論文 / 著書情報
Article / Book Information

題目(和文)	
Title(English)	A Study on Productization and Servitization of Machine Tool Trading Company in Service System Science Perspective
著者(和文)	合田和彦
Author(English)	Kazuhiko Goda
出典(和文)	学位:博士(工学), 学位授与機関:東京工業大学, 報告番号:甲第10242号, 授与年月日:2016年3月26日, 学位の種別:課程博士, 審査員:木嶋 恭一,桑子 敏雄,坂野 達郎,後藤 美香,中丸 麻由子
Citation(English)	Degree:Doctor (Engineering), Conferring organization: Tokyo Institute of Technology, Report number:甲第10242号, Conferred date:2016/3/26, Degree Type:Course doctor, Examiner:,,,,
学位種別(和文)	博士論文
Type(English)	Doctoral Thesis

A Study
on
Productization and Servitization
of
Machine Tool Trading Company
in
Service Systems Science Perspective

Kazuhiko Goda

A thesis submitted in partial fulfillment of the requirements
For the Ph.D. Degree in the Department of Value and Decision Science,
Graduate School of Decision Science and Technology,
Tokyo Institute of Technology

Thesis Adviser: Professor Kyoichi Kijima
February 2016

Executive summary

Although it is said nowadays that Japanese manufacturing (monozukuri) has declined, is this really true? We believe that scientifically investigating the reason for this and applying a scientific approach to a Japanese manufacturing revival strategy will contribute to the national growth strategy.

The purpose of this thesis is (a) to develop frameworks for analyzing and describing machine tool trading (MTT) companies from service systems science perspective and (b) to propose some unified servitization and productization strategies for them to become one of the crucial players contributing to Japanese manufacturing revival, based on the frameworks and the author's business experiences.

This thesis simply defines servitization as "the provision of services through value co-creation", while by productization it means the productizing of services by service industries.

MTT companies are thought to fulfill four roles: manufacturing industry, service industry, customer, and platform. That is, they purchase from manufacturers durable production goods that embody production technology and engage in face-to-face selling; MTT companies indeed have potential for both servitization and productization.

We first consider servitization by means of a service industry productization strategy. Production technology is treated from the perspective of the design information transmission theory "architecture of design information". The value orchestration platform model is introduced as a reference framework and then strategies and prescriptions are derived through an approach involving four-phase value co-creation and three strategies. Seven quality control (QC) tools are invoked as a means of transmitting production technology to machine tools with attached peripheral equipment.

Next, we consider servitization by means of a service industry servitization strategy. After the design information transmission theory "open manufacturing" and

Hierarchical Model of Service Ecosystems Innovation (HMSEI) are introduced, adaptive transition and phase transition are discussed. A prescription is derived from the Cynefin framework and a response to phase transition by means of the co-design strategy is discussed.

Finally, we attempt an approach to management in general based on service science. The three-dimensional approach of the translational systems science is shown to be effective.

Some of main contributions of the thesis are as follows.

1. To realize integral skills by modular customizing production technologies for revitalizing Japanese manufacturing (monozukuri), we point out that a machine tool trading (MTT) company can play an essential role as a platform where such production technologies interact and some synergy emerges.

2. We develop a value co-creation process model and a value orchestration platform model of a MTT company and then derive from the models specific prescriptions to implement three strategies.

3. In particular, a MTT company should play a role of a customer, provider as well as a facilitator as the orchestrator of the platform to promote co-elevation phase of the value co-creation process. A MTT company should also take responsibility for co-development phase by integrating or coordinating people and their products, services and activities. That is, a MTT company is required to take both productization and servitization in a broad sense.

4. When a MTT company develop its productization and servitization strategies, Hierarchical Model of Service Ecosystems Innovation (HMSEI) is useful to indentify its position and ways to go in a comprehensive manner.

TABLE OF CONTENTS

Chapter 1. Introduction

1.1 Background

Although it is said nowadays that Japanese manufacturing (monozukuri) has declined, is this really true? This impression may stem from the media reporting on the struggles of cutting-edge companies such as Sharp and Sony, which posted respective losses of 220.0 billion yen and 120.0 billion yen in the fiscal year ended March 31, 2015. On the other hand, Toyota remained the global leader in automobile sales in 2014, selling more than 10.23 million units worldwide. Furthermore, the media has reported earnings increases and vigorous business recovery at some general electrical equipment manufacturers as well, with Hitachi posting record-high earnings of 600.5 billion yen and Panasonic posting an increase in earnings to 380.0 billion yen for the fiscal year ended March 31, 2015. What accounts for the polar difference in business performance at companies that appear similar at first glance and were previously considered blue-chip companies representative of Japan? We believe that scientifically investigating the reason for this and applying a scientific approach to a Japanese manufacturing revival strategy will contribute to the national growth strategy.

Machine tools, called mother machines because can they make other machines, process the parts that constitute products. A detailed survey of the vintage of machine tools installed in Japan classified by type conducted in March 2013, immediately after the implementation of Abenomics, revealed the state of aging of machine tools. Machines in service for ten years or longer accounted for more than 60% of the total, and machines in service as long as twenty to thirty years accounted for fully 18.5%. Since this survey was conducted at the start of the national growth strategy, the Japanese government presumably considers capital investment in machine tools essential for recovering manufacturing industry competitiveness. Subsequently, the government has sought to rejuvenate facilities as a concrete growth strategy by enacting temporary legislation such as the productivity improvement, capital investment promotion, tax system and manufacturing subsidies.

However, the environment surrounding domestic factories remains adverse, and willingness to invest by business managers is insufficient to resolve the issue of aging facilities. The chief causes are a decline in domestic production demand because of shifting of production overseas, foreign exchange risk, and labor shortages coupled with high wages. Another reason is that the only sales strategy machine tool trading (MTT) companies have for stimulating demand in the market is to sell single items, and these companies have been unable to depart from a sales approach of promoting cost performance and quick delivery. As things stand, trading companies may not be able to survive, let alone contribute to a Japanese manufacturing revival. We believe that a scientific approach to selling may be expected to accelerate machine tool facilities rejuvenation.

1.2 Purpose of this thesis

The purpose of this thesis is (a) to develop frameworks for analyzing and describing machine tool trading (MTT) companies from service systems science perspective and (b) to propose some unified *servitization* and *productization* strategies for them to become one of the crucial players contributing to Japanese manufacturing revival, based on the frameworks and the author's business experiences.

This thesis simply defines servitization as "the provision of services through value co-creation", while by productization it means the productizing of services by service industries. In service-dominant (SD) logic (Vargo & Lusch 2014), "All economies are service economies" (foundational premise FP5), regardless of the presence or absence of tangible artifacts. Furthermore, SD logic defines service as "the application of specialized competences (operant resources—knowledge and skills), through deeds, processes, and performances for the benefit of another entity or the entity itself". That is to say, the term "service" as defined in SD logic includes the concept of value co-creation. As a result, in this thesis SD logic FP5 becomes "All economies are servitization (Vargo 2014)." "Value co-creation" means a state in which products, services, and operant resources emerge through a process of networking and resource integration among stakeholders and are highly integrated through aggregation of their value. We place greater importance on value-in-context than on value-in-exchange at the time of purchase. Whereas value-in-exchange is momentary value separated into company production and customer consumption, value-in-context is continuous value co-created by company activity and customer behavior in the process of customer use of products or services.

Researches on servitization heretofore have focused mainly on manufacturing industries and medical institutions, and there has been little research on trading companies. This is presumably because of a preconception that trading companies, apart from general trading companies, are specialized single-function entities. MTT companies are typical service industries that mainly engage in face-to-face selling. At the same time, since machine tools do not serve any function on their own and require complex functional complementation, MTT companies are thought to fulfill four roles: manufacturing industry, service industry, customer, and platform. That is, they purchase from manufacturers durable production goods that embody production technology and engage in face-to-face selling; MTT companies indeed have potential for both servitization and productization.

Servitization is a term said to have been coined by Vandermerwe and Rada (1988) that subsequently has been variously referenced, with seemingly no attempt to standardize the terminology (Baines 2009) (Table 1).

Table 1 Definition of sevitization

Definition of servitization			
№	Focused	Author	Definition of servitization
1	☆	Vandermerwe and Rada(1988)	"Market packages or 'bundles' of customer-focused combinations of goods, services, support, self-service and knowledge"
2	Manufacturing	Desmet et al. (2003)	"A trend in which manufacturing firms adopt more and more service components in their offerings"
3	Manufacturing	Tellus Institute(1999)	"The emergence of product-based services which blur the distinction between manufacturing and traditional service sector activities"
4	Manufacturing	Verstrepen and van Den Berg(1999)	"Adding extra service components to core products"
5	goods + services	Robinson et al. (2002)	"An integrated bundle of both goods and services"
6	functionality	Lewis et al. (2004)	"Any strategy that seeks to change the way in which a product functionality is delivered to its markets"
7	Manufacturing	Ward and Graves (2005)	"Increasing the range of services offered by a manufacturer"
8	Manufacturing	Ren and Gregory (2007)	"A change process wherein manufacturing companies embrace service orientation and/or develop more and better services, with the aim to satisfy customer's needs, achieve competitive advantages and enhance firm performance"
Baines et al., 2009 The Servitization of manufacturing A review of Literature and reflection on future challenges			
9	goods + services	Andy Neely (2013)	"The innovation of organisation's capabilities and processes to better create mutual value through a shift from selling product to selling Product-Service Systems"
10	Manufacturing	Aston Business School (2013)	"The concept of manufacturers offering services tightly coupled to their products"
Author revision to Baines et al.,2009			

The table suggests that although the term servitization first appeared as a comprehensive perspective, it subsequently developed with a central focus on manufacturing industries, and that research on service industries was limited. Returning to the starting point shows that the likely purpose of servitization was promotion of increased emphasis on providing services and adding value through services in all industries.

Hereafter, we call servitization used in the sense of increased emphasis on providing services and adding value through services by manufacturing industries “servitization in the narrow sense”. Manufacturing industries that practice servitization do not merely sell products but add value by providing after-services bundled with products. This is exemplified by the sale of Daikin air conditioners inclusive of installation service and General Electric’s switching from the sale of jet engines to “power by the hour (PBH).” PBH is a performance-based service agreement that is a delivery requirement of the U.S. Department of Defense.

In contrast, productization is the productizing of services by service industries. Ordinarily, this is considered the opposite concept to servitization in the narrow sense. For example, a service industry may attempt to enhance services by taking a manufacturer-like approach. Restaurants, a service industry, may standardize, optimize, and provide products using manufacturer-like methods, as MacDonald’s does. Although the hospitality *(Omotenashi)* of Kagaya Ryokan, an operator of traditional Japanese inns, is considered representative of typically Japanese service, behind the scenes is a state-of-the-art distribution system that uses automatic guided vehicles (AGVs) as serving wagons. In this way, labor-saving typical of manufacturing industries renders direct guest room services hospitable.

Since trading companies engage in face-to-face selling, they are typical service industries (T. Fujimoto 2007). Other than on delivery days and other exceptional occasions, they do not deal with tangible artifacts. Although trading company representatives must have advanced technological knowledge and hospitality skills, they cannot bill hourly charges. In this way, trading companies are different from barber shops or cram schools. Moreover, without contracting (= order reception), there is no revenue contribution. Failure to receive an order means that all preceding economic activities come to naught and results in a loss. Economic activities continue even after contracting, from delivery, acceptance, and invoicing to collection. In the case of payment by promissory note, an additional six months is necessary to receive cash. Ordinarily, service industries are thought to deliver intangible services, not tangible artifacts. However, trading companies fall into a paradox in that they engage in actual economic activity only through dealing with tangible artifacts.

It may seem possible for MTT companies, which possess polar opposite characteristics of service industries and manufacturing industries, to consider both strategies: productization (productizing of services by service industries) and servitization in the narrow sense (increased emphasis on providing services and adding value through services by manufacturing industries). However, this is not the case. Productization and servitization are terms that classify activity from a provider perspective. Hence, manufacturing industry providers would see this as cooperation with their own servitization in the narrow sense at the front-end of distribution, and customers would see it as an extension of servitization in the narrow sense. Terminology differs according to an entity’s position. Rather, what is required of trading companies is servitization in a broad sense aimed at promoting increased emphasis on providing services and adding value through services in service industries, which does not fall within the category of productization. If strategies and prescriptions can be written for both strategies—productization and servitization in a broad sense—segmentation of the four roles of trading companies and the presence or absence of the operand resources referred to as tangible artifacts will become largely meaningless. Progress in research into multi-role trading companies can be expected to facilitate development of servitization research into research that comprehensively applies to all industries. At that time, the categories primary industry and secondary and tertiary sectors of the economy may become mere statistical conveniences.

Some of main contributions of the thesis are as follows; First we analyze and examine MTT companies based on systemic models in service systems science perspective to find what is required of MTT companies in the future is servitization in a broad sense aimed at promoting increased emphasis on providing services and adding value through services in service industries. In addition, we derive strategies and prescriptions for both strategies—productization and servitization in a broad sense.

1.3 Structure of thesis

Figure 1 shows the structure of this thesis.

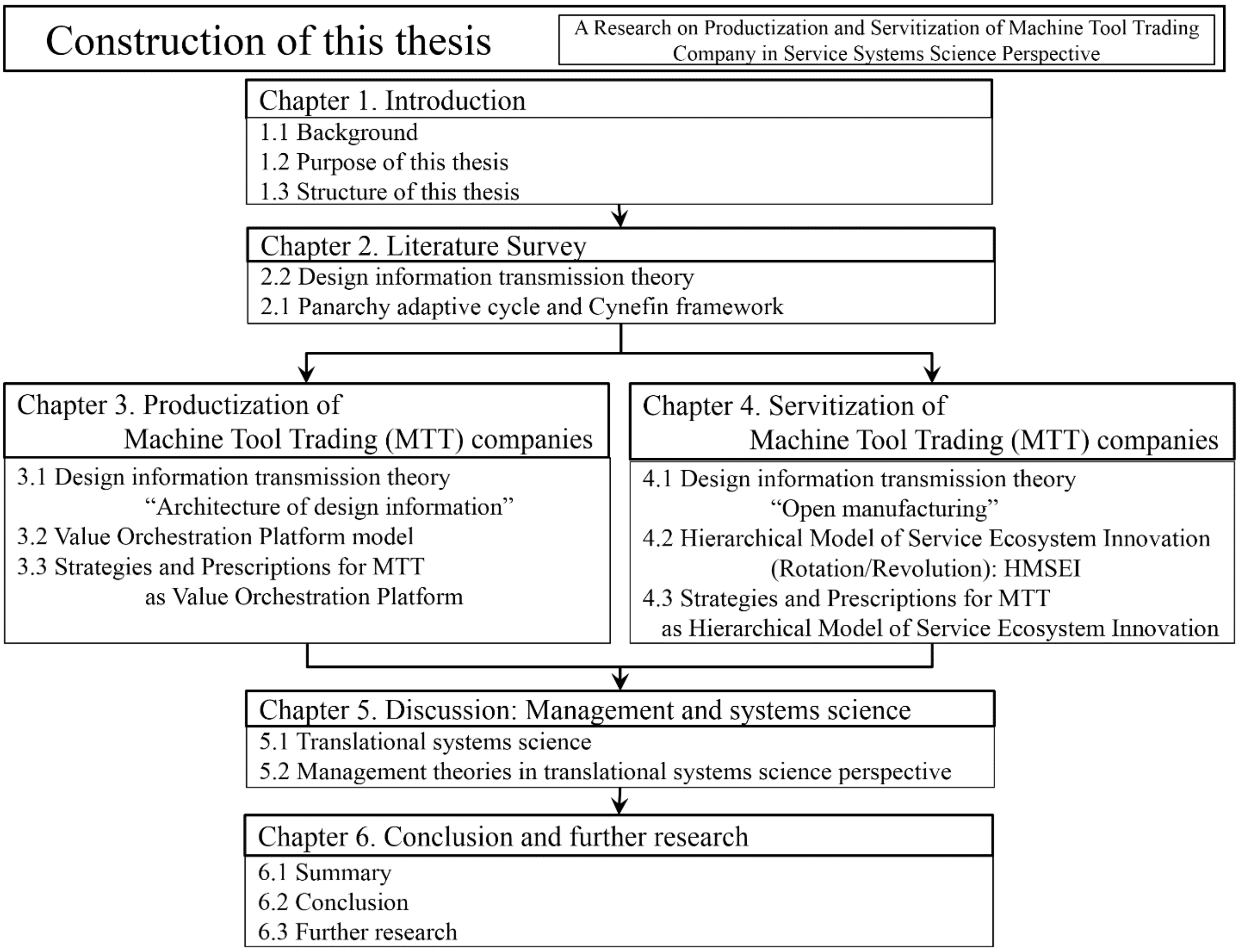


Figure 1 construction of this thesis

Chapter 1, Introduction, discusses the current state of Japanese manufacturing (*monozukuri*), considered a source of Japan's national strength, and the importance of machine tool facilities. MTT companies play a major role in enhancing the competitiveness of domestic factories. Devising strategies and prescriptions for servitization of MTT companies may be expected to contribute to Japanese manufacturing revival. In addition, since MTT companies perform four roles, analysis of those roles may be effective in generalization of servitization.

Chapter 2, Literature Survey, discusses design information transmission theory, the Panarchy adaptive cycle, and the Cynefin framework. Design information transmission theory, which originated in Japan, is a theory that provides an overview of Japanese manufacturing. Panarchy is a complex systems model of the adaptive cycle that originated from forest ecosystem research. The Cynefin framework is a complex systems model of society that discusses leadership in terms of stages.

Both Chapter 3 and Chapter 4, the main bodies of the thesis, discuss a business model for MTT companies derived from design information transmission theory. Application of a theory that originated in manufacturing industries in business model analysis of MTT companies, which are closely involved with Japanese manufacturing, is valid and effective.

Chapter 3 “Productization of Machine Tool Trading (MTT) Companies” considers specifically servitization by means of a service industry productization strategy. Production technology is treated from the perspective of the design information transmission theory “architecture of design information”. The value orchestration platform model is introduced as a reference framework. Strategies and prescriptions are derived through an approach involving four-phase value co-creation and three strategies. Seven quality control (QC) tools are invoked as a means of transmitting production technology to machine tools with attached peripheral equipment.

The foundation of the strategy is that product and process are two sides of the same coin (Abernathy 1978). MTT companies enable the emergence of production technology as producers of new manufacturing site industrial clusters. This is transmission of service design information to a tangible and durable medium. MTT companies perform the role of typical manufacturing industry providers.

Chapter 4 “Servitization of Machine Tool Trading (MTT) Companies” considers servitization by means of a service industry servitization strategy. Based on the design information transmission theory “open manufacturing” and Hierarchical Model of Service Ecosystems Innovation (HMSEI) are introduced, and then adaptive transition and phase transition are discussed. A prescription is derived from the Cynefin framework and a response to phase transition by means of the co-design strategy is discussed.

Since the medium is intangible and ephemeral, face-to-face selling is classified as a typical service industry activity, and since MTT companies engage in face-to-face selling, they are classified as typical service industries. The medium is unstable, and so design information instantaneously decays and perishes. Countering this, perishing through repetition of transmission is rational. According to SD logic, feedback exchanged simultaneously and equivalently with transmission exists. This is called “service exchange”. Also, networking and resource integration exist behind service exchange. Face-to-face selling cycles and repeats these three activities.

The productization strategy considered in Chapter 3 is a strategy that places emphasis on networking and resource integration, whereas Chapter 4 considers a strategy that focuses attention on service exchange face-to-face with customers.

Chapter 5 “Discussion” attempts an approach to management in general based on service science. The three-dimensional approach of the translational systems science is shown to be effective.

The foundation is an upward spiral between *techne*, which is tacit knowledge, and *episteme*, which is explicit knowledge. The importance of elevating episteme to the level of design information is understood in light of the idea “The source of value to the customer is the design information that the product embodies,” the starting point of design information transmission theory. The purpose of Chapters 3 and 4 is to elevate the trading company business model, which has been thought transmittable only through experience and intuition, to the level of service design information.

Phronesis is a philosophical concept that may take either a positive or negative value, and a positive value is considered difficult to cultivate. The abstruse concept of phronesis is clarified using a scientific approach to find two axes. Furthermore, good management is aspired to through parallel use of the promotion of business ethics activities, the foundation of corporate social responsibility (CSR) strategy.

Finally in Chapter 6 we summarize the research findings and points out further research topics.

Chapter 2. Literature Survey

2.1 Design information transmission theory

Design information transmission theory provides the definition "A product is design information transmitted to a medium," a definition that uniformly covers all industries from the perspective of product design information transmission (T. Fujimoto 2004). If we substitute "medium" for "goods", this agrees with service-dominant logic FP3, "Goods are a distribution mechanism for service provision." Furthermore, Fujimoto holds that if the medium is intangible, it is a service industry product, and if it is tangible, it is a manufacturing industry product. Regarding design information, the design philosophies of designers are called "architectures" and are classified according to the relationship between function and structure. The architecture of structures having a simple relationship of nearly one-to-one correspondence in the interface of function and structure (parts = modules) is called a "modular architecture", and that of structures having a complexly tangled relationship is called an "integral architecture". Another architectural feature in addition to the integral and modular axes is an axis of classification according to the design rule for the interface between parts (modules). If the design rule is specific to a single company (*keiretsu*), it is called "closed", and if it transcends companies and is standardized at the industry level, it is called "open". We show the spectrum of architectures classified using these two axes in Figure 2 (T. Fujimoto 2007).

