of Manufacturing Systems

- Factors that define and distinguish manufacturing systems:
  1. Types of operations performed
  2. Number of workstations
  3. System layout
  4. Automation and manning level
  5. Part or product variety

Manufacturing Operations

- Basic activities that must be carried out in a factory to convert raw materials into finished products:
  - Processing operations, uses energy including mechanical, thermal, electrical, and chemical, to alter a work part's shape, physical properties, or appearance to add value to the material
  - Assembling operations, two or more separate parts are joined to form a new entity which is called an assembly, subassembly, or some other term that refers to the specific joining process, either permanently or semi permanently.
  - Material handling and storage, move the product from one operation to the next in the manufacturing sequence
  - Inspection and test, to insure high quality.
  - Coordination and control.

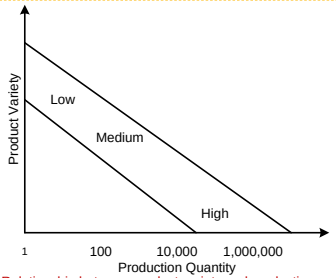
Types of Operations Performed

- Processing operations on work units versus assembly operations to combine individual parts into assembled entities
- Type(s) of materials processed
- Size and weight of work units
- Part or product complexity
  - For assembled products, number of components per product
  - For individual parts, number of distinct operations to complete processing
- Part geometry
  - For machined parts, rotational vs. non-rotational

Production Quantity vs Product Variety

- Production quantity refers to the number of units of a given part or product produced annually by the plant
  - Low production: quantities in the range of 1 to 100 units per year
  - Medium production: quantities in the range of 100 to 10,000 units annually
  - High production: production quantities are 10,000 to millions of units
- Product variety refers to the different product designs or types that are produced in a plant
  - Hard product variety is when the products differ substantially → the variety between different product categories
  - Soft product variety is when there are only small differences between products → the variety between different models within the same product category
- When product variety is high, production quantity tends to be low; and vice versa → inverse correlation

Production Quantity vs Product Variety



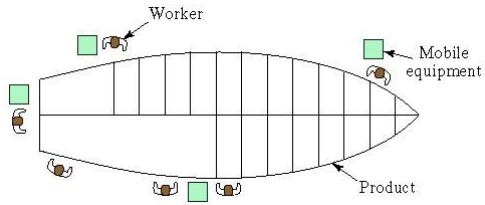
Relationship between product variety and production quantity in discrete product manufacturing

Low Production Quantity

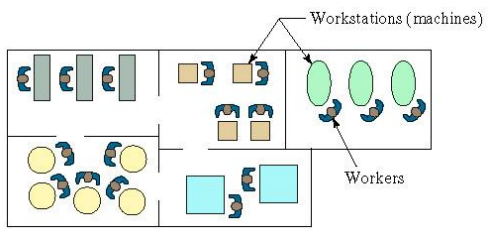
Job shop – makes low quantities of specialized and customized products

- Also includes production of components for these products
- Products are typically complex (e.g., specialized machinery, prototypes, space capsules)
- Equipment is general purpose
- Plant layouts:
  - Fixed position
  - Process layout

Fixed-Position Layout



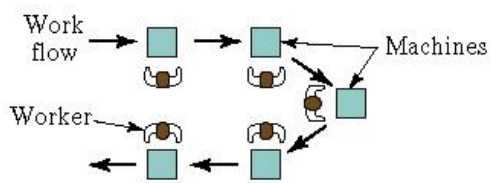
Process Layout



Medium Production Quantities

1. ***Batch production*** – A batch of a given product is produced, and then the facility is changed over to produce another product
   - Changeover takes time – setup time
   - Typical layout – process layout
   - Hard product variety
2. ***Cellular manufacturing*** – A mixture of products is made without significant changeover time between products
   - Typical layout – cellular layout
   - Soft product variety

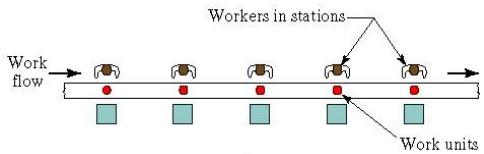
Cellular Layout



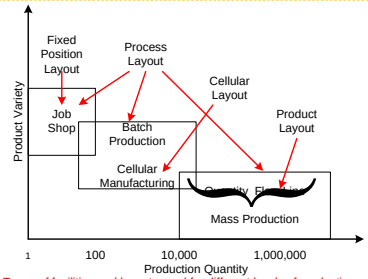
High Production (mass production)