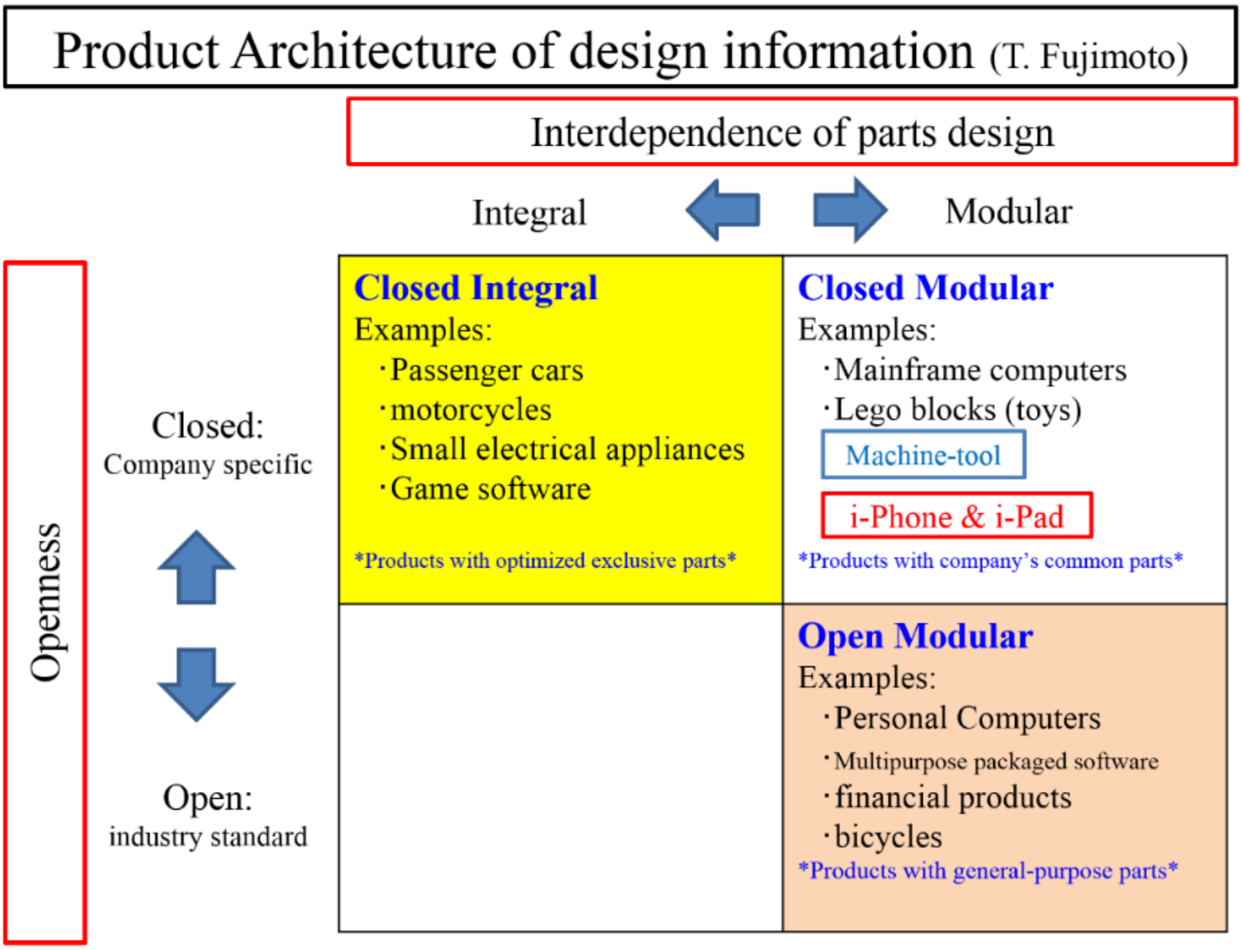


Figure 2 Product Archtecthre of desing information (T. Fujimoto 2004)

In design information transmission theory, "Value itself resides in design information, and value is only created when design information is transmitted to media." (H. Sasaki 2008). The theory holds that the transmission characteristics of media characterize industries. This is called "open manufacturing", which has been the subject of research into cross-industry unified strategies. There are two axes in medium analysis—tangible property and durability—and a spectrum from typical manufacturing industry to typical service industry exists (Figure 3) (T. Fujimoto). Manufacturers of durable goods such as automobiles are typical manufacturing industries. Companies that engage in face-to-face selling, such as the provision of face-to-face services as exemplified by luxury hotel services, or broadcasting are typical service industries, which lie at the opposite end of the spectrum. Between these two poles lie perishable foods, which are tangible and ephemeral, and software and financial products, which are intangible and durable. Since machine tool trading (MTT) companies engage in face-to-face selling, they are typical service industries. The same is true of automobile dealers in Japan. The deportment of face-to-face sales personnel, sales talks, presentations, workshops, exhibitions, and showroom atmosphere perish without customer involvement, and memory of them also fades and disappears over time. The medium being intangible and ephemeral both characterizes service industries and is a problem for them.

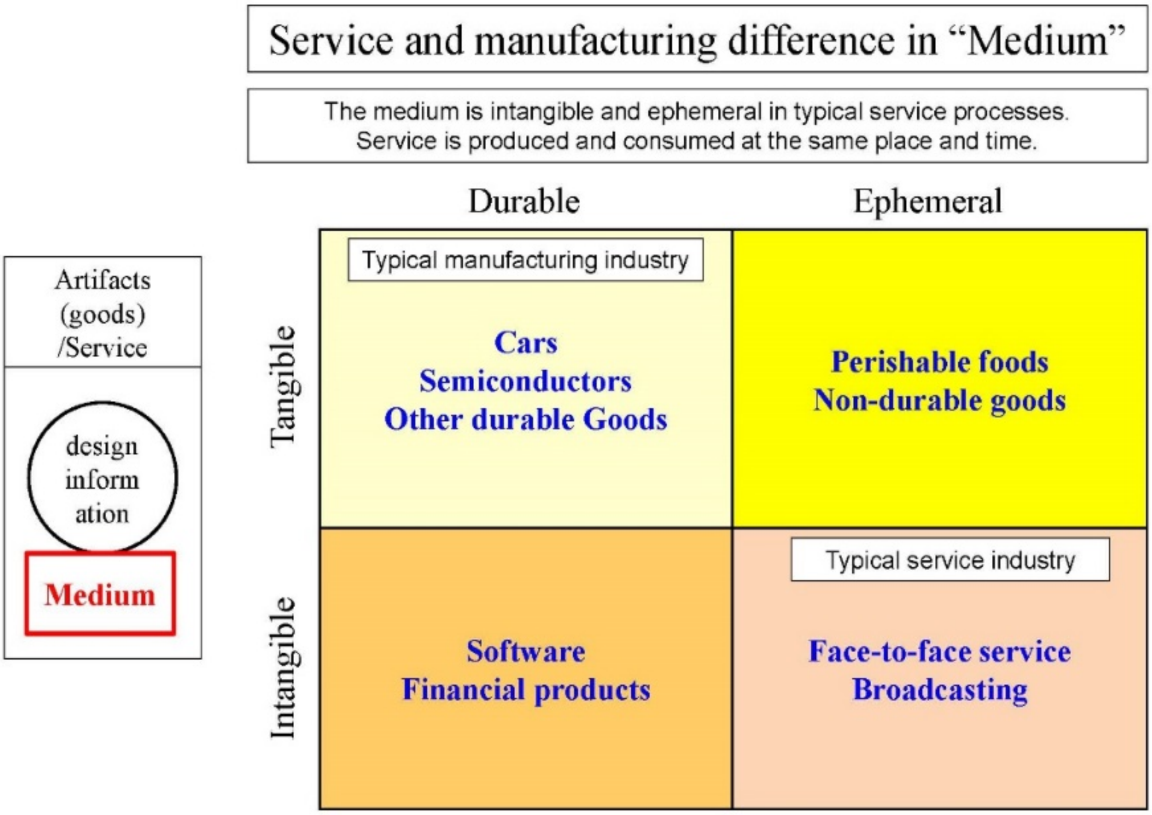
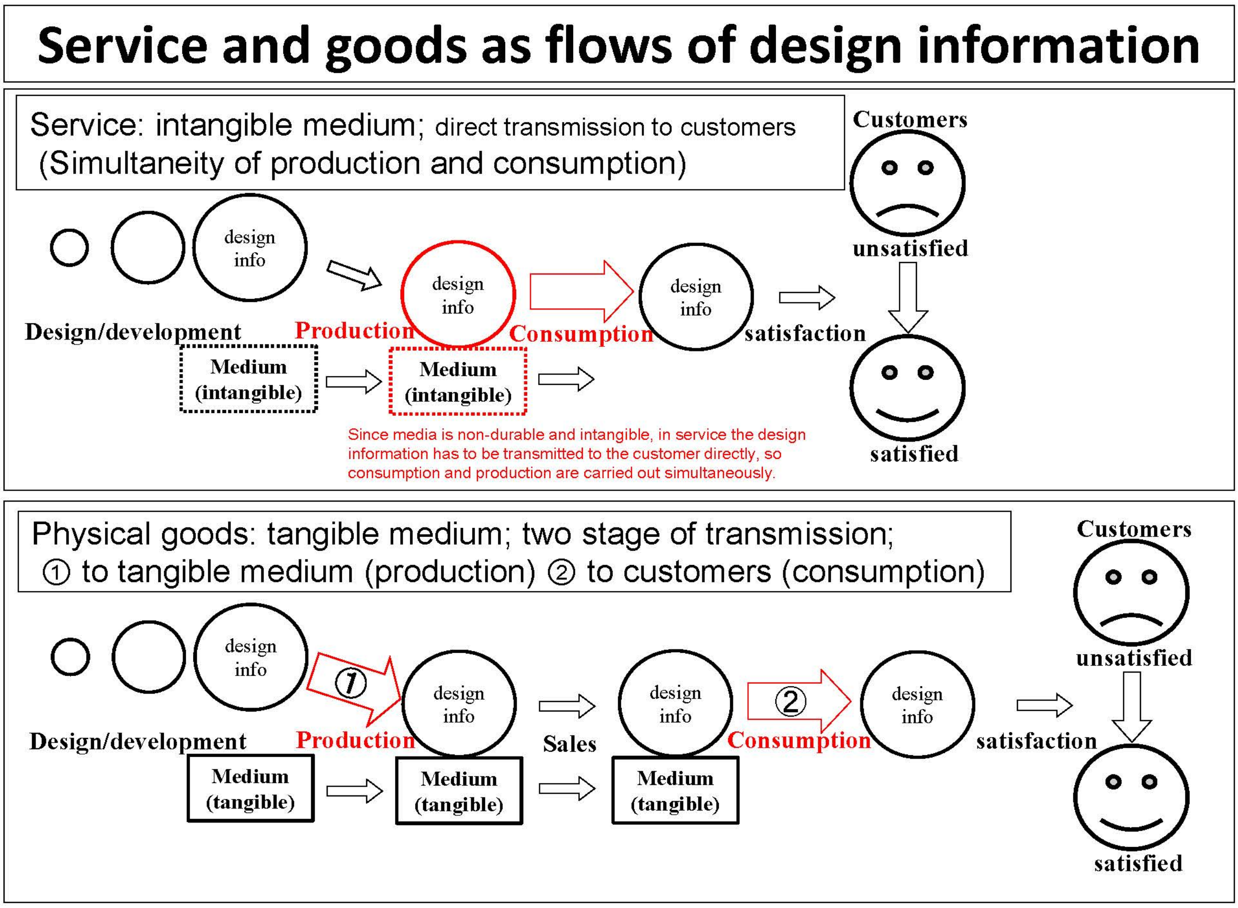


Figure 3 Mediam spectrum (T. Fujimoto 2004)

The bottom half of Figure 4 (T. Fujimoto2004) depicts manufacturing industry transmission. Chapter 4 discusses service industry transmission, depicted on the top half of the figure, in detail. In manufacturing industries, there are two stages of transmission: Transmission 1 is transmission by factory production, and Transmission 2 is transmission by customer consumption. Transmission 2 is value-in-exchange. In manufacturing industries, Transmission 1 at factories is easy to control. Quality control (QC), total quality management (TQM), total productive maintenance (TPM), industrial engineering (IE), process engineering, and supply chain management (SCM) are among the control theories that have been established for Transmission 1. The advancement of information technology led to the emergence in Germany in 2011 of INDUSTRIE 4.0, a new framework.

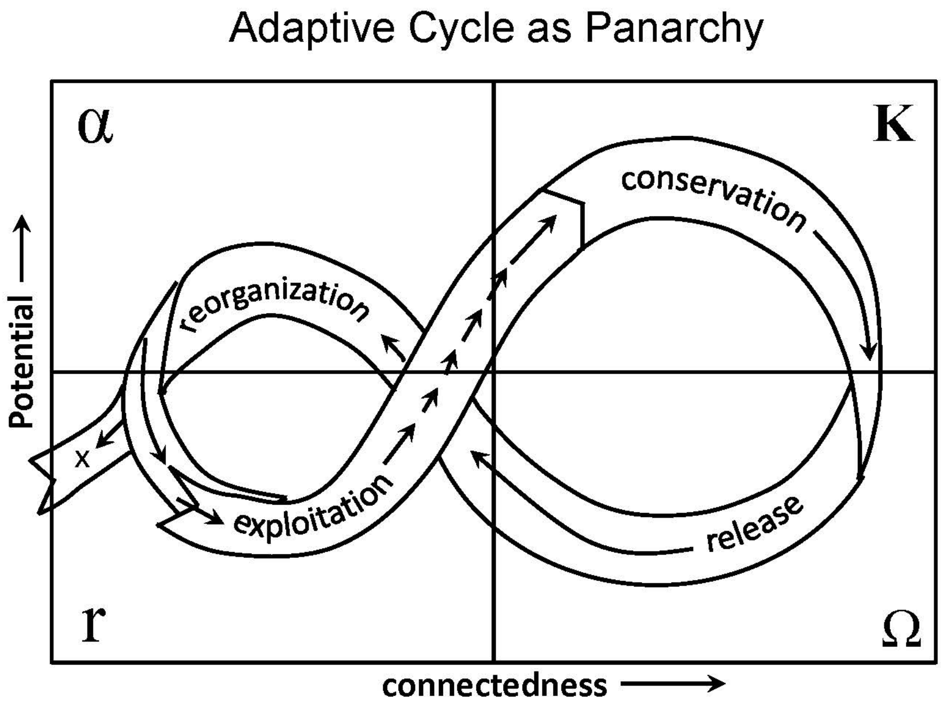


Takahiro Fujimoto. "Manufacturing Business Administration ~production philosophy beyond the manufacturing industry." *KOBUNSYASHINSYO*, March 2007

Figure 4 Sevice and goods flows ofdesign information (T. Fujimoto 2004)

2.2 Panarchy adaptive cycle and Cynefin framework

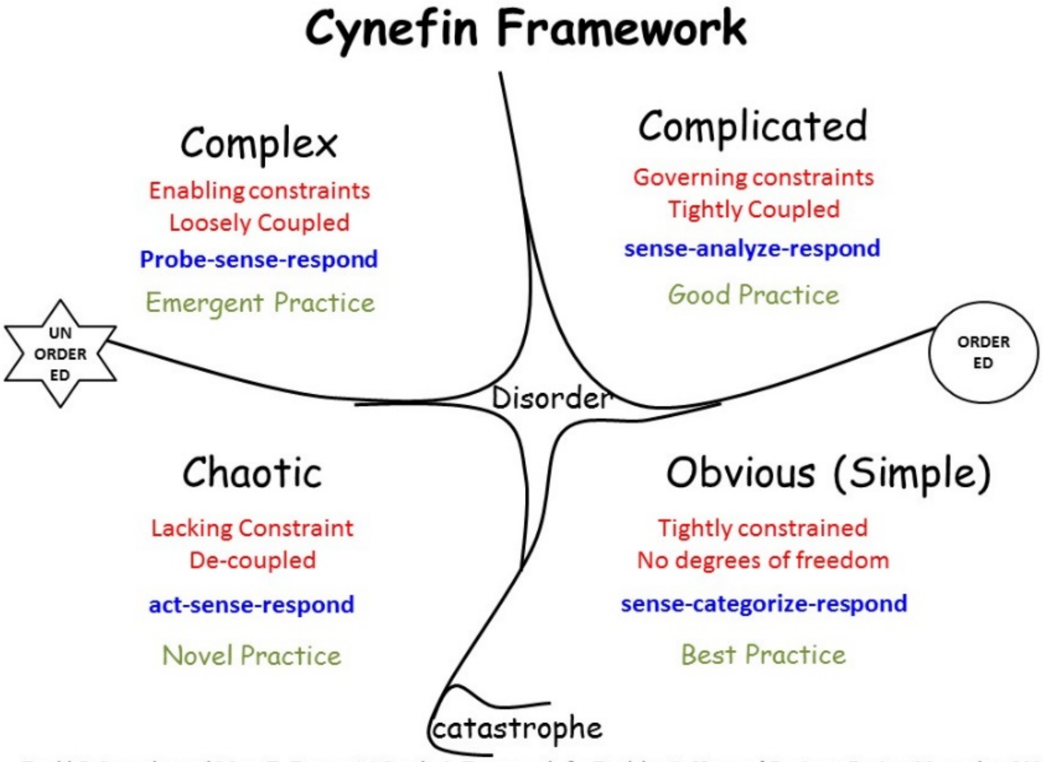
In recent years, complex adaptive models to explain the co-evolution and resilience of social systems and ecosystems have been discussed as social-ecological systems theory. The Panarchy adaptive cycle is known as a model that theorizes the characteristics of predictable stages and unpredictable stages and can explain self-organization, stability, and the complex system cycle. Panarchy has four stages: exploitation (r) → conservation (K) → release (Ω) → reorganization (α). It is depicted graphically as a sideways Figure 5 with a vertical axis representing potential or capital and a horizontal axis representing connectedness (Figure 5) (C.S. Holling 2001). The units of this circulation model are positioned on a level for each scale, forming a hierarchy in which large cycles enclose small cycles. Panarchy includes the concept of cross-scale interactions, and transition occurs between upper and lower levels. Transition from lower to upper levels is called "*revolt*", and transition from upper to lower levels is called "*remember*".



Lance H. Gunderson and C. S Holling. "Panarchy understanding transformations in human and natural systems". *ISLAND PRESS*, December 2001

Figure 5　Panarchy (Gunderson and Holling 2001)

In social systems research, the Cynefin framework is attracting attention as a new method of decision-making support based on complex systems science. A leader's decision-making must be adapted to the situation faced. In practice, it is said, "The situation dictates." However, there are few frameworks that classify situations in stages for which the effectiveness of specific prescriptions has been demonstrated. The Cynefin framework classifies situations using the stages Obvious, Complicated, Complex, and Chaotic, to which are added Disorder and Catastrophe, and teaches appropriate concrete decision-making and leadership for each stage (David J. Snowden 2007) (Figure 6)(table 2). Elaborating the Cynefin framework makes it possible to construct a clear framework that takes into account scenarios for situations that may occur in the future. New York Mayor Rudy Giuliani, who demonstrated superb leadership at the time of the 9/11 terror attacks, was unable to change his decision-making method even though the city had weathered the chaos. He was criticized for matters such as his remarks about an extension of his term as mayor and left office as planned. He later entered the presidential primary contest on the back of his popularity and subsequently withdrew after a series of primary election setbacks. To avoid such situations, the Cynefin framework changes decision-making methodology in response to complex social situations. The U.S. Defense Advanced Research Projects Agency has used the Cynefin framework in terrorism countermeasures, the government of Singapore has used it in its Risk Assessment and Horizon Scanning program, a global pharmaceutical manufacturer has applied it to develop a new product strategy, and a Canadian provincial government has used it to engage employees in policy-making.



David J. Snowden and Mary E. Boone. "A Leader's Framework for Decision". *Harvard Business Review*, November 2007

Figure 6 Cynefin Framework (D. Snowden 2007)

Table 2　Prescription of Cynefin Framework (D. Snowden 2007)

	Chaotic	Complex	Complicated	Obvious
THE CONTEXT'S CHARACTERISTICS	High turbulence	Flux and unpredictability	Expert diagnosis required	Repeating patterns and consistent events
	No clear cause-and-effect relationships, so no point in looking for right answers	No right answers; emergent instructive patterns	Cause-and-effect relationships discoverable but not immediately apparent to everyone; more than one right answer possible	Clear cause-and-effect relationships evident to everyone; right answer exists
	Unknowables	Unknown unknowns	Known unknowns	Known knowns
	Many decisions to make and no time to think	Many competing ideas	Fact-based management	Fact-based management
	High tension	A need for creative and innovative approaches		
	Pattern-based leadership	Pattern-based leadership		
THE LEADER'S JOB	Act, sense, respond	Probe, sense, respond	Sense, analyze, respond	Sense, categorize, respond
	Look for what works instead of seeking right answers	Create environments and experiments that allow patterns to emerge	Create panels of experts	Ensure that proper processes are in place
	Take immediate action to reestablish order (command and control)	Increase levels of interaction and communication	Listen to conflicting advice	Delegate
	Provide clear, direct communication	Use methods that can help generate ideas: Open up discussion (as through large group methods); set barriers; stimulate attractors; encourage dissent and diversity; and manage starting conditions and monitor for emergence		Use best practices Communicate in clear, direct ways Understand that extensive interactive communication may not be necessary
DANGER SIGNALS	Applying a command-and-control approach longer than needed	Temptation to fall back into habitual, command-and-control mode	Experts overconfident in their own solutions or in the efficacy of past solutions	Complacency and comfort
	"Cult of the leader"	Temptation to look for facts rather than allowing patterns to emerge	Analysis paralysis	Desire to make complex problems simple
	Missed opportunity for innovation	Desire for accelerated resolution of problems or exploitation of opportunities	Expert panels	Entrained thinking
	Chaos unabated		Viewpoints of nonexperts excluded	No challenge of received wisdom Overreliance on best practice if context shifts
RESPONSE TO DANGER SIGNALS	Set up mechanisms (such as parallel teams) to take advantage of opportunities afforded by a chaotic environment	Be patient and allow time for reflection	Encourage external and internal stakeholders to challenge expert opinions to combat entrained thinking	Create communication channels to challenge orthodoxy
	Encourage advisers to challenge your point of view once the crisis has abated	Use approaches that encourage interaction so patterns can emerge	Use experiments and games to force people to think outside the familiar	Stay connected without micromanaging
	Work to shift the context from chaotic to complex			Don't assume things are simple
				Recognize both the value and the limitations of best practice

Decisions in Multiple Contexts: A Leader's Guide
Effective leaders learn to shift their decision-making styles to match changing business environments. Simple, complicated, complex, and chaotic contexts each call for different managerial responses. By correctly identifying the governing context, staying aware of danger signals, and avoiding inappropriate reactions, managers can lead effectively in a variety of situations.

Chapter 3. Productization of Machine Tool Trading (MTT) companies

3.1 Design information transmission theory "Architecture of design information"

3.1.1 Architectural geopolitics

In *A view of Japanese Manufacturing in 2030* (T. Fujimoto 2015) the manufacturing-site organizational capability of Japanese manufacturing ("*monozukuri*", manufacturing as a craft) is described as a capability for organized creation and transmission of design information, defined by a comprehensive process leading to background competitive strength, foreground competitive strength, and profitability. The basic characteristics of the design information are collectively called its "architecture", which can be analyzed in terms of the correspondence between the constituent function and structure of the product (components: modules) that shows the interdependence of component design.

For a complex product with intricate function groups and component (module) groups, the design information comprises an "integral" (lapped) architecture. For a simple product in which the component function groups and component groups are in nearly one-to-one correspondence, the design information comprises a "modular" architecture. An automobile is typically an integral product, whereas a personal computer typifies a modular product.

In automotive and other integral products, Japanese manufacturing continues to hold a leading position in global markets. In light electrical products, in contrast, it has fallen behind in the face of pervasive modularization of large-volume production that has accompanied the tremendous rise in global market volumes, primarily because consistency between product architecture and organizational capability largely governs competitive strength. In the past, Japanese companies thrived and grew by building their organizational capability for integration-based manufacturing (*monozukuri*) focused on operations and an integral architecture highly suited to their products. Most of the Japanese net-export products were relatively high in integral architecture. In assembled products, in particular, the export ratio and international competitive strength tended to increase with the degree of integration and labor concentration (T. Ohshika &T. Fujimoto 2006). Japanese manufacturing (*monozukuri*) was thus driven by integrated, operation-focused manufacturing sites.

There are geopolitics for architecture as describe above. So we give representative example as list below (Figure 7). Japanese car exists in Closed Integral quadrant, Taiwan smartphone exists in Closed Modular, and Chinese personal computer exists in Open Modular where it is described the United States and South Korea are also strong (Fujimoto 2008).

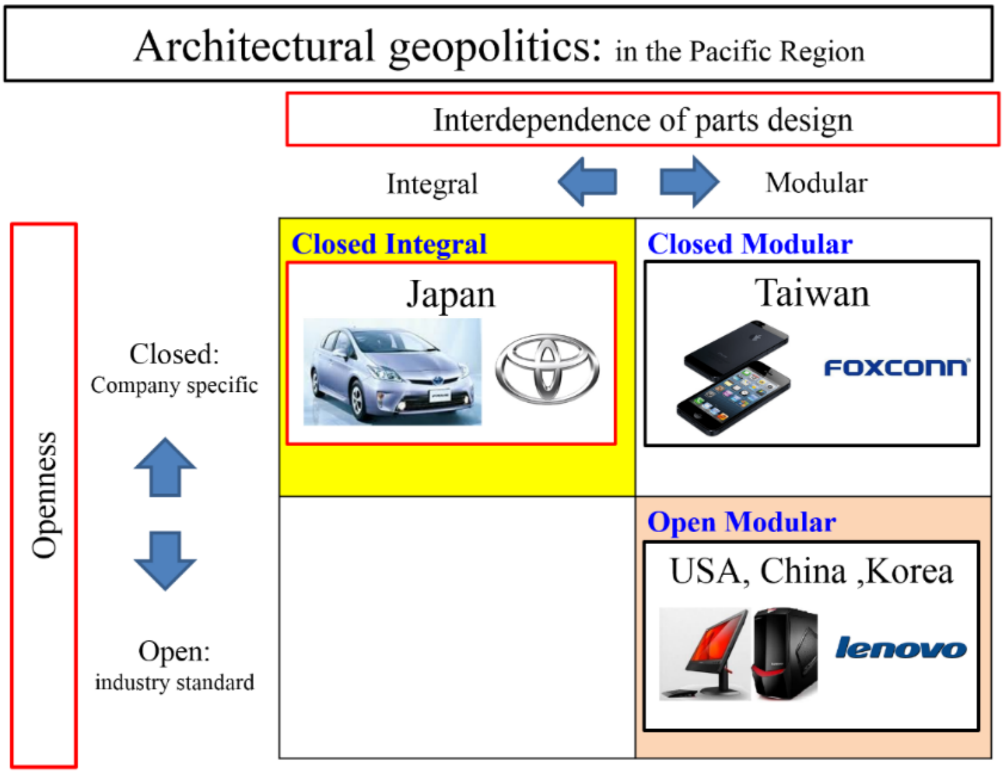


Figure 7 Architectural geopolitics

It is pointed architectural conversion has caused decline of Japanese electronics industry (Fujimoto). Analog cathode-ray tube TV in Closed Modular has converted into digital Liquid Crystal TV in Open Modular, and also analog-cell phone in Closed Integral has converted into smartphone in Closed Modular. They are no longer geopolitical advantage for Japanese products. Japanese manufacturing is still geopolitical strong in Closed Integral (Figure 8).

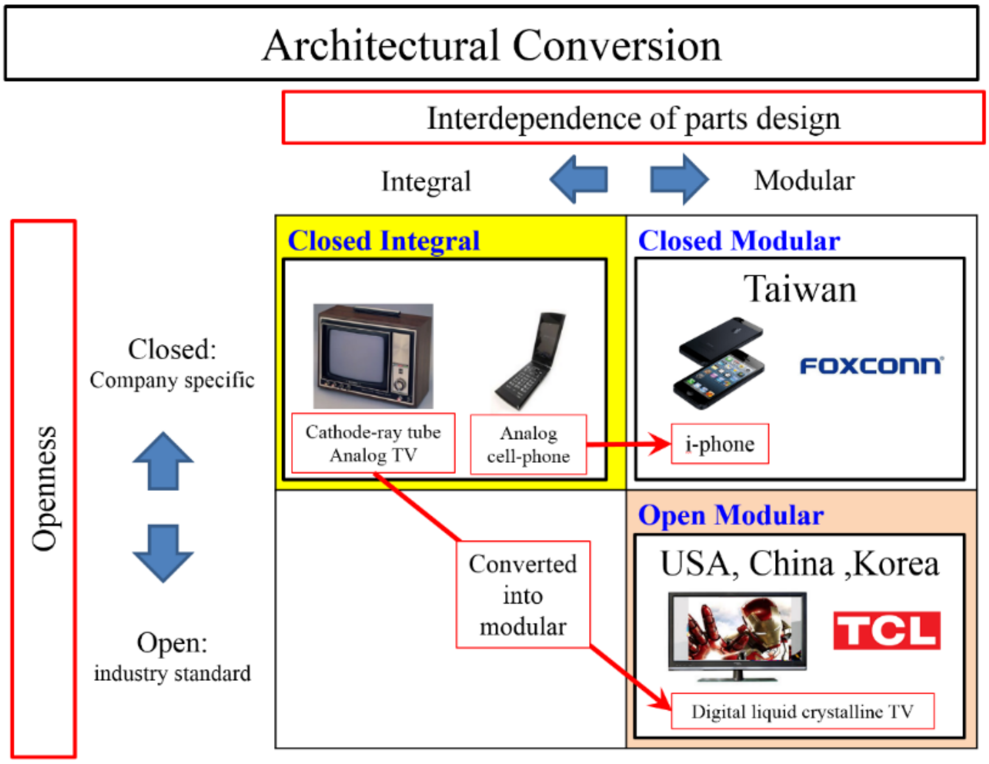


Figure 8　Archtectural conversion

The crucial task for many manufacturers in Japan has now become creation of an innovative modular business model for co-existence of the integrated, operation-focused manufacturing site, which is the strength of Japanese manufacturing, and the American-style concept-based strategy, to enhance the capability for strategy conceptualization at the manufacturing sites. To rebuild the manufacturing capability in this way it will be necessary to (1) further strengthen the long-term, multi-skilled worker teamwork, capability-building, high-productivity, high-wage mode and thereby enhance domestic production of competitive-advantage integral products; (2) build a new modular production system that is modularized but in correspondence with integral manufacturing for creation of Japan-specific high added value; and (3) educate and develop personnel and organizations capable of developing and growing a corresponding strategic modular business model (T. Fujimoto).

Transformation from integral technology to modular technology is essential for realizing these changes, but it is generally very difficult to visualize the internalized integral technology residing in highly skilled individuals and extend it to modular technology. It will require long lead times, with no guarantee of success. This leads us to focus on the role of machine-tool trading companies (MTT companies) as project producers, and the possibility of an MTT company serving in that role to obtain the participation of machine-tool manufacturers and complementary companies (peripheral equipment manufacturers) holding competitive advantages in planning and implementation of a new site-generated industrial cluster, and function as a business architect (designer) to allocate, interlink, and modify the component work sectors (T. Fujimoto 2004). It must view the target product of business discussions as a single system, with various single-function, independent component products and services as modules in planning and collaborative value creation in cooperation with the customers, as a cooperative effort for goal attainment. To fulfill this role as the producer, the MTT company must be capable of advance conceptualization, expert, informed judgment and evaluation, and formation of networks that transcend boundaries between industrial sectors (T. fujimoto 2004).

If the MTT company can effectively develop a modular business model and apply its producer function, then during the next twenty years, the excellent Japanese manufacturing sites can be expected to achieve sustainability enhancement greater than that of the last twenty, particularly in view of the rapidly shrinking gap between domestic and foreign wage levels (T. Fujimoto 2013).

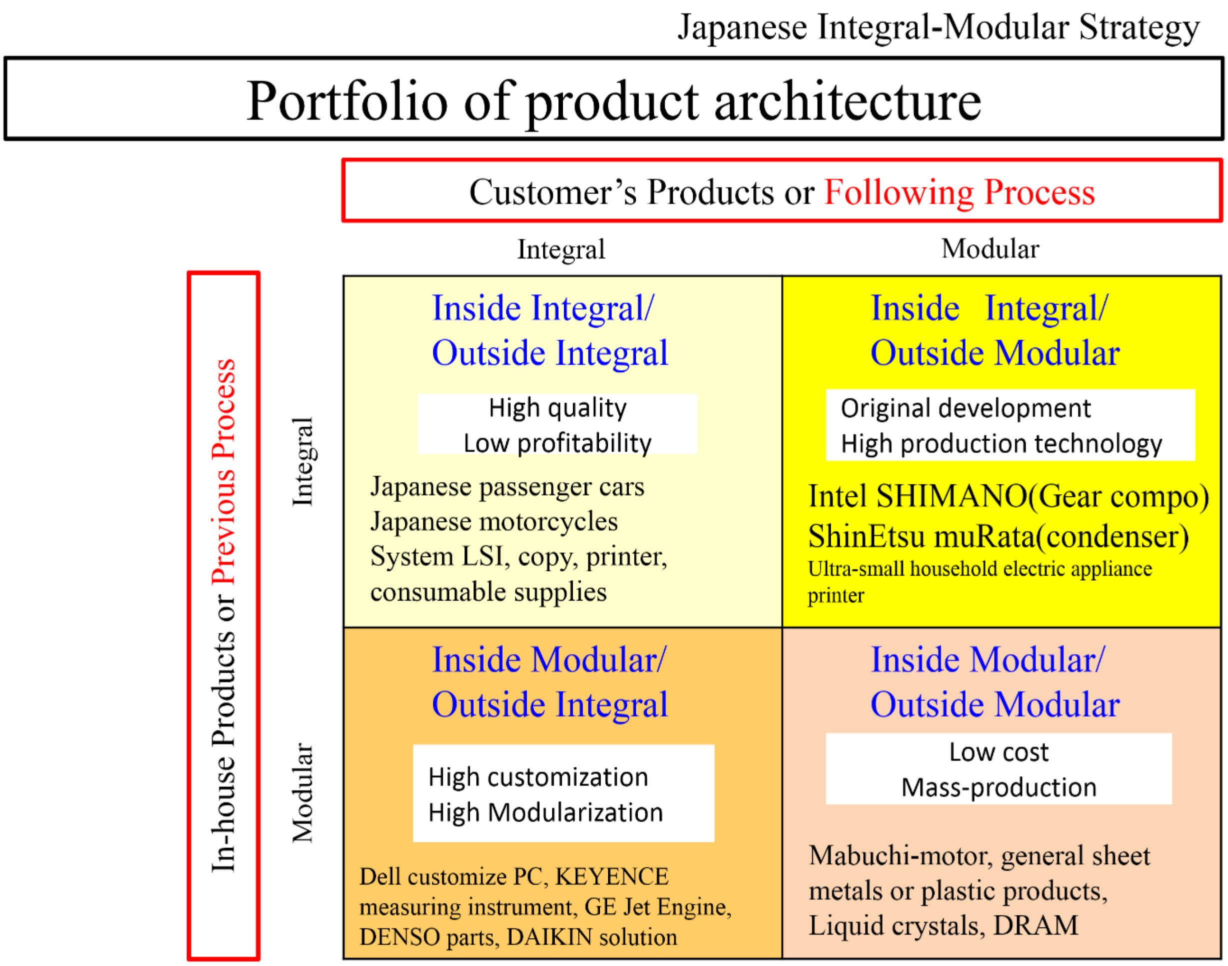
3.1.2 Modular customization strategy of production technology

Next, we discuss the conversion strategy from integral skills to modular technology as a vision for the future of Japanese manufacturing. We call this vision a modular customization strategy of production technology. Figure 2 shows a well-known typological classification of products by the characteristics of their design information architecture (T. Fujimoto 2004). The horizontal axis represents the degree of component design interdependence, from product modularization (assembly) on the right to product integration (internal inter-adjustment) on the left. The vertical axis represents the degree of linkage with other companies, from open (industrial standards-based) products on the bottom to closed (internalized) operation on the top. Automobiles are prime examples of closed-operation, integral products, located in the upper left region of the chart. Each product is designed and manufactured within a corporate group keiretsu with a closed, hierarchical supply chain and end-product assembly under its own standards.

The personal computer is a prime example of open-operation modular products, located in the lower right region of the chart. It is composed of a CPU and many other components produced under industry standards. A minimum of specialized knowhow and skill is sufficient for its production, which is advantageous to countries and regions with relatively low wages and low-value currencies.

In his research on future configurations for Japanese manufacturing (*monozukuri*), T. Fujimoto has investigated the “architecture portfolio strategies” on the basis of Figures. 9 and 10. In Figure 9, contributory products and subsequent processes are classified as “external” and the corresponding components and prior processes as “internal”, and the position in the chart is thus determined by the internal/external integral/modular combination. To date, the manufacturing technology of plants in Japan is positioned as both internal- and external-integral, with integral products and components manufactured by integral technology and thereby fully utilizing the strengths of integrated organization. This position tends to result in total product optimization but also in high cost and low earning power.

Shifting downward from this position, as shown in Figure 10, may be expected to yield cost reduction through transformation from internal to modular production technology in combination with customization by high-level assembly. If products equivalent to integral products and components can be produced in this way, as though they were the result of integral production technology alone, it will contribute to cost reductions that effectively offset the high-wage, high-currency handicap of domestic factories and may effectively establish an internal- and external-integral combination. In this figure, internal integral/external integral technology is called simply “integral technology”, and internal modular/external integral technology is called “modular technology”.



Reference: Takahiro Fujimoto. Business Administration of “Monozukuri” - Manufacturing concept exceeding manufacturer .Kohbunsha Sinsyo, March 2007

Figure 9 Prtfolio of product architecture (T. Fujimoto).

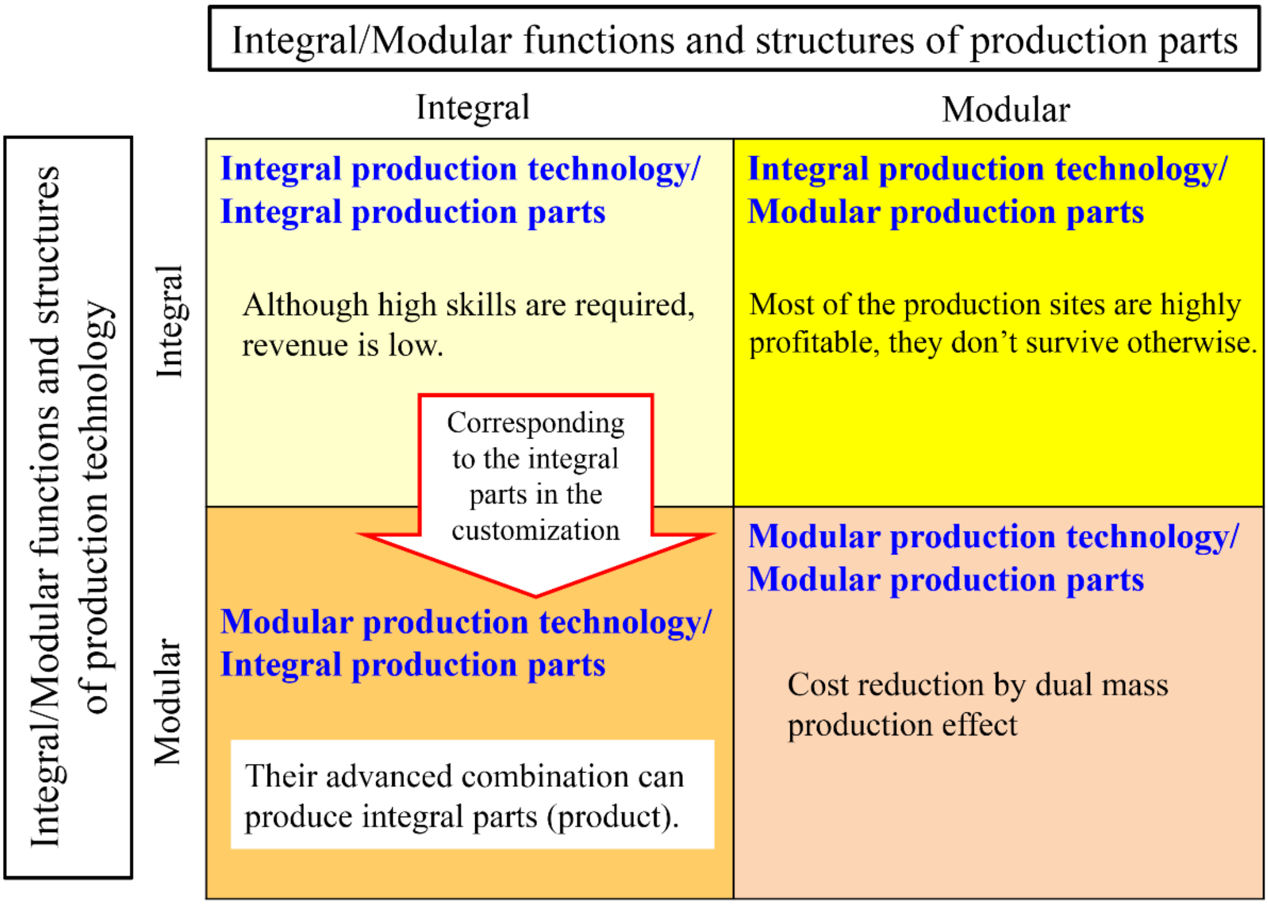


Figure 10 Modular customizing strategy of production technology

Integral technology is generally an art that is dependent on the capability of individuals in what is known as "skill". The skill inheres in the individual, and is difficult to set forth in manuals and is both difficult and costly to transmit to others. In addition, this transmission is highly dependent on the ability of the individual. Thus, this skill is high in attenuation and low in communicability. The capabilities required for achievement of integral (intermodificaton) technology and provided by veteran workers born during the "baby boom" period of the late 1940s (who are known as "the artisans") have long supported the rise of Japanese competitive strength, but the transmission of these skills to the younger generation is now directly confronted by a particularly grave difficulty. The Statistics Bureau of the Ministry of Internal Affairs and Communications has sounded an alarm in its report on "The 10-year problem (2007–2016) of baby boomer retirement" (M. Chino 2010), with many veteran craftsmen scheduled to retire from their domestic manufacturing workplaces around 2016.

In modular technology, a key objective is to express skill in readily transmissible diagrams, equations, words, and other forms of objective, explicit knowledge, thereby facilitating its propagation and enabling its direct written input to machinery (K. Mori 2005). The hand of the human craftsman has long been superior in accuracy and precision to that of machines. Recent technological advances have now brought machinery to an extremely high level of accuracy. This, together with the increasing modularization of machine-tool supplementary products (i.e., peripheral equipment) and assembly customization, now makes it possible to attain a level of modular technology equaling that of integral technology. Mechanization of the requisite tools for skill embodiment is in progress, and related goals are the transformation of skill to a field of science and merging them with machine technology. Conversely, technology is becoming increasingly complex with its rising control capabilities, thus creating the need to incorporate a capability for knowhow and intuitive understanding, and in this respect is itself approaching the nature of a skill.

In developing the future configuration of Japanese manufacturing, comparative investigations to determine the combination required for modularization of integral technology would be impracticable because of the huge number of potential combinations involved. It is more realistic to apply a platform strategy in which new industrial clusters of intercompany linkages can emerge at the manufacturing site, and thus within the factory, and in this way work toward the goal of modular transformation (T. Fujimoto 2004b). In general usage, the term “industrial cluster” refers to either (1) the emergence of a new enterprise having a small to medium-sized company that holds a regional competitive advantage at its core and linkages between this and other companies, local authorities, universities, and other organizations in that region, or (2) a wide-ranging industrial aggregation. In the present context, however, it refers to a configuration in which various independent parties can meet at a manufacturing site and participate in plans for its improvement, with no intrinsic need for geographical proximity.

In this thesis, we argue that MTT companies can serve as the platform, enabling the emergence of a high-level modular production system and thereby accelerating the transmission of skills to young workers and contributing greatly to construction of Japanese manufacturing capabilities.

3.2 Value Orchestration Platform model: reference framework of MTT

3.2.1 Definition of service: four-phase value co-creation process model

In the value orchestration platform model, the process of value co-creation by the providers and the customers in the service system proceeds in four phases (Figure 11) (K. Kijima 2014).

In joint value creation by the customer and the providers, both participate in this process and share the service experience, starting from interaction. We refer to this initial phase of value co-creation as the "co-experience" phase.

This is followed by the "internal model co-definition" phase, in which they apply their co-experience to tentatively developing, considering, and identifying their respective internal models, reach a mutual understanding on what the customer wants and what the provider can do, and develop a shared internal model in which the service value emerges.

The development of this shared internal model is a process of customer and provider matching, which is at the heart of value creation. In marketing, it is at the center of the well-known ribbon diagram model (Figure 12) (Nihon Keizai Shimbun 2004). In layered segmentation, if an action taken by a target customer with latent demand matches the expectation of a target provider seeking a latent customer to expand sales, the provider's gain increases and the platform value rises.

In optimization of the shared internal model, the customer and the provider interact to raise the level of service, in two phases: a bilateral phase for service co-elevation and a multilateral phase for service co-development. This provides feedback on the co-created service value. A process of cyclical co-evolution then proceeds, leading to emergence of new service value (K. Kijima 2014).

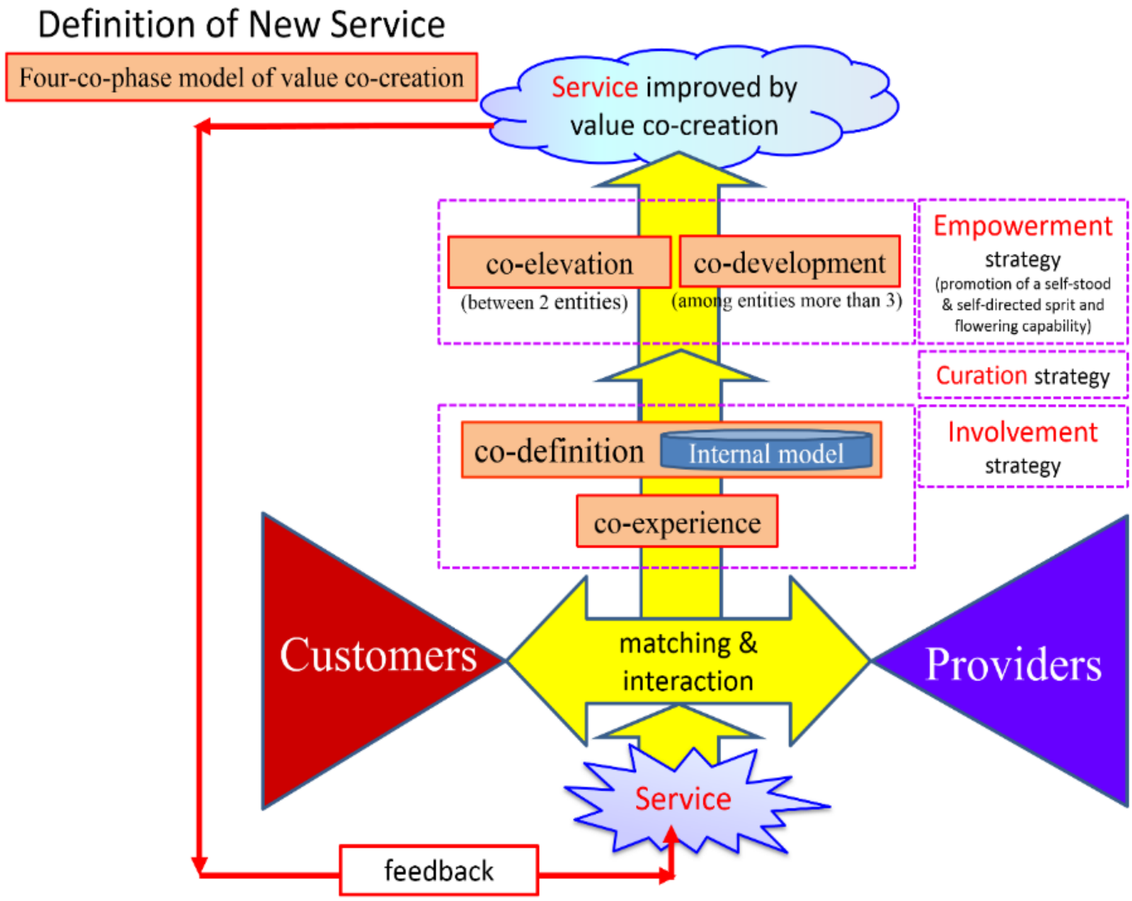
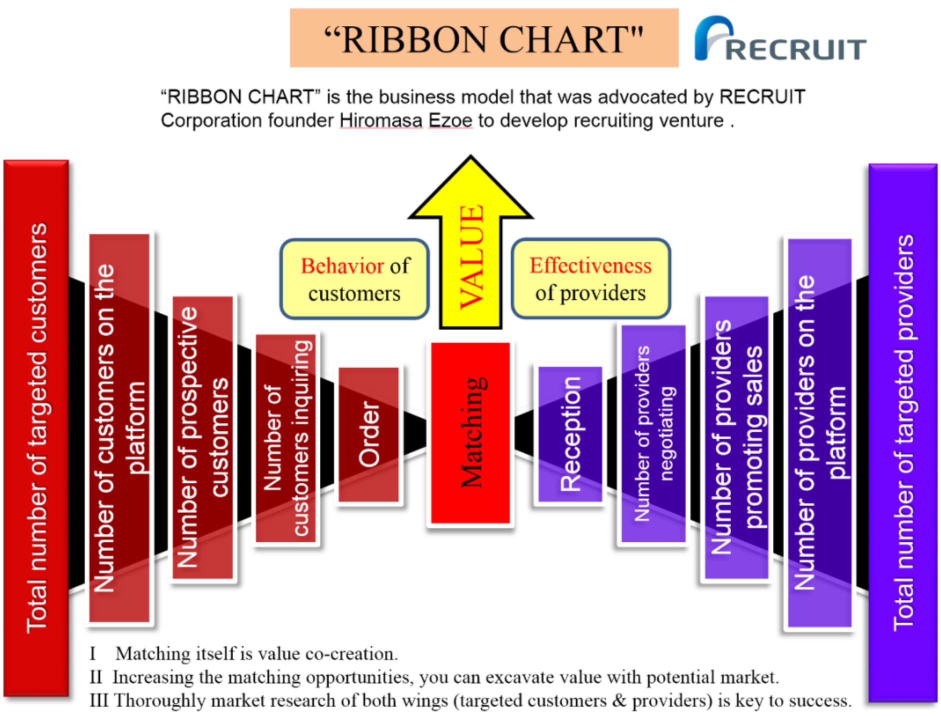


Figure 11　Definition of service (K. Kijima 2014)



GODA revised the source and corrected it and wrote this figure.