1. ***Quantity production*** – Equipment is dedicated to the manufacture of one product
   - Standard machines tooled for high production (e.g., stamping presses, molding machines)
   - Typical layout – process layout
2. ***Flow line production*** – Multiple workstations arranged in sequence
   - Product requires multiple processing or assembly steps
   - Product layout is most common

Product Layout



Production Quantity vs Product Variety: Layout and Production Type



Types of facilities and layouts used for different levels of production quantity and product variety

Number of Workstations

- Convenient measure of the size of the system
  - Let n = number of workstations
  - Individual workstations can be identified by subscript i, where $i = 1, 2,...,n$
- Affects performance factors such as workload capacity, production rate, and reliability
  - As n increases, this usually means greater workload capacity and higher production rate
  - There must be a synergistic effect that derives from n multiple stations working together vs. n single stations

System Layout

- Applies mainly to multi-station systems
- Fixed routing vs. variable routing
  - In systems with fixed routing, workstations are usually arranged linearly
  - In systems with variable routing, a variety of layouts are possible
- System layout is an important factor in determining the most appropriate type of material handling system

Automation and Manning Levels

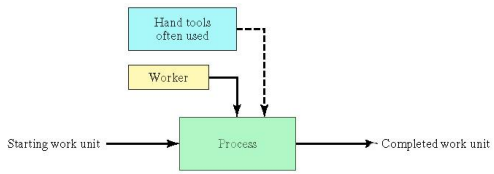
- Level of workstation automation
  - Manually operated
  - Semi-automated
  - Fully automated
- Manning level M_i = proportion of time worker is in attendance at station i
  - $M_i = 1$ means that one worker must be at the station continuously
  - $M_i \geq 1$ indicates manual operations
  - $M_i < 1$ usually denotes some form of automation

Automation and Manning Levels: Human Participation

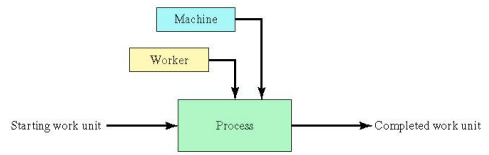
Three categories in terms of the human participation in the processes performed by the manufacturing system:

1. *Manual work systems* - a worker performing one or more tasks without the aid of powered tools, but sometimes using hand tools
2. *Worker-machine systems* - a worker operating powered equipment
3. *Automated systems* - a process performed by a machine without direct participation of a human

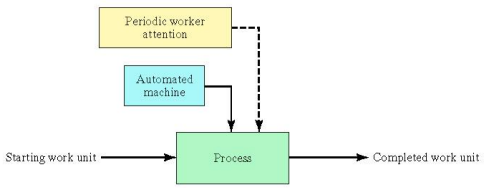
Manual Work System



Worker-Machine System



Automated System

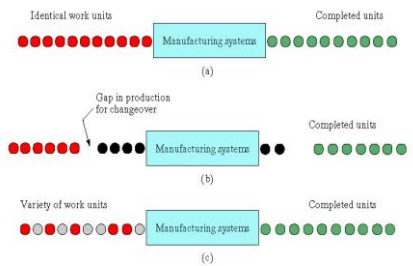


Part or Product Variety: Flexibility

"The degree to which the system is capable of dealing with variations in the parts or products it produces"

- Three cases:
  1. Single-model case - all parts or products are identical (sufficient demand/fixed automation)
  2. Batch-model case - different parts or products are produced by the system, but they are produced in batches because changeovers are required (hard product variety)
  3. Mixed-model case - different parts or products are produced by the system, but the system can handle the differences without the need for time-consuming changes in setup (soft product variety)

Three Cases of Product Variety in Manufacturing Systems

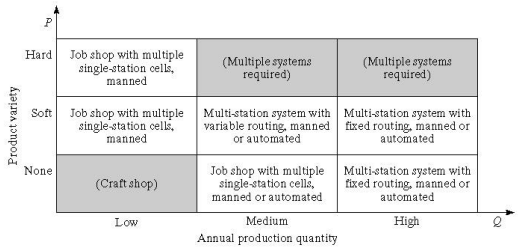


(a) Single-model case, (b) batch model case, and (c) mixed-model case

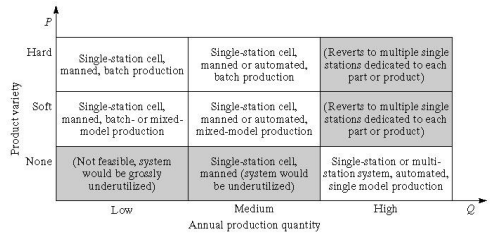
Enablers of Flexibility

- Identification of the different work units
  - The system must be able to identify the differences between work units in order to perform the correct processing sequence
- Quick changeover of operating instructions
  - The required work cycle programs must be readily available to the control unit
- Quick changeover of the physical setup
  - System must be able to change over the fixtures and tools required for the next work unit in minimum time