Figure 12　Ribbbon chart of platform

Co-elevation is a mechanism of value co-creation through needs-pull and seeds-push interaction between the customer and the provider (Figure 13). In sharing internal models with the customer, the provider generally tends to identify the customer's needs and expectations and attempt to meet them by raising its service provision capability. If this capability rises, the customer receiving the service tends to raise its receiving capability and expected service value incrementally, to a new level of needs and expected value. The co-elevation of service value proceeds through repetition of this interaction. The course of service elevation is characteristically discontinuous, as in a game of "playing catch", and proceeds in intervals between actual service provision, thus taking on a zigzag, spiraling form.

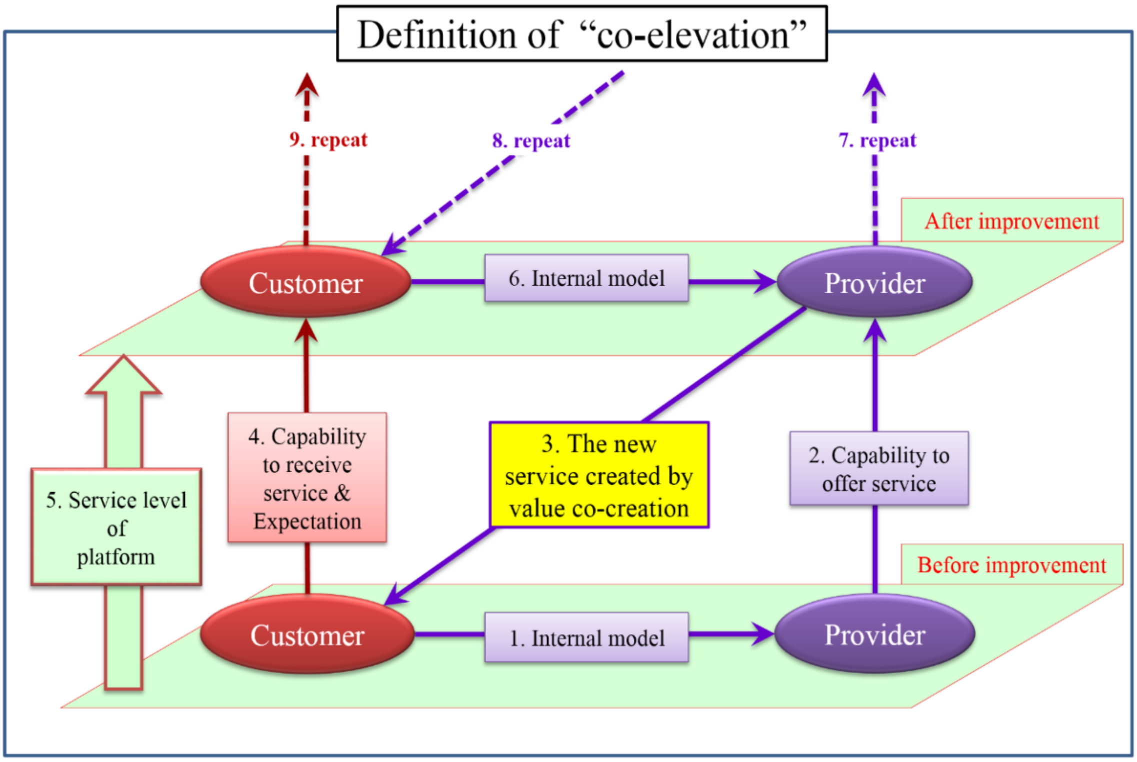


Figure 13 Co-elevation

In the co-development phase, in contrast, service value is created jointly by customers and providers as they achieve a wholly harmonious unity (Figure 14). As it proceeds, the customers and the providers organize and adjust their mutual services and effectively form into combinations to perform mutual problem solving, thereby carrying forward a continuous process of elevating service value. Classic examples of co-development may be seen in Linux software development and in the composition of Wikipedia by customers and providers who form a united, harmonious whole.

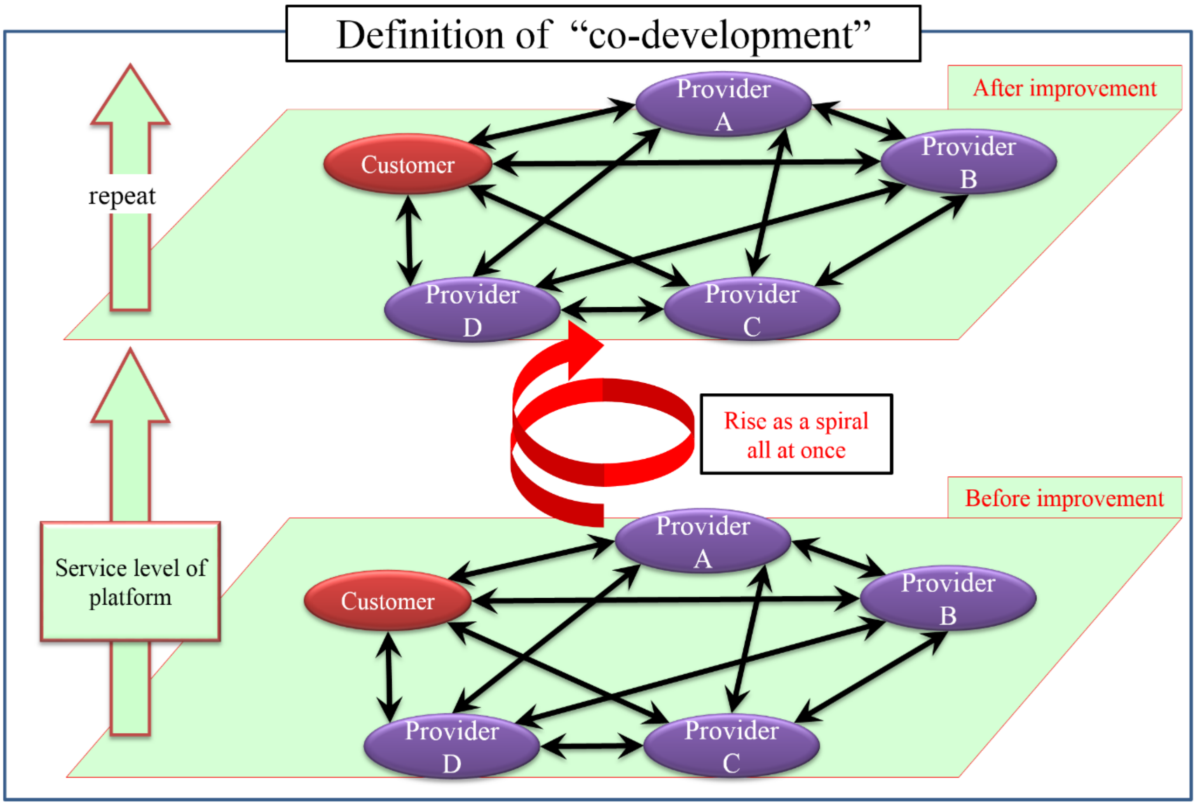


Figure 14 Co-development

3.2.2 Value Orchestration Platform model and its three strategies

The value orchestration platform model is a two-level service system model comprising the value co-creation process defined in Sec. 3.1 and the supporting platform (K. Kijima 2014) (Figure15). The chief interest of this platform model is examining the strategy for management of the four phases of value creation and supporting new value creation.

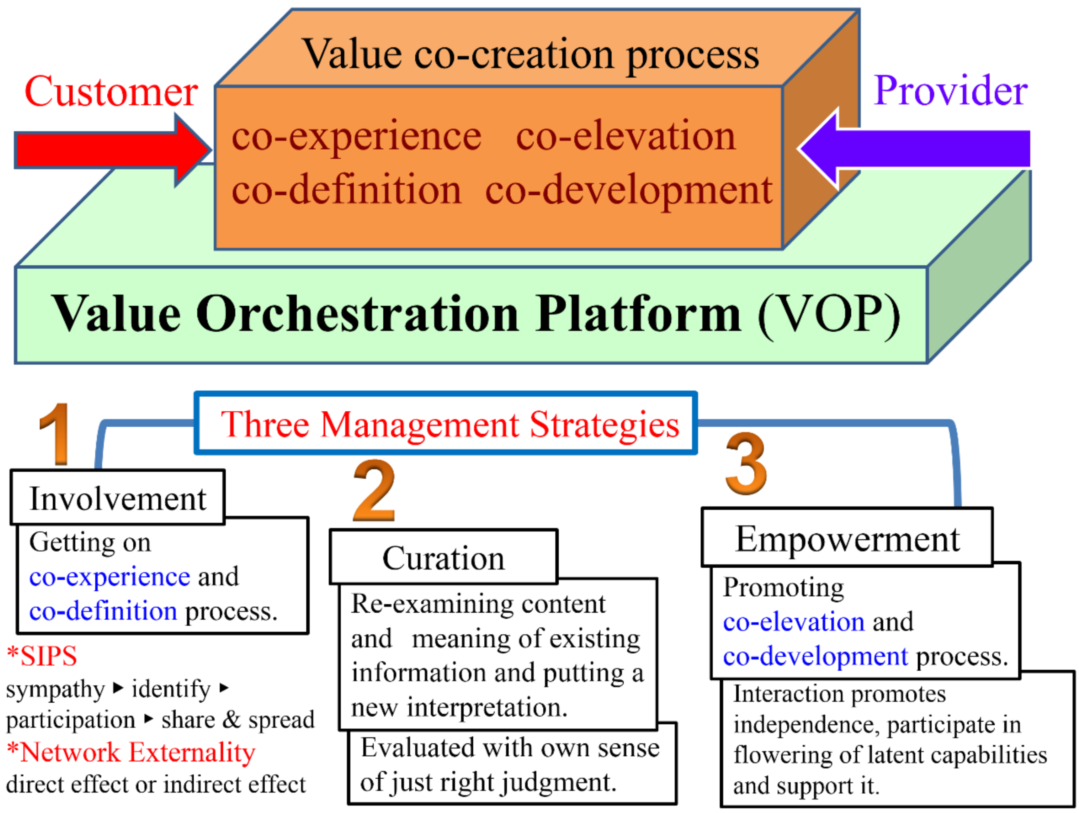


Figure 15 Value Orchestration Platform (K. Kijima)

Support and management of the value creation process by the value orchestration platform involves at least the three key basic strategies of (1) involvement, (2) curation, and (3) empowerment (K. Kijima 2014). These strategies are deeply related to the four phases of value creation.

The involvement strategy is chiefly concerned with advancement of the co-experience and co-definition phases. It is a strategy for involvement and participation of the customer and the providers in the value creation process. In the co-experience phase, in particular, the customer and provider “fan-making strategy” is key. It has been noted that for this purpose it is important in practical terms to operate the SIPS (sympathy → identification → participation → sharing) cycle as a positive feedback loop, thereby inducing both provider and customer to become repeaters (N. Sato 2011). The strategy for involvement in this cycle is known as the “onboard strategy” (K. Kijima 2014). In the co-definition phase, on the other hand, the quality of the internal model explication and visualization will determine the effectiveness of subsequent value creation.

The curation strategy is a strategy for new value creation through acquisition, sorting, editing, and sharing large volumes of information, and is applicable to all four value creation phases. The term “curation” derives from the curator function of art museums, libraries, and other cultural institutions that collect and maintain materials of value. A curator is expected to be able to appraise, research, manage, and supervise the institution’s materials, as well as to combine and organize high-level academic knowledge and expertise and thereby create new value (Steven Rosenbaum 2010). In the business world, the iPhone may be considered an excellent example of an innovative product that was created through highly original curation-based combination, rather than through development of new technology.

Empowerment, as the third basic strategy, applies especially to the co-elevation and co-definition phases. It serves to heighten the capabilities of the participating providers and the expectations of the participating customers, and thereby raise the service level of the platform. A primary concern of the empowerment strategy is to complement the customers and the providers and thereby spur active initiative in both, but its true objective is their utilization and fulfillment of their deep, latent potentials. Its resources include space, time, knowledge, technology and skills, information, organizations and networks, service and consideration, and funds and facilities investment. These elements are both independent and interdependent. The ultimate empowerment is the emergence of trust, awareness, confidence, and responsibility, through bottom-up network creation (John Friedmann 1995).

3.3 Strategies and prescriptions for MTT as Value Orchestration Platform

3.3.1 Old fashioned MTT and vision for MTT

The traditional business model of MTT companies in Japan in effect generally restricts each MTT company to a single machine-tool manufacturer and to support of that company (Figure 16). The platform does not provide for value creation. It portrays, rather, a world of price competition marked by exchanges of machine-tool specifications and estimates.

In some cases, the relationship between the manufacturer and the trading company is based on a firm secure agreement, but the business flow is generally determined in an information-advantage registration system. In domestic business practice, the manufacturer issues its estimate and specification only to the first trading company to transmit information on an inquiry, and any trading company that falls behind it cannot enter into a discussion on that business. Accordingly, the main interest of the sales representative is to learn when the discussion will begin, whether the inquiry is genuine, whether the customer is serious, what the customer preferences are, and which manufacturer is most likely to win. The sales representative's reason for being becomes establishing a strong and binding relationship with that manufacturer. The sales representative has no interest in small-ticket peripheral equipment and, since a warranty will be issued, no motivation to consider the construction of the total production system. The traditional business model is far removed from any sort of modular business model.

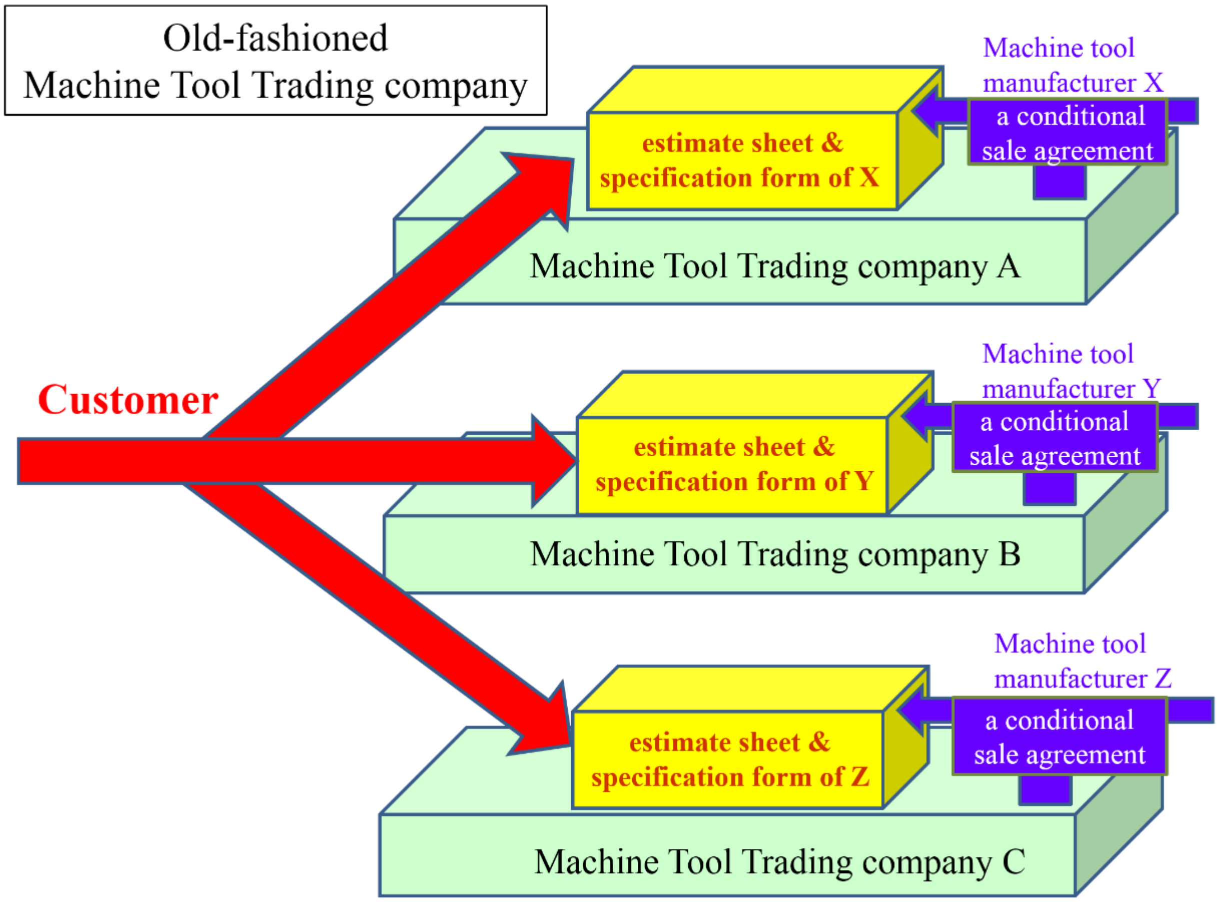


Figure 16 Traditional business model of MTT companies

In its new configuration, the MTT company itself should be transformed to a value orchestration platform, bring a number of manufacturers and customers onboard, and employ a strategy for their co-creation of value. Those to be brought aboard must total at least seven or eight companies which are independent entities, and include brand manufacturers and suppliers as customers and machine-tool, cutting-tool, holder, jig, materials-handling (robots), CAD/CAM, and production-material manufacturers as providers (Figure 17).

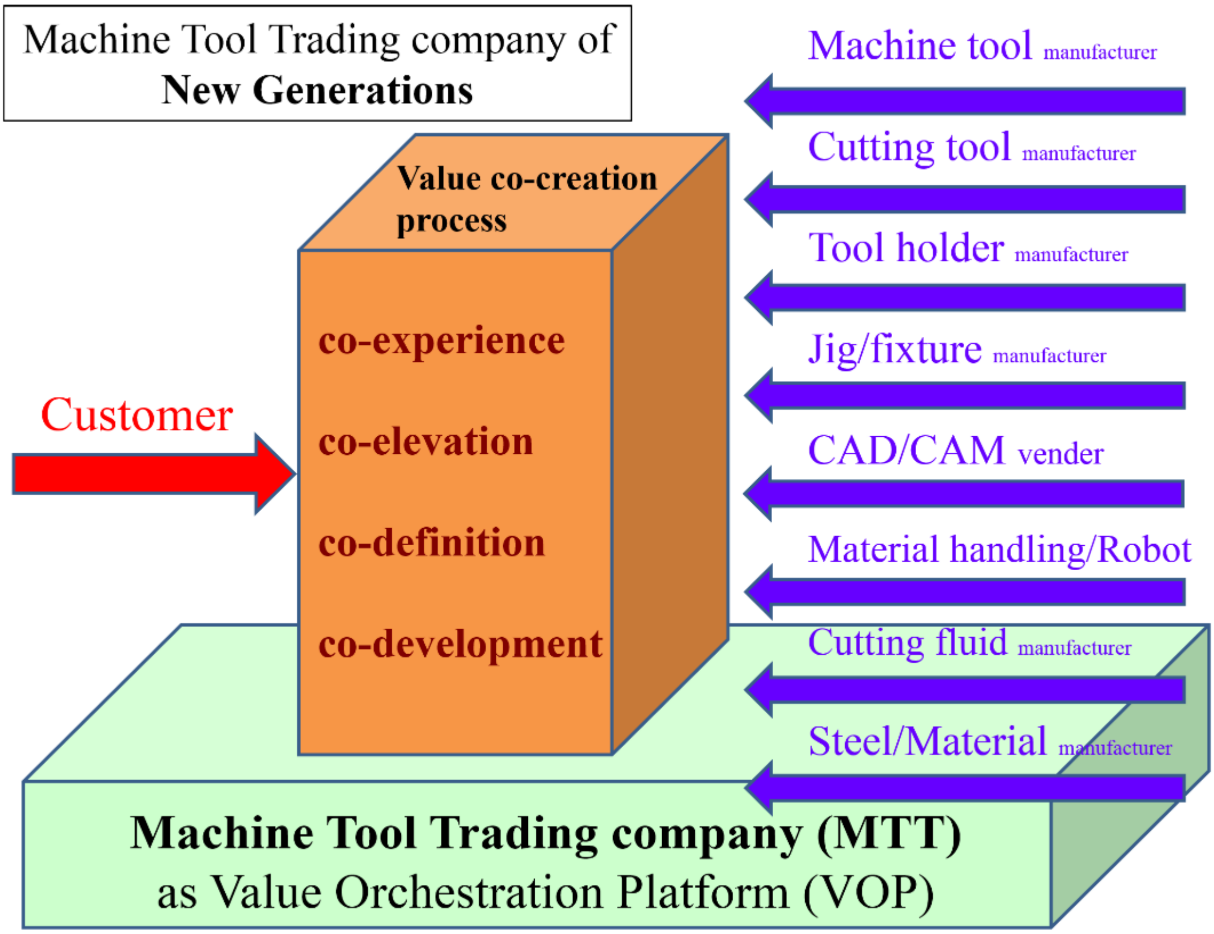


Figure 17　New configulation of MTT companies

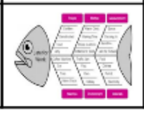
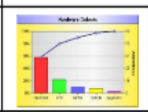
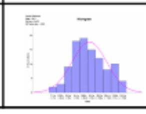
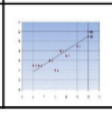
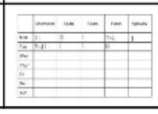
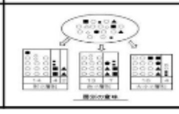
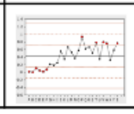
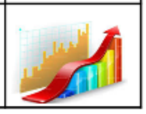
3.3.2 Prescription for achievement of a Value Orchestration Platform

Let us next consider a "recipe" for a strategy for the function of an MTT company as a value orchestration platform. The recipe is based on our own direct experience and on the state of business in Japan. In this we utilize QC tools, which can provide an optimal framework for shared understanding as they are generally familiar to machine-tool customers and providers, who are in most cases experienced in QC activities and have been substantially influenced in their conceptual approaches by QC tools. These "QC7 tools" together comprise a scientific technique that is generally used in each step of Quality Control, from the identification of a problem to its solution. To these Seven QC tools for quantitative analysis of phenomena, we add the "new Seven QC tools" designed for qualitative analysis dealing with linguistic data (T. Asaka 1980). They are applied in our investigation of the recipe for realizing a value orchestration platform. The two types of seven QC tools are listed in Table 3. Red is the tool to be utilized in later. Other tools would be read because they are also useful. I show a list of two types of Seven QC tools below.

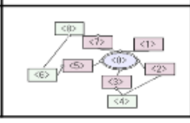
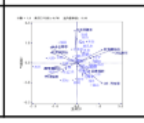
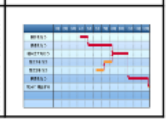
Table 3 Two types of seven QC tools

Two types of "Seven QC tools"

Seven QC tools for quantitative analysis & numerical data

No.	1	2	3	4	5	6	7	(7)
Tools	Fishbone Diagram	Pareto Chart	Histogram	Scatter diagram	Check sheet	Stratification (Segmentation)	Control chart	Graph
Focus	Causes(factors) and effects	Problem and factor	Variation of Cause and effect	Correlation of (x, y)	Data acquisition and reduction	Material, Machine, Men, Method, Measurement, Environment, Time	Process control	Trends and relationship and contrast
Target	Arrangement of causes	Problem finding	Quality variation	Correlation of effects	Error occurrence status	Causes of quality variation	Processes status	Perspective of data
Ex.								

New Seven QC tools for qualitative analysis & language data

No.	1	2	3	4	5	6	7
tools	Relation diagram	Affinity diagram	Tree diagram	Matrix diagram	Matrix data analysis	Process Decision Program Chart (PDPC)	Gantt chart (arrow diagram)
Focus	Causes and consequences Ends and means	Previous/Next processes or customers	deployment of a strategy into tactics	Relation of elements	Set of data	Anticipating countermeasures	Optimal scheduling
Target	Structure of a problem	Requirement of P/N processes	Ends and means	Measures without oversight	Minority as the cause	preventive action	Process control
Ex.							

In the following, we discuss the abovementioned involvement strategy. We propose application of the segmented onboard strategy and the internal model fishbone strategy in the co-experience phase, as two strategies new to an MTT company. Together, they serve to elucidate and heighten sales skill effectiveness and efficiency by visualizing what has long been implicit knowledge (I. Nonaka & H. Takeuchi 1995) and thus converting it to explicit knowledge.

In our discussion of the co-experience phase, we referred to the strategy of drawing customers into the SIPS cycle as the "onboard strategy." We now further propose the addition of QC tool segmentation, to obtain a "segmented onboard" strategy for customer and solution-process segmentation.

Making decisions on producer goods with priority given to performance and based solely on cost-performance is often regarded as an unduly conservative approach, but this approach has highly dedicated adherents, particularly in regard to producer goods. It is said that 70% or more of domestic machine-tool purchasers are repeat users (MORI SEIKI 2004). Consumer-good SIPS begins with “sympathy” (N. Sato 2011), but MTT company customers begin with “participation”, and for them the cycle is Participation → Share ＆ Spread → Sympathize → Identify. For the purchaser of a big-ticket producer good destined for long-term use, the minimum condition for transactions on this platform is attaining in the customer a certain level of sympathy and a sense of unity that can be trusted.

Segmentation should include education, enlightenment, and problem solution. Specifically, education involves courses in technology, enlightenment involves new-product exhibitions and courses on new technology, and problem solution involves process demonstration. The service level is serially heightened in the order education → edification → problem solution. Among the three, education is broadest in reach and most readily draws in customers, and it is therefore well positioned for development of new business. In enlightenment, participation in the new-product presentations and new-technology courses of enlightenment tends to be more restricted and may require registration, and the range of customers is naturally narrowed. In the process demonstration of problem solution, the manner of solution for the process or component seen as a problem by the customer is verified by the customer. This strategy is the most effective for customer approach, but its workload and cost are both high. It is therefore generally implemented only with customers likely to show a high rate of agreement conclusion in the related business discussions. In short, optimization of resource allocation to these segments is a key determinant of the platform profitability.

To avoid network externality, an MTT company should also implement an onboard strategy in regard to providers. In this field, the market is small in scale. Relatively few manufacturers have a good capability for delivery of peripheral equipment products acceptable to the customers. In addition to this “direct effect”, an “indirect effect” is also prevalent, in which the focus on higher performance results in a rapid succession of new standards that involve incompatibility with previous standards. Even where a new standard represents a major advance in performance, however, it should be adopted only with a discerning eye on the market trend. Adopting a future minority standard may prove fatal. Swift, sweeping replacement of a standard that has lost marketability inflicts huge costs and a sense of defeat on both the involved trading company and the manufacturing site, and must be avoided.

The internal model fishbone strategy visualizes the customer internal model using a fishbone diagram (also known as a characteristic factors diagram and an Ishikawa diagram) for organization and examination of the constituent elements of that model. The QC perspective is known for its broad "4M" classification, using the four main categories of "man" (operator), "material", "machine", and "method". In the present curation perspective, the three main categories are "tangible", "human", and "intangible", which are further divided into five broad categories with "tangible" comprising "product", "production component", and "cuttings", "human" comprising "company" and "responsibility", and "intangible" comprising "achievement". Cuttings are the metal waste (chips, shavings, filings, or other waste forms) that occurs in product manufacturing. They provide a ready indication of the quality of the manufacturing process, and have been called "a report card on productivity" (K. Matsumoto 2012). Many veteran sales representatives look at process cuttings rather than production components. Lastly, the internal model is classified in terms of 26 focal points and described in terms of 58 elements (Figure 18). These numbers may seem large, but veteran sales representatives are deeply familiar with these categories and elements, and in approaching a business negotiation always set their priorities and develop a success story leading to a contract.

There is currently no existing means of systemizing and visualizing this capability, but if the implicit knowledge of the individual sales representatives were made explicit through visualization by the proposed tools, it could then be used as a checklist. Such a checklist would (1) provide a base for consideration of the following two strategies, enable an approach to understanding root causes by clarifying the interrelations of the individual elements, and help avoid oversights; (2) help to heighten the capability of the individual sales representatives through explication of that sales representative's implicit knowledge and moreover enable the implementation of a heretofore difficult "team approach" to machine-tool business discussions; and (3) with further progress in implicit knowledge explication, be used as an educational tool for the heretofore difficult process of sales representative education.

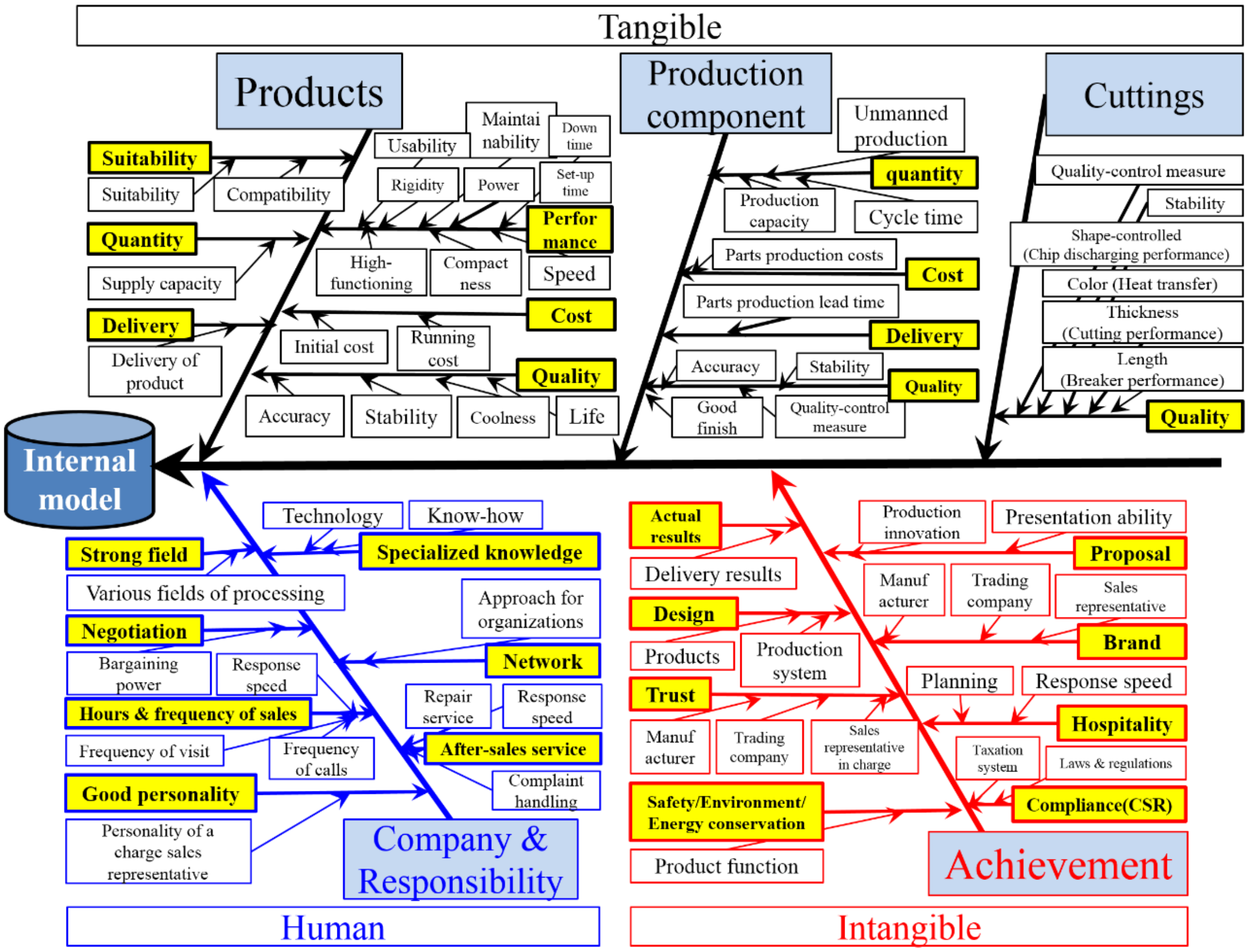


Figure 18 Internal model as Fishbone

Next, we propose two curation strategies: the dynamic curation strategy and the intellectual property (IP) ethics strategy. The dynamic curation strategy is in particular accord with the longstanding machine-tool business practice of information-priority registration in which the providers who are expected to be onboard change rapidly. The purpose of the IP ethics strategy, which is based in corporate social responsibility (CSR), is to ensure strict observance of confidentiality obligations concerning individual customer's production-technology IP and eliminate the risk of production-technology IP divulgence, a risk that has increased sharply with the modularization of production technology and the high-level digitization of machine technology.

In the transformation of integral skill to modular technology, the number of possible solution combinations tends to increase without limit in successive investigations. A machine tool cannot function without its peripheral equipment. Only a machine tool with an excellent combination of peripheral equipment can attain its true performance. Maximization of customer satisfaction requires the achievement of optimum processing through determination of the optimum solution. The primary objective of a curation strategy is to shorten the lead time to achievement of that objective.

The need for an effective dynamic curation strategy is strong and rising. A peripheral equipment provider that has been expected to become an ally at the outset of a business discussion may turn out to be a strong competitive threat after its elimination under the information-priority registration system. The externality effect at the interfaces of an information network may bring onboard a new competitive provider and lead to a new search for a solution matching the customer-specific constraints and conditions of agreement. These challenges are magnified by the rapid succession of technological advances that emerge almost monthly and could strike a final blow. The adverse effects of technological advances are even stronger than those of networking. Given the singular business practices and the rapid stream of technical innovations, the resources available to the MTT company in its function as a platform may change drastically in the course of a business discussion. A dynamic curation strategy is essential for effective response to this change in resources.

A dynamic curation strategy requires discernment of a story line that includes a time axis for entry of changes in available resources and technical innovations. Here, our analysis is based on the nine constituent elements of the QC story for task achievement (N. Kano 1990), which may be described as the following: theme selection, procedure selection, point of attack and objective setting, countermeasure proposal, success scenario determination, success scenario implementation, confirmation of effectiveness, standardization and control emplacement, and reflection and future response.

In illustration, let us consider a case in which the goal is to increase the level of automated operation and the selected theme is improvement of cuttings disposition.

The procedure will depend on whether the target is a machine, a tool, or a material. If a tool is chosen as the target, for example, the procedure begins with consideration of countermeasures development based on analysis of the present state of processing. The point of attack might be tool-type change, cutting conditions, tool path, cutting fluid, or machine-tool specification revision or addition. Let us assume that there are two: change in tool-type and cutting conditions; then the objectives may then be set as cutting conditions and state of cuttings. The countermeasure development and the success scenario will depend in rather large part on the related catalog values, and the cutting test implementation will itself constitute the success scenario implementation and performance of the confirmation step. An increase in the level of automated operation will require standardization and control emplacement, and a summary outline of each is therefore compiled in sheet form and the circumstances are captured by digital imaging or video. The PDCA loop is implemented for the reflection and the future countermeasures, as an essential part of QC activity. The control technology as envisioned from thoroughgoing compilation, and pervasiveness of the control sheet is evaluated in the automated process. From the vantage point of resource integration, moreover, a merging with customer journey mapping (N. Takeyama 2012) may also be effective.

The IP ethics strategy, the CSR-based curation strategy, is an essential requirement. When a company repositions its production technology from internal/external integral to internal-modular/external-integral, the technology-bearer center of gravity shifts from human to machine. This facilitates transcription of the technology and enhances its transmissibility within the company, but the attendant speed of propagation with very low attenuation also has the adverse effect of increasing the risk of IP divulgence outside the company.

The core competence of a customer is generally based on a high-level system of production (C.K.Prahalad & Gary Hamel 1990), and the obligation for confidentiality in the platform must, as a matter of course, be strictly honored. On the other hand, the curation capability of the MTT company accrues in large part from its acquiring knowledge of the most advanced production lines of its many and various customers.

Utilization of a curation capability gained from one customer in a proposal of an advanced production system to another customer is pregnant with the risk of violating an IP right.

In the integral era, it took a long time for a sales representative to gain the capability to reproduce a production technology and obtain an order for a large-scale production system, by which time the sales representative had also received a clear guideline on the obligation to the customer for confidentiality, which obviated problems in platform corporate compliance. In the emerging modular era, in contrast, even a young sales representative lacking any such guideline can reproduce a production technology, though not completely, by combining data on the related process conditions with a specific list from a successful case showing the model numbers of the machine tool and its peripheral equipment.

No clear legal standard explicating IP rights relating to production technology has yet been established, and it has now become impossible to protect the IP of a customer simply by compliance in the narrow sense of complying with law and regulations. In this light, a clear need has been noted for the development of a sincere and faithful corporate culture (Figure 19) through promotion of business ethics (i.e., activities for ethical operation) that are the foundation of CSR.

With a shared approach for sincere, faithful operation, corporate ethics can advance the sharing, permeation, and implanting of principles and values, aid the establishment and maintenance of a well-aired corporate structure, and assure implementation of a corporate governance that imbues its personnel with the proclivity for generating and maintaining ethical judgment and behavior (SANNO UNIVERSITY Research Institute 2008).

The collective activity for advancement of corporate ethics in effect comprises the IP ethics strategy. The IP ethics strategy that sets the direction for the platform in this regard closely resembles the involvement strategy. It must promote self-discipline, openness, self-awareness, confidence, trust, responsibility, fairness, and equality, add ethics and sincerity, and be directed toward shared principles and values, for all parties.

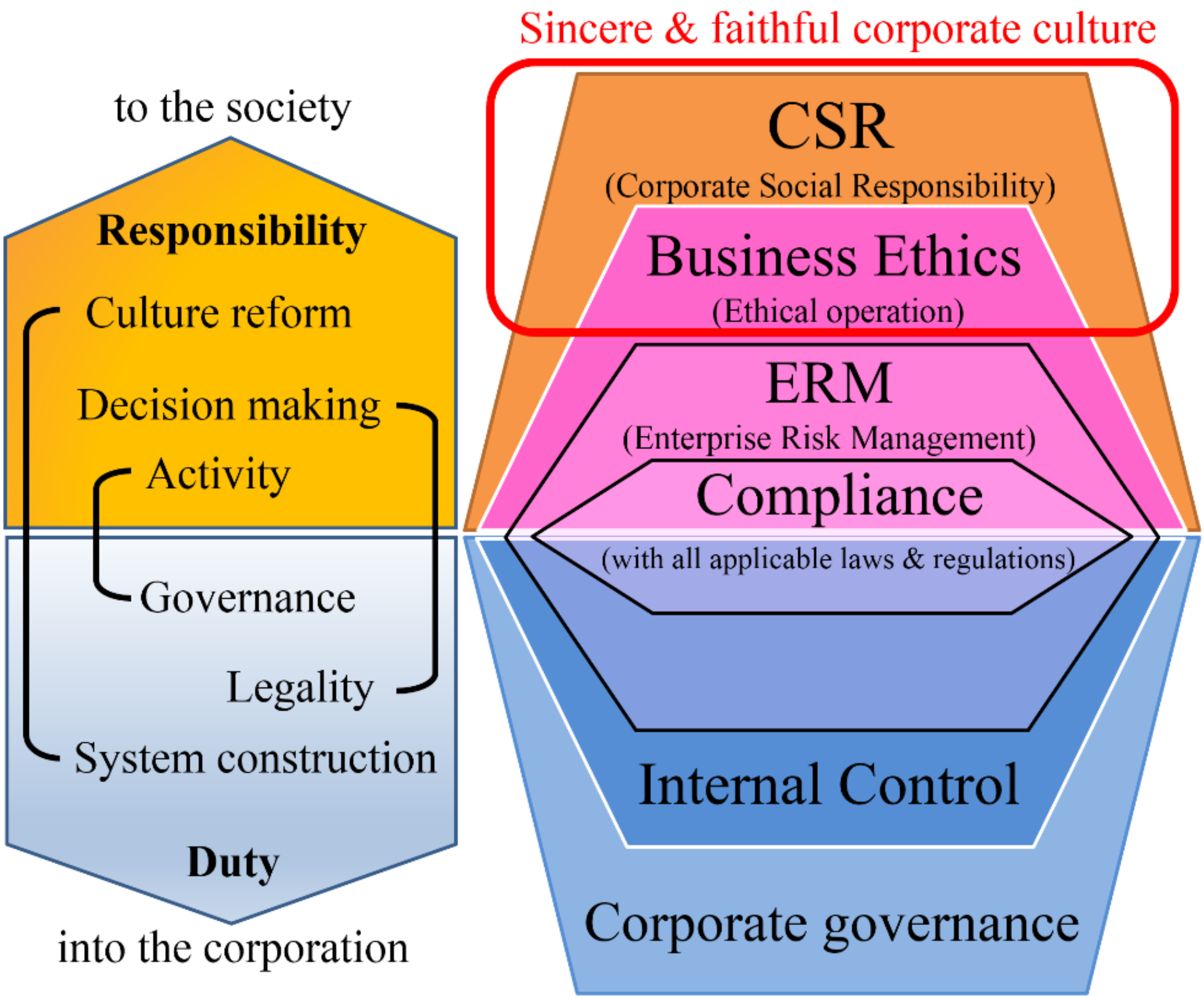


Figure 19 CSR (SANNO UNIVERSITY Research Institute)

In the following, we discuss the empowerment strategy. The Four strategies that are essential constituents of the empowerment strategy are the orchestrator strategy in the co-elevation phase, the objective-function identification strategy, the relation-matrix strategy in the co-development phase, and the co-design strategy.

The orchestrator strategy is directed toward development of the MTT company into a mediator complementing the discontinuous elevation of the service level in the co-elevation phase. The objective-function identification strategy for problem solving narrows the problem from what initially seems to involve many parties to a two-party problem through identification of the objective function.

The relation-matrix strategy is for visualizing and organizing, in the form of a matrix, the interrelations of multiple parties involved in solving a problem, to advance the visualization of solutions to problems in relation to orders of priority and levels of difficulty and to elucidate the leverage points. The fourth strategy is the co-design strategy, which is directed toward manufacturing-site-generated design revision and thus a return to the origin in the recognition that the essence of manufacturing is transcription of design information.

In the co-elevation phase, the process of value co-creation by customers and providers rises in a discontinuous, zigzag spiral. Let us analyze this process using an example in which a machine-tool manufacturer and a cutting-tool manufacturer, i.e., two providers, are striving to raise the level of service (Figure 20). At the time of announcement of a new machine tool or a new cutting tool, the performance of one may exceed that of the other. Let us assume the performance offered by the machine-tool manufacturer is lower than that offered by the cutting-tool manufacturer. Even though the machine-tool performance has been raised by, say, one rank, the customer’s productivity may not rise at all. Raising it by two ranks is then deemed necessary, and the machine-tool manufacturer strives to achieve this increase. If that effort is successful, then it may in response become necessary for the cutting-tool manufacturer to catch up by raising its own product performance by two ranks. In actual practice, however, this sequence would be exceptional. Following delivery by the manufacturers, they do not ordinarily perform continuing follow-up inspections because of the high cost of performing them at the production site.

An effective solution to this difficulty would be for the customer and the multiple providers to enlist the assistance of a third-party mediator and enter related negotiations (John Winslade & Gerald Monk 2000). It would, moreover, be most natural for an MTT company to undertake this role, as a mediator that would constantly have information on both internal models and new products, and transmit it in both directions. If the mediator had continuously transmitted the internal models to both of the manufacturers in our example, then both might have been able to concurrently offer new products with each raised by two ranks in performance, without incurring the costs of market research. Conversely, if the mediator can sequentially transmit new-product information to the customer, then the customer itself can perform continuous level elevation. As a platform, the MMT company can thus act as though it were a customer to multiple providers and as though it were multiple providers to a customer (K. Kijima 2001). This is referred to as the “orchestrator strategy”, a name which derives from the name of the platform.

In its original guise, an orchestrator is a deconstruction producer. To achieve a strategy of competitive advantage that raises total value in the face of changes such as a rising cost of labor and technological advances, the orchestrator deconstructs the existing value chain and identifies only high-value-adding processes as part of the core while outsourcing all low-value-adding processes. In the value orchestration platform, in contrast, whenever one or more of the involved parties achieves a technological advance, the orchestrator works for reformation of the combination of the service layers of all involved parties while confirming the service layer of each one. The role of the orchestrator rises in weight and importance in concert with the recognition by all parties of the validations issued by the orchestrator.

The orchestrator strategy is specific to trading companies, in which curation of the products can transcend the frameworks of their manufacturers.