Manufacturing Systems for Medium or High Product Complexity



Manufacturing Systems for Low Product Complexity



Overview of Classification Scheme

- Single-station cells
  - $n = 1$
  - Manual or automated
- Multi-station systems with fixed routing
  - $n > 1$
  - Typical example: production line
- Multi-station systems with variable routing
  - $n > 1$

Single-Station Cells

- $n = 1$
- Two categories:
  1. Manned workstations - manually operated or semi-automated production machine ($M = 1$)
  2. Fully automated machine ($M < 1$)
- Most widely used manufacturing system - reasons:
  - Easiest and least expensive to implement
  - Most adaptable, adjustable, and flexible system
  - Can be converted to automated station if demand for part or product justifies

Multi-Station Systems with Fixed Routing

- $n > 1$
- Common example = production line - a series of workstations laid out so that the part or product moves through each station, and a portion of the total work content is performed at each station
- Conditions favoring the use of production lines:
  - Quantity of work units is high
  - Work units are similar or identical, so similar operations are required in the same sequence
  - Total work content can be divided into separate tasks of approximately equal duration

Multi-Station Systems with Variable Routing

- $n > 1$
- Defined as a group of workstations organized to achieve some special purpose, such as:
  - Production of a family of parts requiring similar (but not identical) processing operations
  - Assembly of a family of products requiring similar (but not identical) assembly operations
  - Production of a complete set of components used to assemble one unit of a final product
- Typical case in cellular manufacturing

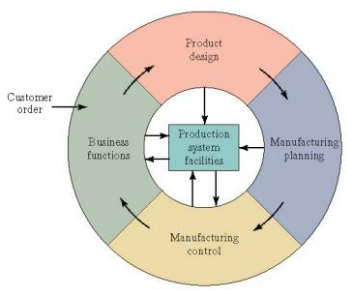
Manufacturing Support Systems

Manufacturing Support Systems

Involves a cycle of information-processing activities that consists of four functions:

1. Business functions - sales and marketing, order entry, cost accounting, customer billing
2. Product design - research and development, design engineering, prototype shop
3. Manufacturing planning - process planning, production planning, MRP, capacity planning
4. Manufacturing control - shop floor control, inventory control, quality control

Information Processing Cycle in Manufacturing Support Systems



Production System: Manufacturing Support Systems

- Business Functions
  - The principal means of communicating with the customer
  - The beginning and the end of the information-processing cycle
  - Including sales and marketing, sales forecasting, order entry, cost accounting, and customer billing
  - Forms of the production order:
    - An order to manufacture an item to the customer's specifications
    - A customer order to buy one or more of the manufacturer's proprietary products
    - An internal company order based on a forecast of future demand for a proprietary products

Production System: Manufacturing Support Systems

- Product Design
  - If the product is to be manufactured to customer design, the design will have been provided by the customer
  - If the product is to be produced to customer specifications, the manufacturer's product design department may be contracted to do the design work for the product as well as to manufacture it
  - If the product is proprietary, the manufacturing firm is responsible for its development and design
  - The departments of the firm that are organized to accomplish product design might include research and development, design engineering, drafting, and perhaps a prototype shop

Production System: Manufacturing Support Systems

- Manufacturing Planning
  - The information-processing activities in manufacturing planning include process planning and production planning (master scheduling, requirements planning, and capacity planning)

Production System: Manufacturing Support Systems

- Manufacturing Control
  - Managing and controlling the physical operations in the factory to implement the manufacturing plans
  - Including
    - *Shop Floor Control*. It deals with the problem of monitoring the progress of the product as it is being processed, assembled, moved, and inspected in the factory.
    - *Inventory Control*. It attempts to strike a proper balance between the danger of too little inventory (with possible stock-outs of materials) and the carrying cost of too much inventory.
    - *Quality Control*. The mission is to ensure that the quality of the product and its components meet the standards specified by the product designer.