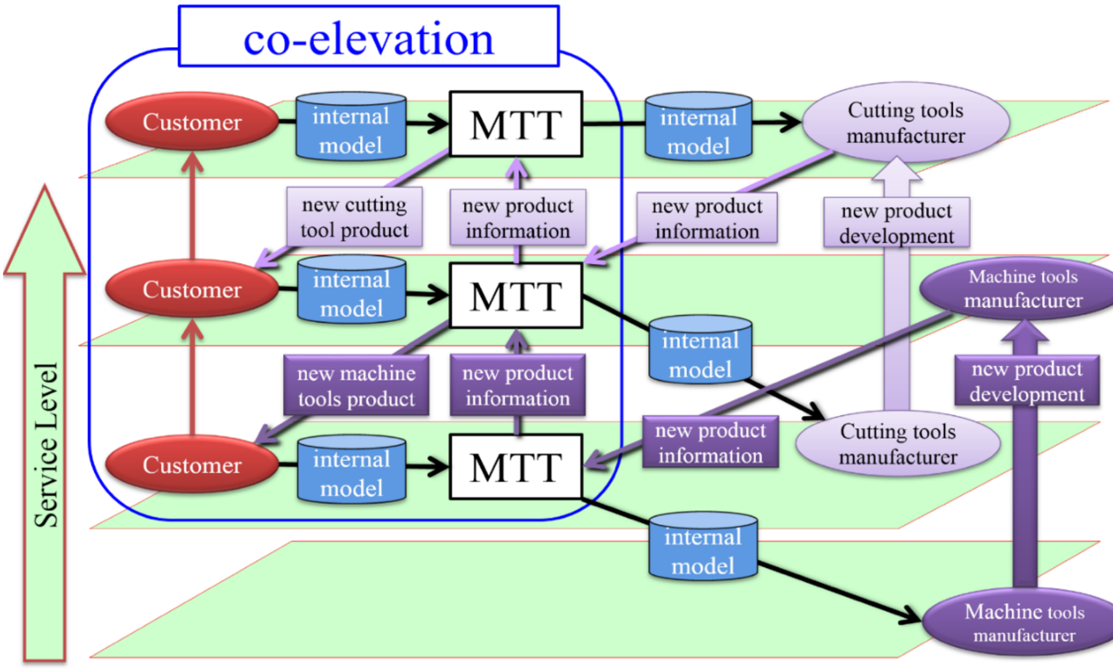


Figure 20 Orchestrator strategy

Let us now consider the objective-function identification strategy. Identification of an objective function as a theoretical formula (Y. Ito 2004) based in the fundamental theory of machine-tool manufacturing can effectively narrow what initially appears to be a multiparty problem to a two-party problem, and thereby facilitate its solution. The objective-function identification strategy can bring actual sales activities, which generally tend to shun theory, back to the basics and increase their efficiency in the process (Y. Yamane 2013). It can also effectively transform implicit sales skills to explicit sales technology.

A prime example is a theoretical formula for the rate of cuttings generation Q, which is an indicator of productivity in turning processes and is formally defined as the quantity of cuttings generated per minute as excess material that is removed to obtain the product in its final geometry. In short, it is an indicator of the number of cubic centimeters discarded per unit time. For increased machining productivity, the objective is accordingly maximization of Q, with Q expressed as

$Q = Vc \times ap \times fn \ (cm^3/min)$

where Vc is the cutting speed (m/min), ap is the cutting depth (mm), and fn is the feed rate (mm/rev). It is also necessary to include consideration of the machine-tool and cutting-tool constraints in terms of the net cutting power Pc (kW) of the former and the cutting resistance kc (N/mm) of the latter (A. Yokoyama 2012)(SANDVIK coromant company 2013)(Sumitomo Electric Hardmetal Corp. 2013).

$$P_c = \frac{v_c \times a_p \times f_n \times k_c}{60 \times 10^3} \qquad k_c = k_{c1} \times h_m^{-m_c} \times \left(1 - \frac{\gamma_0}{100}\right)$$

These two equations indicate that for maximization of Q it is desirable to increase Pc and decrease kc. In most cases, however, Q is maximized by first selecting the maximum feed rate fn that is in correspondence with the ap matching the cutting tool size, next reducing kc, and then selecting the maximum Vc on the power band (the maximum Pc region). Narrowing the verification processes to three or four can reduce the number of man-hours that must be redirected form business activities and the cost of test materials to be borne by the customer, and conserve the management resources on the platform. This value elevation would be difficult to achieve by any other means.

Let us next consider the two strategies applied in the co-development phase: the relation-matrix strategy and the co-design strategy.

The relation-matrix strategy facilitates resolution of the multiparty interrelations involved in co-development by entering them in a matrix diagram, which is a QC tool. Let us here take die machining as an example and analyze its interparty relationships (Figure 21). The customer and all participating providers are entered in the same order on the vertical and horizontal axes of the matrix. Requests as seen from the perspective of each party shown on a green background in the top row are entered in order from top to bottom for each party. Problems as seen from the perspective of each of the parties are shown on a pink background at the left of the rows. The focal points of human, tangibles, and intangibles from the perspective of curation are distinguished by their colors, with human shown as green, tangibles as yellow, and intangibles as orange.

If a problem is present at symmetric positions (cells framed red in the figure) around the matrix diagonal from upper left to lower right, then it is called a “symmetric problem”. In such a case, each related party thinks the other is at fault and therefore expects that party to solve the problem and itself takes no steps for its solution. If the symmetric problem is in the tangible or human category, then a solution can be found through platform mediation. If it is an intangible, then it relates to intracompany factors involving design development and IP in both companies, and solution is therefore difficult. In the relation-matrix strategy, the capability for identification and solution of opposing tangibles in symmetric problems is the key.

In an asymmetric problem, the problem resides in one side only. The party in which it resides knows that its solution is beyond the reach of the other party, and in most cases the company with the problem can solve it through its own efforts.

	Customer	Machine tool	Cutting tool	Tool holder	Jig/ fixture	CAD /CAM	Steel/ Material
Customer					【Symmetric】 Design changes to expand the clamp area		
Machine tool						【Symmetric】 Dispatch of programming instructor	
Cutting tool		Non-interference long milling tool is required.			【Symmetric】 Non-interference long milling tool is required.	【Symmetric】 High rotation tool for medium load cutting is required.	
Tool holder		Anti-vibration holders of NBT40 standard are required.	Quick delivery of a wide variety of collet		【Symmetric】 Non-interference long holder is required.	Non-interference long holders are required.	
Jig/ fixture	【Symmetric】 Design changes to increase the clamping strength	Specification change for allowable moment	【Symmetric】 Specification change of height to non-interference height	【Symmetric】 Specification change of height to non-interference height		【Symmetric】 Specification change of height for non-interference	
CAD /CAM		【Symmetric】 Short-term debugging	【Symmetric】 Tool path optimization for high accuracy and short time				
Steel/ Material		Quick delivery of special size metal material					

Figure 21 Relation-matrix strategy

Pinpointing problems in the relation matrix can effectively lead to their identification and solution. For this purpose we leave the parties in the leftmost column as they are, move the problem cells leftward, and place them from left to right in the order intangible, human, and tangible (Figure 22). The symmetric problems shown here are framed in red. We actually use this procedure daily to solve problems.

Let us here demonstrate its effectiveness with an example taken from our experience.

	Problems faced by the leftmost column stakeholders					
Customer	【Symmetric】 Design changes to expand the clamp area	Design (Intangible)				
Machine tool	【Symmetric】 Dispatch of programming instructor	Specialized knowledge (Human)				
Cutting tool	【Symmetric】 Non-interference long milling tool is required.	Suitability (Tangible)	【Symmetric】 High rotation tool for medium load cutting is required.	Performance (Tangible)		
Tool holder	【Symmetric】 Non-interference long holder is required.	Suitability (Tangible)	Quick delivery of a wide variety of collet	Delivery (Tangible)	Anti-vibration holders of NBT40 standard are required.	Suitability (Tangible)
Jig/ fixture	【Symmetric】 Design changes to increase the clamping strength	Design (Intangible)	【Symmetric】 Specification change of hight for non-interference	Specialized knowledge (Human)	Specification change for allowable moment	Specialized knowledge (Human)
CAD /CAM	【Symmetric】 Debugged post-processor	Quality (Tangible)	【Symmetric】 Tool path optimization for high accuracy and short time	Specialized knowledge (Human)		
Steel/ Material	Quick delivery of special size metal material	Delivery (Tangible)				

Figure 22 Pinpointing problems in the relation matrix

In this case, we first took up the asymmetric problems, which are generally relatively easy to solve, and included problems involving perspectives on tangibles, and solved them through curation and negotiation on delivery times and prices for the product to be supplied. We similarly solved the tangible symmetric problems and the human asymmetric problems.

In a case of symmetric problems which on one side was a design improvement problem in the classic human category involving total jig height and on the opposing side was in the tangible category, we were able to have the party with the more-easily solved problem engage in and achieve its solution by procuring a long cutting tool, which involved a change in product dimensions. We were then left with the most difficult problem, a symmetric problem in the intangible category. It had reached a deadlock with the customer and the jig manufacturer each seeking to have the other change its design. It was solved through platform concentration on conducting sufficient hearings and mediation between both sides. The customer was also a manufacturer and its technology chief was close to the person holding authority for design changes, which facilitated approval of the related design revision. In the jig manufacturer, the manager and the designer were actually the same person, who was therefore able to make the decision to respond to the customer's new design with a corresponding new design. As a result, it was possible to achieve both a substantial reduction in product cost and a very large increase in product quality.

In this way, we use the relation matrix for visualization of the relationships based on the fishbone internal modular model with the addition of segmentation performed from the curation perspective, and proceed with the visualization of ordering priorities and levels of difficulty for the problem that is to be solved. It is also possible to produce a plan of action that elucidates the leverage points, though incorporation of the 5W3H investigation into the platform, and thereby elevate the platform service level by a previously non-existent high-efficiency strategy.

Lastly, let us consider the co-design strategy. Several rounds of experience in value creation with strategy analysis using the relation matrix brings a clear, experience-based understanding that the best strategy is "design renewal", which solves problems in intangibles. Many people refer to it as "design change", but design change is difficult even when the customer itself is a manufacturer, and in many cases a customer involved in processing is actually a collaborating plant, which makes a design change even more difficult because, although the design teams of manufacturers tend to respond with alacrity to requests from field users and carry out the design improvement, they are generally reluctant to accept requests for improvement from manufacturing sites. Their reluctance stems from the fear that a design change made due to internal circumstances may have unforeseeable adverse effects on the market. In a situation involving multiple customers that are independent parties, it is all the more necessary to consider the use of a platform matrix that further subdivides the customers and thereby enable the discovery of a path leading to the solution.

Design has progressed through various modes, from the era of the manufacturer-centric industrial design conception, through user-centric design and participatory design, to the present focus on co-design in which co-creation is performed by various types and kinds of individuals at various sites.

In co-design, the producers are brought together by various processes, co-create value together with the customers, and thereby vitalize their sites (Tim Brown 2009).

Engineers merge with designers, the business model moves from product-centric perspective to an eco-system emergence, and the container-like elements undergo a metamorphosis to platforms (Joi Ito 2013a 2013b)(Figure 23).

In the automotive industry, design-in through simultaneous (or concurrent) engineering has successfully expanded its scope so that it extends from purchasing to upstream processes of design development. Co-design differs from this in several key respects. It involves a substantially larger variety of value-creation sites. The producer, known as the designer, is an "orchestrator", and the MMT trading company serves that role. For the MTT company co-design is generated on site, but it implements servitization through co-creation that vitalizes customers' production, design and development, purchasing, and services and their related divisions, and it is devoted to increasing contributions from the customers to the customers. The goal is evolution to a servitization strategy through provision of a prescription for the co-design strategy.

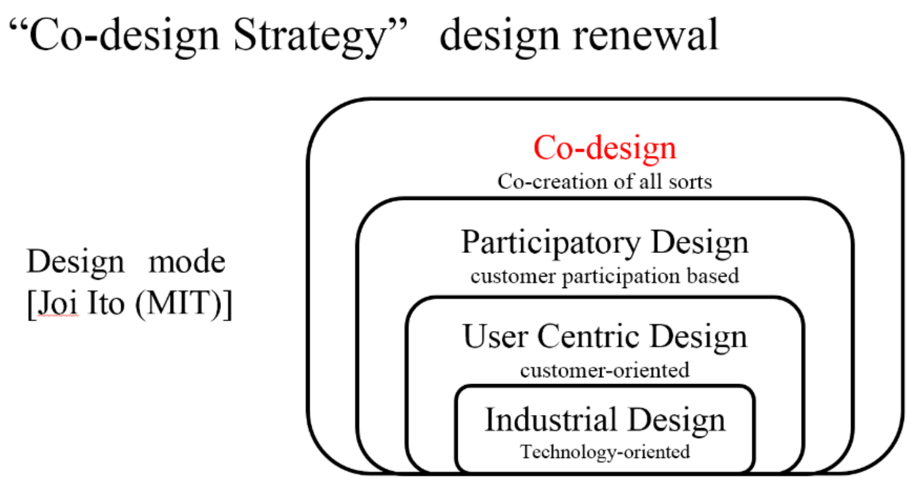


Figure 23 Co-design

Figure 24 shows a road map summarizing the new strategies proposed to this point with the MMT company as a value orchestration platform, and Table 4 shows a comparison of the applied pre-existing and new strategies.

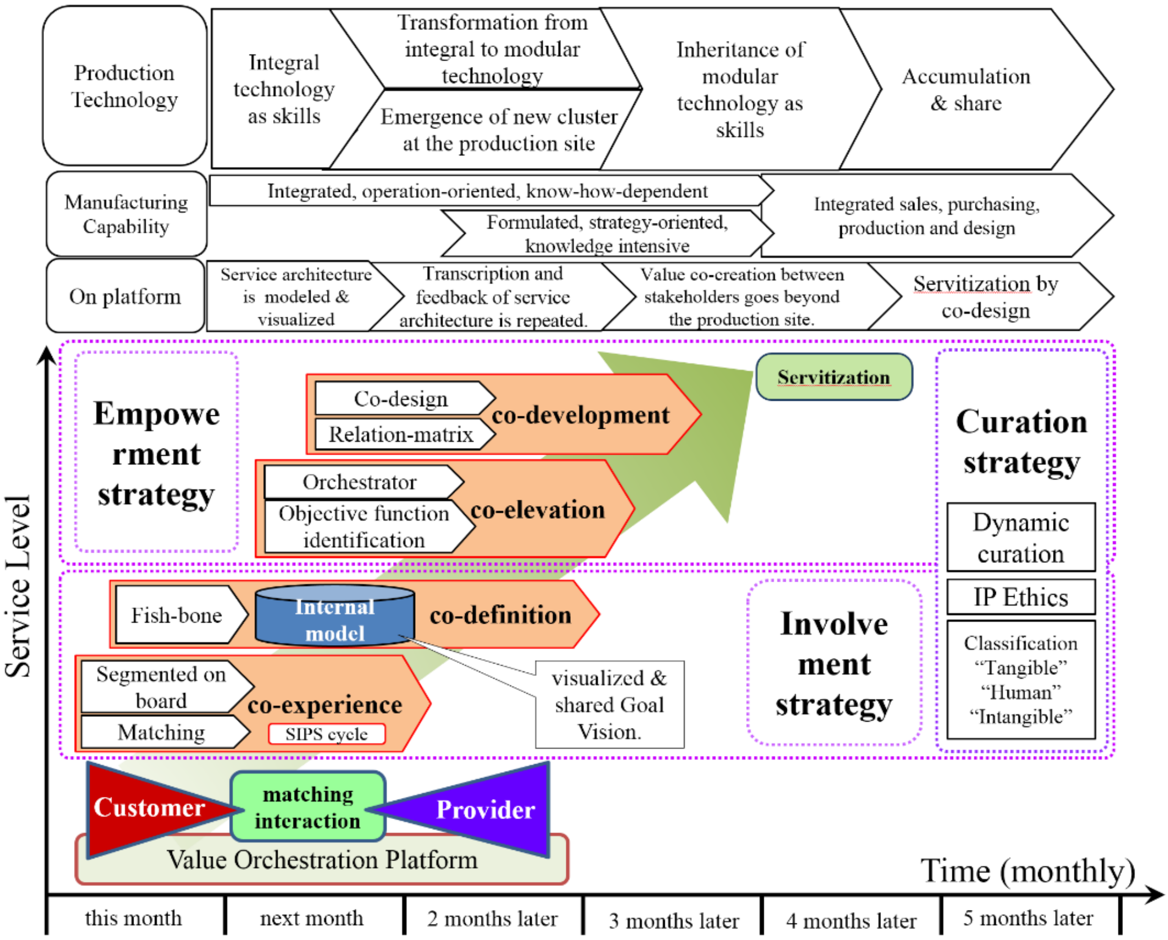


Figure 24 Servitization- productization roadmap Roadmap

Table 4 Reconstruction of MTT strategies

◂Yellow cells are new strategies. The introduction of 7 basic QC tools and New 7 QC tools is written by red letters.

	Four Value co-creation process →	Involvement				Curation		Empowerment			
		co-experience		co-definition				co-elevation		co-development	
▽old/new	▽model	strategies	prescriptions	strategies	prescriptions	strategies	prescriptions	strategies	prescriptions	strategies	prescriptions
Old genelation	Linear model	Strategy to visit regularly	"Exhibition", "Class" "Manufactures' companion sales"	Estimation of preference vector X strategy	Depending on experience and intuition	Conditional sale agreement strategy	The strategy that linear shape operates expectation effect E from specifications vector S.› E=SX	Specifications alignment strategy	Submission of estimate sheet & specification form by obtaining the competitor information	Price competition strategy	price-war thoroughly with a competitor.
New geneliton	Value Orchestration Platform model	Matching strategy	"Demonstration processing" "New product announcement exhibition" "Technical workshop" "Manufactures' companion sales"	"Fish-bone diagram" Strategy	Description of "Internal Model" by "Fish-Bone Diagram"	"Stratification" focuses strategy	"Stratification" from three points of view of "Products &Services", "Talented people" and "Actual contents"	"Orchestrator" strategy	The platform plays the role as "Mediator".	Relation Matrix strategy	To solve "symmetric problems" by sweeping out method on "Relation Matrix"
		"Stratification" on board strategy	Examination of the tactics by "Stratification" into education and enlightenment and three of problem solving			Dynamic curation strategy	Correspondence to resources change by "QC Story & Theme Achievement"	Extracting target objective function strategy	Application of theoretical formula of machine tools engineering		
						IP-Business Ethics strategy	Promotion of "Business Ethics" to protect customer's IP			co-design strategy	To apply the "I-PASS" matrix as a prescription of Servitization
		Drawing Road map in detail as a prescription									

In Chapter 3, we have considered what strategy should be adopted for the reconstruction of an existing MTT company from the traditional business model to an innovative modular business model, investigated what strategy should be adopted for that purpose with a value orchestration platform model, and presented a prescription for that platform. More specifically, we began with an analysis of the existing MTT company model and then introduced the value orchestration platform model as a referential framework for the new MTT company configuration, together with a number of new component strategies. These include a segmented onboard strategy, an internal-model fishbone strategy, a dynamic curation strategy (a QC story), an orchestrator strategy, an objective-function identification strategy, a relation-matrix strategy, and a co-design strategy. We concluded with a roadmap to the new configuration. In the course of our consideration, we also demonstrated that QC tools provide an effective framework for specific prescription formulation.

Through visualization of the value creation process, we were able to visualize and explicate sales activities, which have generally been largely dependent on the experience and intuition of individuals and thus on implicit knowledge. The visualization and transformation to explicit knowledge of the value creation process may be expected to transform machine-tool business discussions from individual play to team play, and by this transformation facilitate the transmission of sales skills and education to younger sales representatives.

We have actually applied the value orchestration platform strategy in machine-tool transactions. It effectively cast off the traditional shell of captive-party sales restriction. Implementation of the strategy prescription contributed to a rise in the contract rate, which has long been difficult to accomplish because of the difficulties involved in concluding agreements for big-ticket modular production systems, and to a rising sales trend. It led to clear and specific expression of increased levels of satisfaction directly from the customers. Furthermore, it confirmed the platform effect of heightening value co-creation. On the other hand, it has also brought substantial concern in regard to the large added workload of monitoring the progress of multiple independent parties, each with its own high-level technology.

Chapter4. Servitization of Machine Tool Trading (MTT) companies

4.1 Design information transmission theory “Open manufacturing”

4.1.1 Service features in accordance with medium intangible ephemeral properties

Service industries are ordinarily said to have seven features—inconsistency, consumer involvement, intangibility, perishability, simultaneity, inseparability, and irreversibility—which until now have been regarded as unique to services and discussed separately (Table 5). Since design information transmission theory holds that service industry media are intangible and ephemeral, it provides a unified explanation of these features. We call this “open manufacturing”.

Table 5 Service features

Service Features Cyclic transmission strategy based on visualization: Cycle repetition of the service design, provision and feedback to transmit the service design information					
№	Features	Properties	Difficulties	Strategies	Tactics
1	Inconsistency (heterogeneity) (Variability)	While customer demand is infinite variety, service quality is also provided inconsistently.	Standardization, customization, quality control and human resource development	Service design ,education and evaluation for employees, skills and ethics	Textbook, working environment, mechanization and IT
2	Involvement	Customer involvement is absolutely necessary. Customer play a role and co-creates value.	Immediate feedback test (compliance with prior customer expectations)	Inverse analysis or to repeat the cycle of involvement	Trust for repeater
3	Intangibility	Medium is intangible.	Design information transmission, appeal of advantage, pre-trial and progress confirmation	Visualization or to repeat the cycle of service provision	Visualization, prior experience, and referral system
4	Perishability	Service is perishable and disappears.	Inventory	To repeat the cycle of service provision	Reservation system
5	Simultaneity	Production and consumption of services are simultaneous.	Factory mass-production or to provide a place to share time and space as a platform (“ba”)	To repeat the cycle of service provision	Variable price system
6	Inseparability	Production and consumption of services are inseparable.	Delivery and delivery inspection	To repeat the cycle of service provision	User’s voice publication
7	Irreversibility	Irreversible	Redoing	To repeat the cycle of service provision	Skills training system

Industries with intangible ephemeral media are typical service industries. “Intangible media” are kinetic energy, electricity, heat, light energy, and other media without the fixed shape of tangible articles. “Ephemeral media” are media by which design information has been transmitted that are prone to deformation due to factors such as corruption, dissolution, or decay of their structure, form, or composition. Face-to-face selling and face-to-face service, which transmit design information to customers at sites using site atmosphere as a medium, are typical service industries. Broadcasting, which uses instantaneously decaying radio waves as a medium, is similar. Typical service industries can be defined as industries that seek to directly transmit design information to customers themselves using non-durable, intangible energy as a medium. Since the medium decays on the spot and production and consumption are co-located, no inventory can be kept. In addition, since consumption ends instantaneously, variation in customer evaluation tends to occur. Furthermore, since the medium instantaneously decays, direct transmission to the customer is a necessity, and direct transmission contributes to higher customer satisfaction (T. Fujimoto 2007).

Let us elucidate that medium intangibility and ephemerality are largely the reasons for the above being the seven service features, considering the case of the front-desk service of a luxury hotel, a prime example of a service industry. The medium for this face-to-face service is the front-desk atmosphere, the intangible ephemeral medium of intangible energy. We understand that "inconsistency" between customers at their entrance to the hotel are differences in season or differences between day and night, and that "consumer involvement" stems from the fact that the customer cannot enjoy the atmosphere if not present and that the appearance of the other people present affects the atmosphere. "Intangibility" lies in the untouchable nature of atmosphere and "perishability" stems from the fact that the pleasant atmosphere is immediately lost if a power outage or similar problem occurs and that memory of atmosphere fades over time. "Simultaneity" and "inseparability" apply because atmosphere cannot be realized without the simultaneous presence of provider and customer. "Irreversibility" lies in the impossibility of return and replacement in response to complaints.

With regard to customers as a medium, although actual customers are neither intangible nor ephemeral, they can be considered intangible in terms of their receptivity when receiving services and memory. There are heterogeneous individual differences in receptivity, and satisfaction and dissatisfaction are subjective. Memories, being transient, will fade and so are perishable. Accordingly, customers are a subjective intangible ephemeral medium. Since they are subjective, they should furthermore be considered unstable. Typical service industries have a tendency to focus attention on direct transmission to customers (T. Fujimoto 2007) and prioritize this over transmission to objective intangible ephemeral media. This is because if information perishability is also high, directly appealing to customers is likely to be more effective. However, we must not forget that customers as a medium are subjective and that individual differences are great. Although prior expected value is heterogeneous, the consequent large divergence is nonetheless a fatal flaw. Therefore, despite its difficulty, prediction of prior expected value is essential. People and steel plates are completely different.

4.1.2 Service exchange of "face-to-face selling": transmission and feedback

Here we analyze service exchange between trading companies and customers. Service-dominant (SD) logic FP1 holds that "Service is exchanged for service." The service exchanged with a customer when a trading company transmits service design information to a customer is the customer's evaluation of the transmitted service design information. Customers feed back deviation from prior expected value (top left of figure 25). Since design information decays and perishes immediately after transmission, measuring deviation is difficult (top center of figure25). Owing to the simultaneity and inseparability of services, deviation must be measured at the moment of transmission. Owing to the inconsistency of services, feedback varies widely from proactive feedback to passive feedback. What is most problematic is nonreactive feedback. Trading companies contribute to improvement of service design information by contextually judging measured deviation. Service exchange in face-to-face selling is instantaneous, reciprocal transmission. Since inexperienced sales representatives are incapable of instantaneous deviation measurement, they cannot improve the next transmission and negotiations become deadlocked.

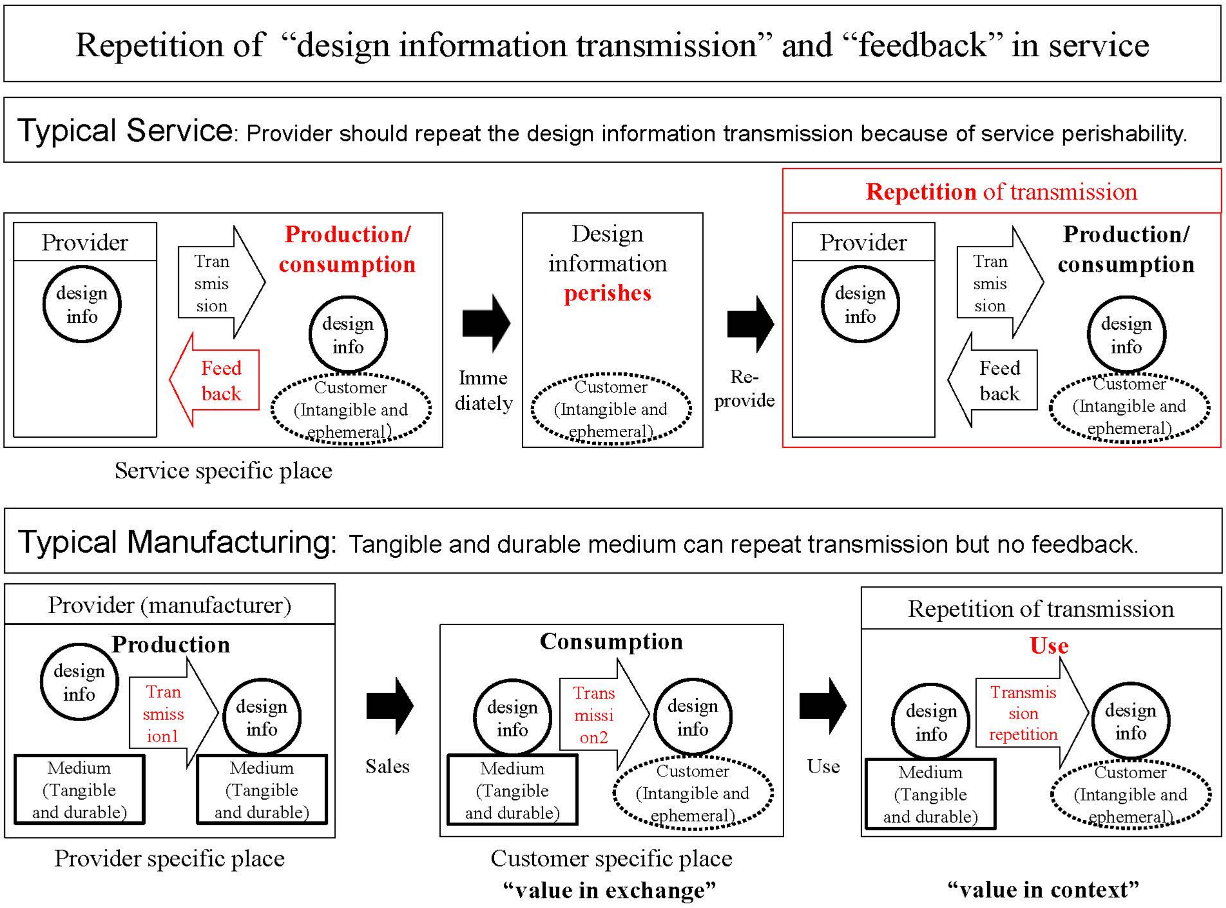


Figure 25 Transmission of service or manufacturing

Let us discuss the rationality of repeating face-to-face selling. SD logic FP10 holds that "Value is always uniquely and phenomenologically determined by the beneficiary." Customers constantly independently judge the value-in-context of transmitted service design information. If it is not equivalent to the value-in-context, the deviation is fed back and the design information of the next transmission must be improved. If equivalence is reached, concrete services such as event participation or contracting are fed back. Although there are cases when equivalence is reached right away the first time and the customer makes an impulse purchase (love at first sight), these are rare. Ordinarily, by continuing the face-to-face selling, the reciprocal value-in-context rises in a zigzag spiral in an intense exchange of transmission and feedback. Face-to-face selling is continued until equivalence is reached. From a value orchestration perspective, this is a co-elevation process. Furthermore, there is inconsistency in the medium due to decay and perishability, individual differences, and temporal difference. The medium soon forgets design information, expected value differs from person to person, and preferences change over time even for the same individual. The only countermeasure is repetition of face-to-face selling. Because of design improvement and three media characteristics, a strategy of repetition is applied to face-to-face selling value co-creation.

For services, quality control (QC) and industrial engineering (IE) are difficult, involving measurement of transmission accuracy and density. IE is measurement of the number of transmissions per unit of time and cost performance. Although highly experienced sales representatives are aware of the importance of deviation measurement, they have yet to reach the point of recognizing that deviation is a service equivalently exchanged for their transmission of service design information. It is important to formularize evaluation through visualization of deviation and elevate it to a theory corresponding to inspection in manufacturing industry QC. We will leave measurement methodology and QC as a task for subsequent research.

Let us analyze the fact that feedback in face-to-face selling is both explicit knowledge and tacit knowledge. Since trading companies transmit the key points of service design information to customers as explicit knowledge such as clear words, estimates, and sales literature, when deviation is fed back as explicit knowledge, improvement is simple. These are cases where customers provide feedback by means such as accurate language. Even in these cases, cyclic repetition is necessary because of media instability. However, ordinarily tacit knowledge is fed back. Tacit knowledge is transmitted to sales representatives through expressions, attitudes, or moods. Deviation in this must be measured. To offset deviation between tacit knowledge and explicit knowledge, sales representatives return to the company with the customer feedback, then the sales representatives themselves, their managers, or someone else performs inverse analysis from tacit knowledge to identify causes, and thereby the company converts the tacit knowledge to explicit knowledge in the form of improved service design information that it again transmits to customers. This is an upward spiral of tacit knowledge and explicit knowledge. In trading company terminology, when deviation is tacit knowledge it is called a “hint”, and when it is explicit knowledge it is called “homework”.

Design information transmission theory points to a solution to the misgiving expressed in SD logic FP2, “Indirect exchange masks the fundamental basis of exchange.” The lower half of Figure 25 illustrates indirect exchange of services in FP2 for manufacturing industries. It is useful to compare this with direct exchange of services for services industries, shown in the upper half of the figure. Transmission 1 is factory production. In design information transmission theory, Transmission 1 is implemented in a “smooth flow”. QC is improvement of accuracy, IE is improvement of density, and a customization strategy involving attachment of options is improvement of alignment with prior expected value. These three types of improvement improve both Transmission 2 and Transmission 3. Transmission 2 is purchasing, which is instantaneous value-in-exchange. Transmission 3 is use, which is continuous value-in-context. When a medium is tangible and durable, although age deterioration occurs, design information is stably preserved in the medium and design information transmission is repeated each time a customer uses the product. This is indirect value co-creation between the provider of the tangible durable medium and the customer. After-service is improvement of Transmission 3 through restoration of Transmission 1. The reason servitization in the narrow sense (increased emphasis on providing services and adding value through services by manufacturing industries) tends to go no further than discussion in the after-sales service department is that restoration to Transmission 1 restores Transmission 3. Value resides in design information to begin with, and in manufacturing industries, value is transmitted at factories to operand resources, which are tangible durable media, and co-created as value-in-context in the customer’s use process via value-in-exchange in the form of consumption. This figure makes explicit through visualization the basic foundation of indirect exchange in manufacturing industries. Advancing visualization of a design information transmission theory model has brought us closer to a solution to the misgiving expressed in FP2.

Let us now show that the purpose of QC in manufacturing industries is realized in service industries through repetition. Media differences engender strategy differences. We demonstrate this with a concrete example. The beautiful body of a luxury car embodies the storage of design information in steel plates in a high-quality manner. The body does not revert into a steel sheet overnight, and the customer is able to enjoy its appearance for many years. When using a stable medium, it is sufficient to transmit design information with a high degree of accuracy a single time. This is the purpose of QC. However, hotel guests sometimes forget overnight the atmosphere of hotels where they have stayed. Hotel stays rarely become lifelong memories, unless a guest experiences an impressive and moving response to an unforeseen situation. Hotels do not enjoy the benefit of powerful transmission opportunities. Rather, they are constantly challenged to provide quality taken for granted, such as smooth check-ins with no wait whenever guests may visit, and that is what creates repeaters. When using an unstable medium, the way to increase the accuracy of transmission is to repeat transmission to the same medium, and the way to deal with a heterogeneous medium is to gear the initially transmitted service design to suit the great majority of customers, avoid divergence risk, and correct deviation and increase transmission accuracy through repetition. This is QC through repetition in service industries.

In face-to-face selling value co-creation at trading companies, repetition is necessary to counter perishability of design information resulting from media characteristics and to control transmission quality. Analysis using a reference framework suited to the repetitive nature of face-to-face selling value co-creation is necessary.

4.2 Hierarchical Model of Service Ecosystems Innovation (rotation/revolution)

Service system is a dynamic configuration of people, technologies and organizations and shared information that create and deliver value to customers, providers and other stakeholders (University of Cambridge & IBM 2008).

According to service-dominant (SD) logic, in service system the traditional distinction between a "producer" as a creator of value and a "consumer" as a destroyer of value is replaced with a more generic conceptualization of economic (and social) actors, which reciprocally create value as complex systems.SD logic refers to such complex service systems as "service ecosystems" to emphasize their dynamic features like adaptation, viability and sustainability (Vargo, S. & Lusch, R.F. 2011). Indeed, they define the term service ecosystems as "relatively self-contained, self-adjusting systems of resource-integrating actors connected by shared institutional logics and mutual value creation through service exchange" (S. Vargo, 2014) (H. Wieland, et al., 2012) (H. Lush, S. Vargo & R. Lusch, 2015). A service ecosystem itself is often of recursive structure and consists of several or many service systems connected by network (Figure 26).

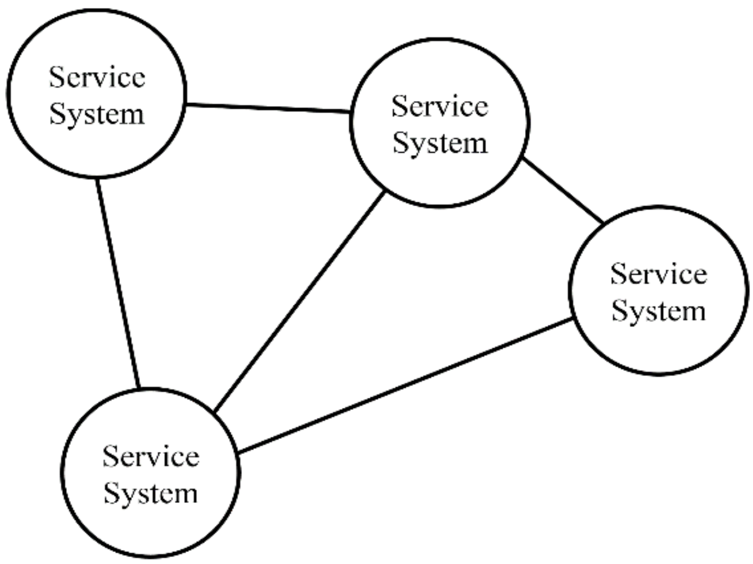


Figure 26 Structure of Service Ecosystem

Service ecosystems are constantly adapting to changing contextual requirements and are simultaneously creating these changing contexts in the process (A. Giddens, 1979). Contextual value creation (value-in-context) in these systems can also be conceptualized as an increase in the dynamic viability of the system (H. Wieland, et al., 2012).

One of the crucial ways to create new value and increase viability for a service ecosystem is to introduce new or significantly improved products (goods or services), processes, organizational institutions, and marketing methods in business practices or the marketplace, i.e., innovation in a broad sense.Innovation is indeed the fundamental source of significant value creation by a service ecosystem.

When we argue service ecosystems in terms of innovation, service ecosystems must be conceptualized as open systems that are (1) capable of improving the state of another system through sharing or applying resources (i.e., the other system determines and agrees that the interaction has value), and (2) capable of improving its own state by acquiring external resources (P.P. Maglio, et al., 2009).As a matter of facts, it is claimed that a fuller exploration of the dynamic and complex nature of service ecosystems requires drawing on systems perspectives (H. Wieland, et al., 2012).They indicate SD logic and service science both point toward a need for a systemic understanding of value and value co-creation processes. In this paper, referring to the roles of innovation in particular, we first analyze and construct models of a service ecosystem in systems perspective, where Panarchy and Transition Management Theory in particular are focused. Panarchy is adopted because it is a framework for analyzing an ecosystem developed to account for the dual, and seemingly contradictory, characteristics of all complex systems, i.e., stability and change (L.H. Gunderson & C.S. Holling, 2001) (C.R. Allen, 2013)(E. Fraser, 2014).It tries to explain about the complex interactions among different areas as well as different levels, bringing together ecological, economic and social models of change and stability. On the other hand, since Transition Management Theory has attracted attentions as a framework for arguing governance of social systems for sustainability (D. Loorbach, 2007) (J. Rotmans & D. Loorbach, 2009), it is adequate for characterizing service ecosystems in terms of social sustainability, In the sense that the former provides microscopic viewpoints, while the latter focuses on wider and macroscopic aspects of service ecosystems, they are complementary.

Then, based on the analysis and the models, we propose a comprehensive model, called Hierarchical Model of Service Ecosystems Innovation, which describes dynamic behavior of service ecosystems especially with focus on the role of innovation.

4.2.1 Adaptive cycle and transition of ecosystem

We will utilize the concept of "value co-creation cycle" in the following. As mentioned above, a service ecosystem often consists of several or many service systems connected by network to engage in value co-creation process as a whole. Networks are generally thought as a third governance structure next to markets and hierarchies.

(S. Vargo, 2014) and (S. Vargo, H. Wieland & M.A. Akaka, 2015) identify three phases of value co-creation process of a service ecosystem, i.e., networking, resource integration and service exchange. Through the network the participating service systems integrate various resources such as market-facing resources, private resources and public resources to create service value. Then, by interactions they exchange service values with each other. Their role in the network changes from provider to customer time to time, while some service systems may play a role of coordinator of the network. By service exchange the network of service systems would be re-structured and re-formed, so that these three phases are modeled as a cycle (Figure 27).

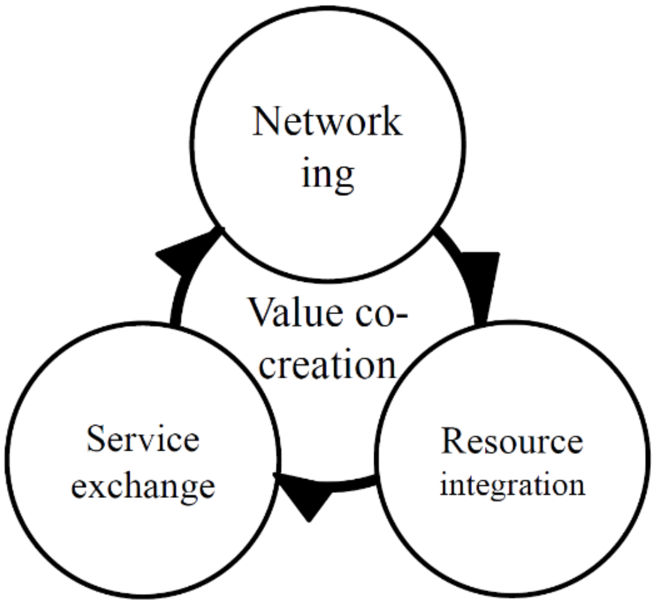


Figure 27 Value Co-creation Cycle

Open Innovation (H. Chesbrough, 2010)(H. Chesbrough, 2013) is a concept that sheds light on the networking phase of the cycle in particular, becuse it is described as “combining internal and external ideas as well as internal and external paths to market to advance the development of new technologies” and it focuses on how, what and when knowledge and resources is required and used internally or externally for innovations. The cyclic model also shows the networking heavily depends on the other phases as well.

Next, we consider adaptive transition of service ecosystems. If we see a service ecosystem as a complex system that follows adaptive cycle, it is certainly suitable to adopt Panarchy to investigate its characteristics. Indeed, Panarchy is an integrative reference framework of Systems Sciences to help us understand the source and role of adaptive change of ecosystem (L.H. Gunderson & C.S. Holling, 2001). According to it, the adaptive cycle of ecosystem is a process that accounts for both stability and change. It periodically generates variability and novelty, either by internally accumulated resources through genetic mutations or adaptation, or by externally accumulating resources that would change the internal dynamics of an ecosystem. Panarchy suggests that such changes can be observed in economic, ecological, and social systems, and they are evolutionary and is concerned with rapid unfolding processes and slow changing ones; gradual change and episodic change. They take place and interact at various scales from local to global.

Panarchy identifies four basic stages in the adaptive cycle of ecosystems: exploitation, conservation, release and reorganization (Figure 28). It claims that all ecosystems, from the cellular to the global level, are observed to go through these four stages in a dynamic adaptive cycle (C.R. Allen, 2013).

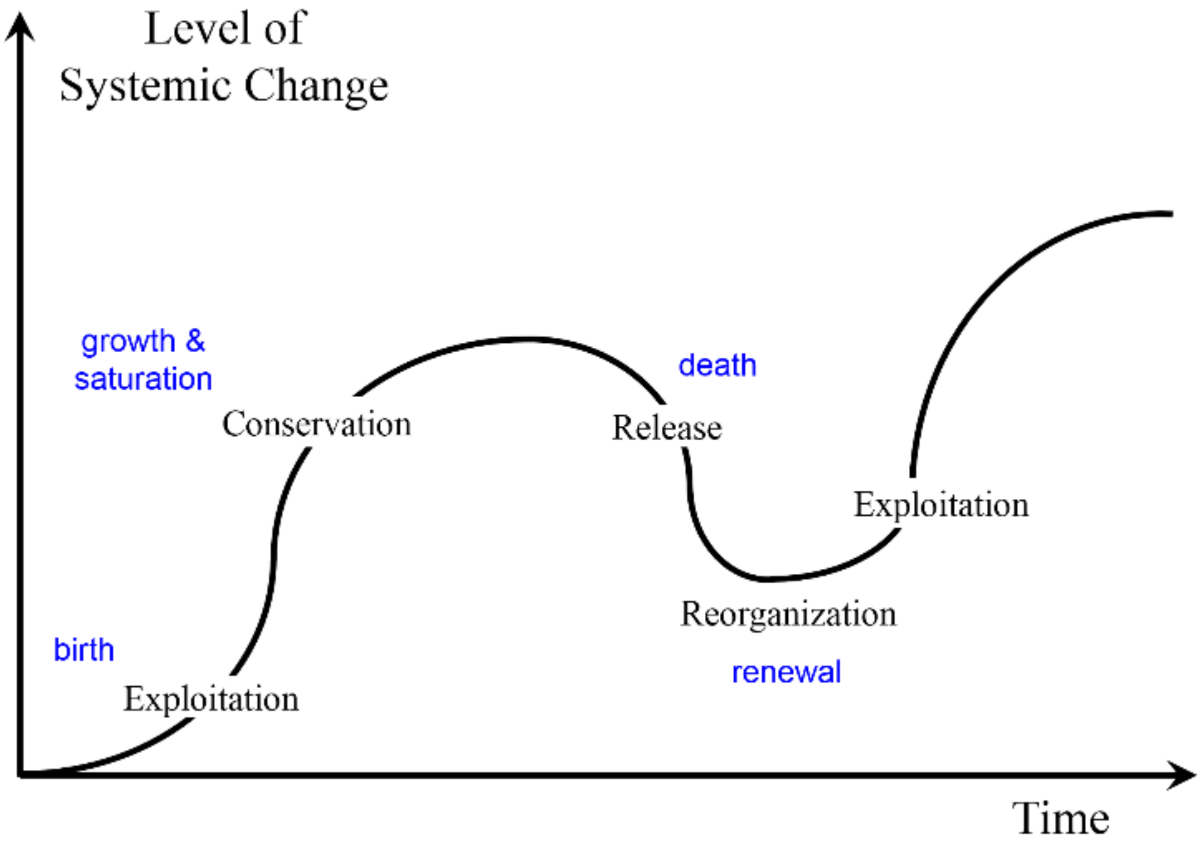


Figure 28 Adaptive Cycle as Panarchy

The exploitation stage is a rapid expansion stage, as when a population finds a fertile niche to grow. The conservation stage is a stage in which slow accumulation and storage of “energy”, i.e., “growth” and “saturation” is emphasized, as when a population reaches capacity and stabilizes for a time. The release stage occurs rapidly, as when a population declines due to a competitor and/or some changed conditions. The reorganization stage can also occur rapidly, as when certain members of the population are selected for their ability to survive in spite of the competitor or changed conditions that triggered the release. Then, a new cycle of the four stages would begin again. We can easily recognize that the four stages of the adaptive cycle are analogous to birth, growth and saturation, death and renewal of living systems.

We now model an adaptive cycle of a service ecosystem as a revolution system, analogous to the Solar system, where value co-creation cycle moves in orbit with rotating around its axis simultaneously (see Figure 29).