Service

Service vs Services

- Service
  - Process of using one's resources for the benefit of another entity
  - A business transaction that takes place between a service provider (donor) and a customer (receiver) in order to produce an outcome that satisfactorily meets the customer's needs
- Services
  - Regarded as a supportive drive to the production of goods
  - Viewed as activities that are done in combination with products as a value-added tool
  - Seen as an intangible type of product

Relationship Between Products and Services

- No rigid distinction can be made between "product" industries and "service" industries
- The outputs of most companies have both product and service attributes in different combinations
- Customers view the outputs of a company as a package, and their satisfaction is determined by the total performance of the elements of this package

Service-Based Competitive Strategy

- Definition
  - An approach taken by a firm to increase its profitability by developing a reputation for excellence in its interactions with customers, and by designing the processes that are needed to support these interactions.
- Evokes Customers Loyalty
  - Clearly understanding the service performance levels desired by customers
  - Committing the consistently and reliably meeting or exceeding these service levels
  - Spending the required time, effort and resources to develop the service infrastructure that can deliver this performance
  - Delivering the performance at a cost that allows the firm to remain profitable and satisfy its obligations to its stockholders

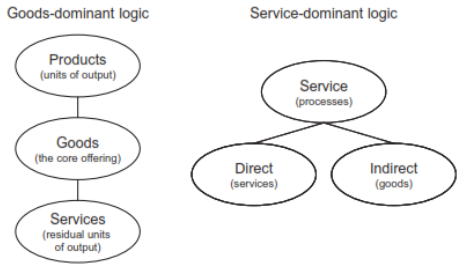
Customer value

- Value creation is the goal of marketing
- Definition of customer value
  - The net gain meaning all the benefits over costs
  - Market perceived quality adjusted for the relative price of your product
    - Perceived value is defined as the "tradeoff between the quality or benefits they perceive in the product relative to the sacrifice they perceive by paying the price"
  - The consumers' overall assessment of utility based on what is received and what is given

Integrative View of Value in Service Consumption

	Dyadic Interactions			Triadic and complex networks
(1) Multi-Actor Interactions	Firm-Customer Dyad		Customer-customer Dyad	Many-to-Many Networks
(2) Service Value co-creation	Value proposed by the firm	Value created by the customer	Value derived from Customer-customer interactions	Value derived from many-to-many interactions
(3) Long Term Relational Value Attributes	Service quality, price benefits, utility benefits, service staff knowledge and skills	Satisfaction, trust, commitment,	Positive Word-of-mouth (self-affirmation, altruism, memory, catharsis, and vengeance)	Customer engagement in social networks, computer mediated environments

The hierarchies of exchange in G-D logic and S-D logic



Conceptual lexicon of marketing

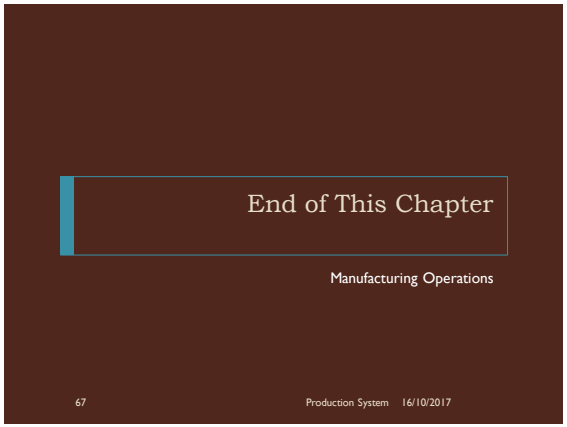
G-D logic concepts	Transitional concepts	S-D logic concepts
Goods	Services	Service
Products	Offerings	Experiences
Feature/attribute	Benefit	Solution
Value-added	Coproduction	Cocreation of value
Profit maximization	Financial engineering	Financial feedback/learning
Price	Value delivery	Value proposition
Equilibrium systems	Dynamic systems	Complex adaptive systems
Supply chain	Value chain	Value-creation network
Promotion	Integrated marketing communications	Dialogue
To market	Market to …	Market with …
Product orientation	Market orientation	Service orientation

Transition for practitioners

G-D logic	S-D logic
Making something (goods or services)	Assisting customers in their own value-creation processes
Value as produced	Value as co-created
Customers as isolated entities	Customers in context of their own networks
Firm resources primarily as operand	Firm resources primarily as operant
Customers as targets	Customers as resources
Primacy of efficiency	Efficiency through effectiveness

Normative guidelines for practitioners

1. The firm should be transparent and make all information symmetric in the exchange process. Because the customer is someone to collaborate with, anything other than complete truthfulness will not work.
2. The firm should strive to develop relationships with customers and should take a long-term perspective.
3. The firm should view goods as transmitters of operant resources (embedded knowledge); the firm should focus on selling service flows.
4. The firm should support and make investments in the developments of specialized skills and knowledge that are the fountainhead of economic growth.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