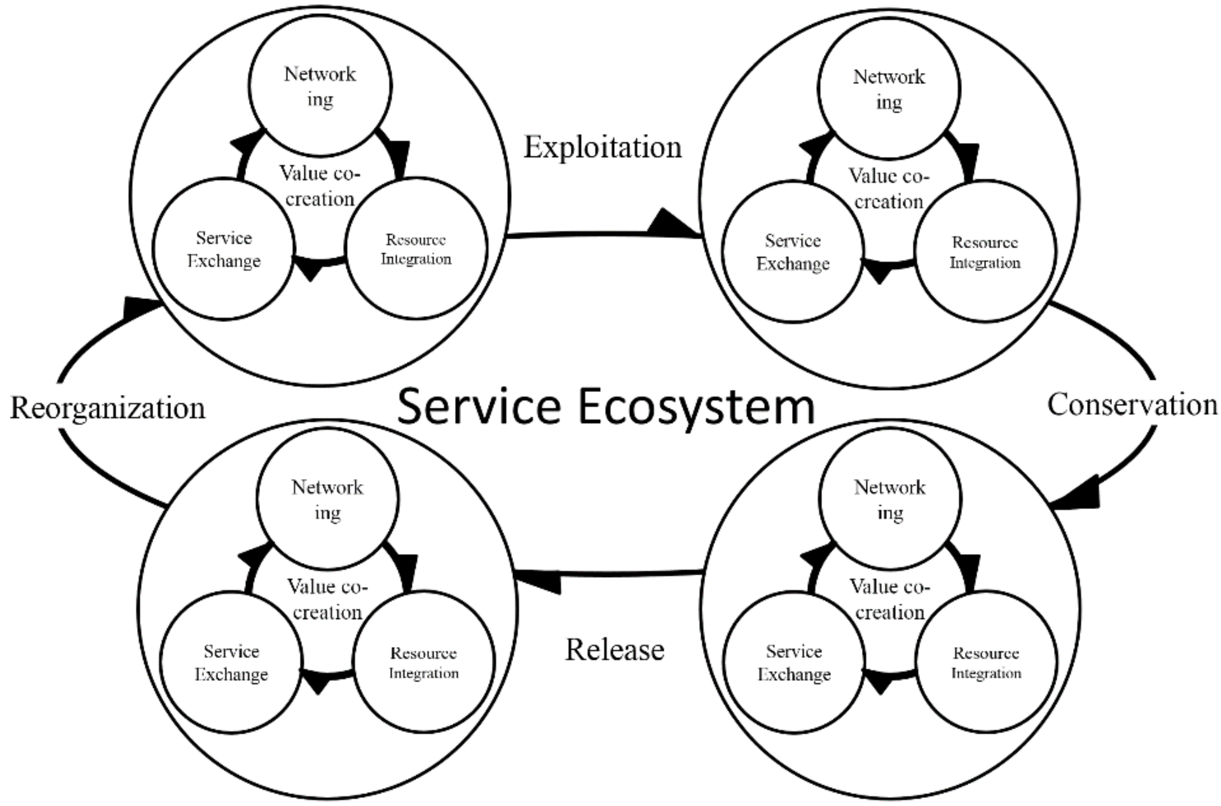


Figure 29 Service Ecosystem as Revolution

We can generally observe this revolution when new service/products are launched: Their value attracts the market (exploitation) to some extent and gets popular (conservation), though the popularity depends. Then, as time goes by, the attractiveness would fade out (release). Finally, the service/products are renewed as more suitable for the market (reorganization) to enter the next round. Since tendency of stability governed by adaption is relatively strong, improvement and/or incremental innovation is the main driving force for the rotation.

A service system moves in orbit over and over in an adaptive way with value co-creation cycle rotating around its axis. We call the revolution adaptive transition. It is essentially scale transition (L.H. Gunderson & C.S. Holling, 2001) (C.S. Holling, L.H. Gunderson & D. Ludwig, 2014).

We next describe adaptive transitions of service ecosystems. The adaptive transition view to eco-system is so natural and legitimate as to argue why and how the system is maintained. It illustrates what we call process change or process innovation.

However, the adaptive cycle sometimes may break down and/or collapse into a qualitatively different state. It is a result of structural change along the orbit and call it phase transition. The phase transition is essentially type transition rather than scale transition. While moving in orbit, the rotation system creates some fluctuations in the relationship and then deviates and spins out from the orbit to another.

Panarchy illustrates such deviation happens in such a way that the rotation system at the release stage of the adaptive cycle jumps to a new conservation stage or the rotation system at the conservation stage jumps to a new re-organization stage (See Figure 30). In order for the service ecosystem to be sustainable it should possess the capacity to create, test and maintain capability for shifting to another service ecosystem.

Concepts such as destructive innovation and drastic innovation can be described relevantly in terms of phase transition. Destructive innovation means a process by which a product or service takes root initially in simple applications at the bottom of a market and then moves up market, eventually displacing established competitors (C. Christensen, 2013)(F. Ricciardi, 2013). The essential idea behind it is a structural jump from a service ecosystem to another. Drastic innovation sets the fundamental pace of economic progress by redefining production possibilities as Schumpeter strongly emphasized (S. Panth, 2013) (M. Toivonen, 2013).

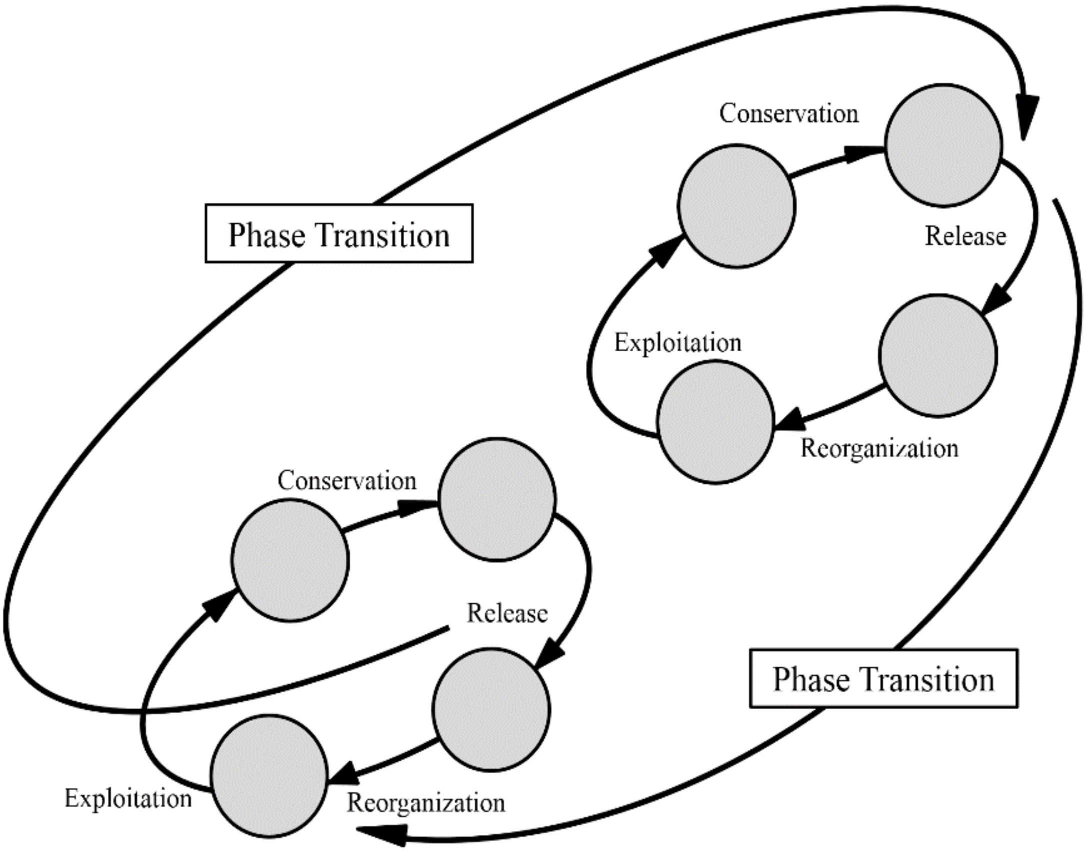


Figure 30 Phase Transition

4.2.2 Hierarchical model of service ecosystem innovation: HMSEI

So far we have pointed out that for sustainable development of a service ecosystem both adaptive transitions and phase transitions are crucial. However, it is not enough; sustainable development of a service ecosystem requires changes in the socio-technical sense, i.e., societal change in beliefs, values and governance that co-evolve with technology changes (R. Kemp, D. Loorbach & J. Rotmans, 2009).

In order to discuss a service ecosystem properly in the context of co-evolution of technologies with wider societal changes, we adopt Transition Management Theory (D. Loorbach, 2007) (J. Rotmans & D. Loorbach, 2009). It is in particular concerned with arguing governance of social systems for sustainability and defines transition as a combined process of adaptation of relatively stable system (adaptive transitions) and structural societal change from one relatively stable system to another (phase transitions) via a co-evolution of markets, networks, institutions, technologies, policies, individual behavior and autonomous trends (R. Djalante & S. Djalante, 2012).

Behind the process of social change, multiple and interrelated innovations take place at a different speed and level (J. Rotmans & D. Loorbach, 2009). The lowest level is the micro-level of innovations, where so-called 'niches' novelties are created, tested and diffused. Such novelties can be new technologies, new rules and legislation, new organizations or even new projects, concepts or ideas. Terms like B2B, B2C and C2C services are relevant to the present level to describe actual value co-creation cycles. Indeed, our arguments so far mainly sheds light on the micro-level. The second and middle level is the meso level at which the so-called regime is located. The term 'regime' refers to the dominant culture, life style, brand, market, and physical and immaterial infrastructures.

Institutional innovation (J. Hagel, J. Brown and L. Davison, 2010) should be discussed at this level, since institutionalized structures give a societal system stability and guide decision-making and individual behavior of actors. At the same time, the regime has a certain level of rigidity that normally prevents innovations from changing the structure fundamentally.

The highest level is the macro-level of innovation or “landscape”, where the overall societal setting in which processes of change occur. The landscape consists of the social values, political cultures, and economic environment and trends. The landscape level directly influences the regime level as well as the niches by defining the room and direction for change.

Each level has non-linear multi-stable properties and it can be stabilized or destabilized through critical connections between levels. Faster and smaller adaptive/phase transitions at the lower level generate and have an impact on slower and larger adaptive/phase transitions at the higher level, while, at the same time, slower and larger adaptive/phase transitions at the higher level regulate faster and smaller adaptive/phase transitions at the lower level (F. Squazzoni, 2008).

These ideas imply that social needs and demands at the meso-level trigger technological innovations and phase transitions at the niche level, while, at the same time, new technologies create and lead to new life style and social culture. Based on these considerations we now propose Hierarchical Model of Service Ecosystems Innovation (Refer to Figure 31).

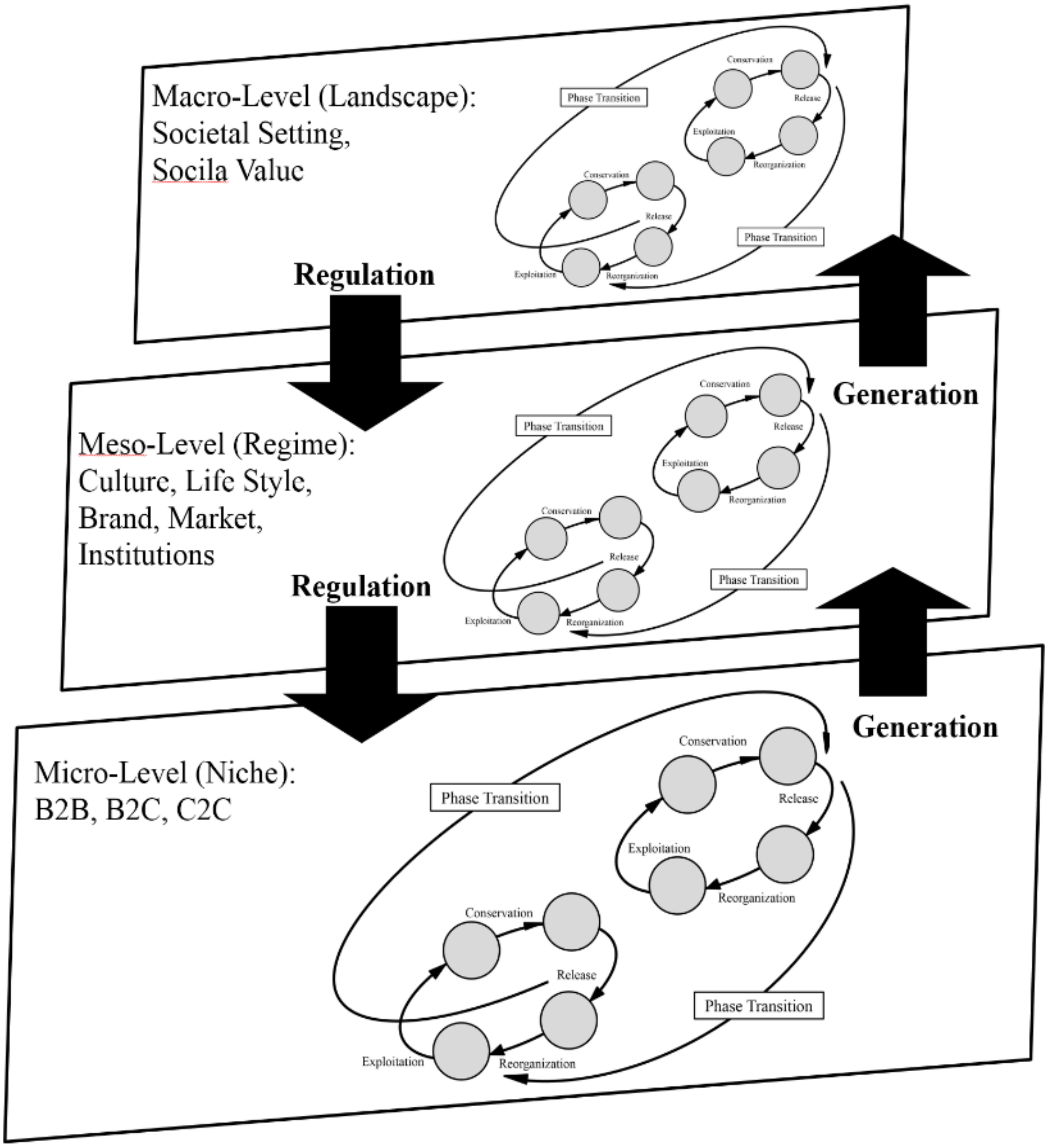


Figure 31　Hierarchical Model of Service Ecosystems Innovation

Based on important concepts and models in systems sciences such as Panarchy and Transition Management Theory, we derived a new model called Hierarchical Model of Service Ecosystems Innovation.

Some unique insights we have obtained by the analysis include:

(1) Value co-creation in a service ecosystem takes a form of cycle consisting of networking service systems, resource integration and service exchange among them. Value co-creation cycle rotates around its axis and at the same time moves in orbit. The

revolution is an adaptive cycle consisting of the four stages; exploitation, conservation, release and reorganization stages.

(2) The adaptive cyclic view to service ecosystem is so natural and legitimate to argue why and how the system is maintained. However, the adaptive cycle sometimes may break down and/or collapse into a qualitatively different state. To explain about such structural change of a service ecosystem, we introduced concept of phase transition.

(3) Based on Transition Management Theory, we identify three levels, i.e., micro, meso and macro level in society. Within each level a service ecosystem usually takes a dynamical and adaptive behavior and may sometimes take phase transition. Between the levels we may observe generation and regulation. Some main ideas developed in this paper are summarized as shown in the table (Table 6)

.

Table 6　Summary of HMSEI

Summary of Main Ideas Developed

№		Process	Systemic Concepts	Innovation
1	Rotation	Value Co-Creation (Networking, Resource Integration and Service Exchange)	Systems of Service Systems, Interaction	Open Innovation
2	Revolution	Adaptive Transition (Exploitation, Conservation, Release and Reorganization)	Adaptation Viability, Sustainability	Incremental Innovation, Improvement
3	Phase Transition	From revolution to another	Structural Change Viability, Sustainability	Destructive Innovation, Drastic Innovation
4	Generation/ Regulation	Between social levels	Co-evolution	Institutional Innovation

4.3. Strategies and prescriptions for MTT as HMSEI

4.3.1 Rotation as definition of servitizatiion

In Section 4.1, we pointed out on the basis of design information transmission theory that the face-to-face selling value co-creation of MTT companies must be repeated. SD logic value co-creation means a state in which products, services, and knowledge and skills (operant resources) emerge through a process of networking and resource integration among stakeholders and are highly integrated through aggregation of their value. Repetition of this value co-creation is the same as the definition of HMSEI rotation mentioned in Section 4.2. Accordingly, we hereafter analyze face-to-face selling of MTT companies as rotation and indicate a strategy prescription using revolution.

In Section 1.2.1, we defined servitization as “the provision of services through value co-creation”. The definition of servitization is also HMSEI rotation.

4.3.2 Rotation of MTT

MTT company rotation is the cyclic repetition of face-to-face selling value co-creation. The service design information of MTT companies is production technology. MTT companies network, engage in resource integration, facilitate the emergence of production technology worth exchanging, and effect service exchange on platforms. For instance, if an invitation to a workshop is suitable, people will participate. Next, MTT companies engage in cyclic repetition of this value co-creation for the purpose of service exchange of even more advanced production technology.

Concrete service exchange such as that mentioned above does not necessarily take place during face-to-face selling. In most cases, deviation from the customer's prior expected value is fed back and measured deviation is put to use in the next transmission. Measurement of feedback of deviation from prior expected value is equivalent to transmission of service design information. This corresponds to SD logic FP1, "Service is the fundamental basis of exchange." The best evaluation of all is contracting, when deviation is 0. When negative deviation has been fed back, MTT companies facilitate the emergence of more advanced production technology by taking back homework, and when this is insufficient, they bring potential providers onboard and form networks. This is the value orchestration platform dynamic quration strategy. Companies transmit production technology that has emerged from resource integration. This corresponds to SD logic FP7, "Enterprises can offer their applied resources for value creation and collaboratively (interactively) create value following acceptance of value propositions, but cannot create and/or deliver value independently."

As is the case with value orchestration, there are two categories of face-to-face selling: "elevation" and "development". There exist one-to-one value elevation by customers and providers through diverse "*ba*" and value development in which multiple stakeholders participate. These are the same as the value orchestration categories co-elevation and co-development in Chapter 3. Through *ba* selection, scale increases from presentation through *kaizen* meeting, technical workshop, and Japan International Machine Tool Fair (JIMTOF; 865 exhibitors and 130,000 visitors), the largest event. Here, we call one-to-one face-to-face selling “elevation face-to-face selling” and multi-actor face-to-face selling “development face-to-face selling”. In elevation face-to-face selling, the orchestrator strategy is adopted. Background networking and resource integration discontinuously enhance platform value. Since elevated value and provider are in one-to-one correspondence, the process is modular. The strategy adopted in development face-to-face selling is the relation-matrix strategy. By networking with multiple actors, MTT companies continuously coordinate resource integration and accomplish value development all at once. Since the relationship between value elevation and stakeholders is complicated, the process is integral.

4.3.3 Revolution of MTT: adaptive transition and phase transition

We have defined new service from a value orchestration perspective and suggested cyclicity (3.2.1). There were four phases: co-experience, co-definition, co-elevation, and co-development (previous figure 11). If we consider platform value as a standard, since the only difference between co-elevation and co-development is the number of participating stakeholders, we combine them here as "co-elevation/co-development", as they are expressed in Figure 32. In value orchestration, the final best strategy was the co-design strategy in the co-development phase. "There can be no work without drawings" is an expression used in the machine tools industry, and drawing alteration changes the sense of platform value. In Section 4.2.1, we pointed out that in HMSEI the rotation system creates phase transition from fluctuations in the relationship and that this is type transition (model change). Drawing alteration resulting from co-design sometimes causes type transition. If we consider this the final phase of value orchestration and call it the "co-design" phase, the adaptive transition process of MTT companies can be broken down into four phases: co-experience, co-definition, co-elevation/co-development, and co-design. Hereafter, we consider adaptive transition stages and phase transition in MTT company revolution on the basis of these four phases and devise strategies and prescriptions (Figure 32). In Section 4.2, the vertical axis represents the level of systemic change. This is market scale, on the basis of which we researched transition. In Section 4.3, however, we analyze extreme values and inflection points as production site platform value.

Since the models differ, the four phases of value orchestration cannot simply become the four stages of revolution adaptive transition without modification. Differences occur. At face-to-face selling sites, ordinarily there is deviation from prior expected value in design information, and cyclic repetition must be continued to reach value orchestration, the objective from a value co-creation perspective. In co-definition, although platform value increases at the point where the direction for internal model identification is decided, once experimentation for the purpose of internal model identification begins, platform value decreases in proportion to investment related to trial and error. Once identification has been completed, co-elevation/co-development begins and platform value increases. When the achieved production technology begins to become obsolete, ordinarily co-design begins, platform value decreases due to drawing release, and production technology reorganization becomes necessary. Because of the above, the starting point and ending point of the value orchestration value co-creation process are, as a rule, located in a neighborhood of the extreme values on the graph.

Furthermore, it is rational to express adaptive transition categories in terms of symbolic service exchange that causes adaptive transition, and we consider it reasonable that adaptive transition categories become stages in which entities find themselves and strategy decision criteria. This way of thinking fits the actual circumstances of face-to-face selling sites. Although feedback in rotation is often deviation, service exchanges other than deviation are symbolic services. As examined in Chapter 3, these are *participation* in various events in co-experience, *estimate/experiment* in co-definition, *contracting* in co-elevation/co-development, and *drawing release* in co-design. Since after rotation has been repeated several times symbolic service exchanges occur and symbolic service exchange itself repeats, ordinarily the process does not cause sudden adaptive transitions.

For the four phases of revolution—co-experience, co-definition, co-advancement/co-development, and co-design—we respectively describe below *participation*, *estimate/experiment*, *contracting*, and *drawing release*, which constitute symbolic service exchanges that cause stage transition. Hereafter, we call symbolic service exchanges “signals”. Adaptive transitions occur because of these signals. Signals are, as a rule, located near inflexion points.

A customer that has obtained a new model drawing via *drawing release* is searching for a production technology and is at the release stage of the Panarchy cycle, corresponding to the Chaotic stage in the Cynefin framework. This is the co-experience phase, and rotation (value co-creation) *invitation* is repeated. When *invitation* begins to change into a *participation* signal, the platform undergoes an adaptive transition to the Panarchy reorganization stage, corresponding to the Complex stage in the Cynefin framework. This means that a proposed production technology has been evaluated as equivalent to participation at a cost. This continues until an *estimate/experiment* signal is observed. We have pointed out that the onboard strategy of MTT companies is inducement to the SIPS cycle and that it begins with *participation*. Companies consider deviation in the form of non-participation feedback, usefully apply it in the next invitation, and increase *participation* accuracy. In Internet-related and similar businesses, we think that it is effective to gather and analyze information such as “Like”, a signal of sympathy, the starting point of the SIPS cycle.

The internal model definition signal in the co-definition phase is *estimate/experiment*. This is feedback relating to specification determination and experimental verification, such as requests for specification estimates or test cuts. This is a state in which the need for internal model identification and verification through *participation* begins to appear. This is an adaptive transition to the panarchy exploitation stage, corresponding to Complicated in the Cynefin framework. Although platform value momentarily decreases since estimate/experiment costs money and someone pays the cost, the system advances. This continues until a *contracting* signal is observed.

The signal in the co-elevation/co-development phase is *contracting*. After *contracting*, the process develops on to *delivery*, *effect measurement*, and *delivery inspection*. The emergence of production technology that realizes a correct internal model defined through payment of cost is facilitated by the platform, and *contracting* and *delivery* rotation is repeated. This is an adaptive transition to the Panarchy conservation stage, corresponding to Obvious in the Cynefin framework. When proper facilities investment continues, platform value increases. This continues until *drawing release*.

In the co-design phase, *drawing release* is the signal. In design information transmission theory, “Value resides in creation and transmission of designs” (H. sasaki 2008). Drawing release does not constitute transmission. Since drawings are a standard of value, the sense of platform value changes. If a drawing release is at the design change level, it is the Chaotic (release) stage, and concrete measures can still be taken. However, if there is a new model *drawing release*, a phase transition occurs. In the Cynefin framework, the situation becomes a warned-of Catastrophe, and strategy formulation is difficult.

Based on the above, the signals of the four phases of revolution (adaptive transition) become *drawing release* → release → *participation* → reorganization → *estimate/experiment* → exploitation → *contracting* → conservation → *drawing release*, and this cycle is repeated. If a drawing release is at the design change level, the process enters a second cycle of revolution. However, in the case of a new model *drawing release*, a phase transition occurs.

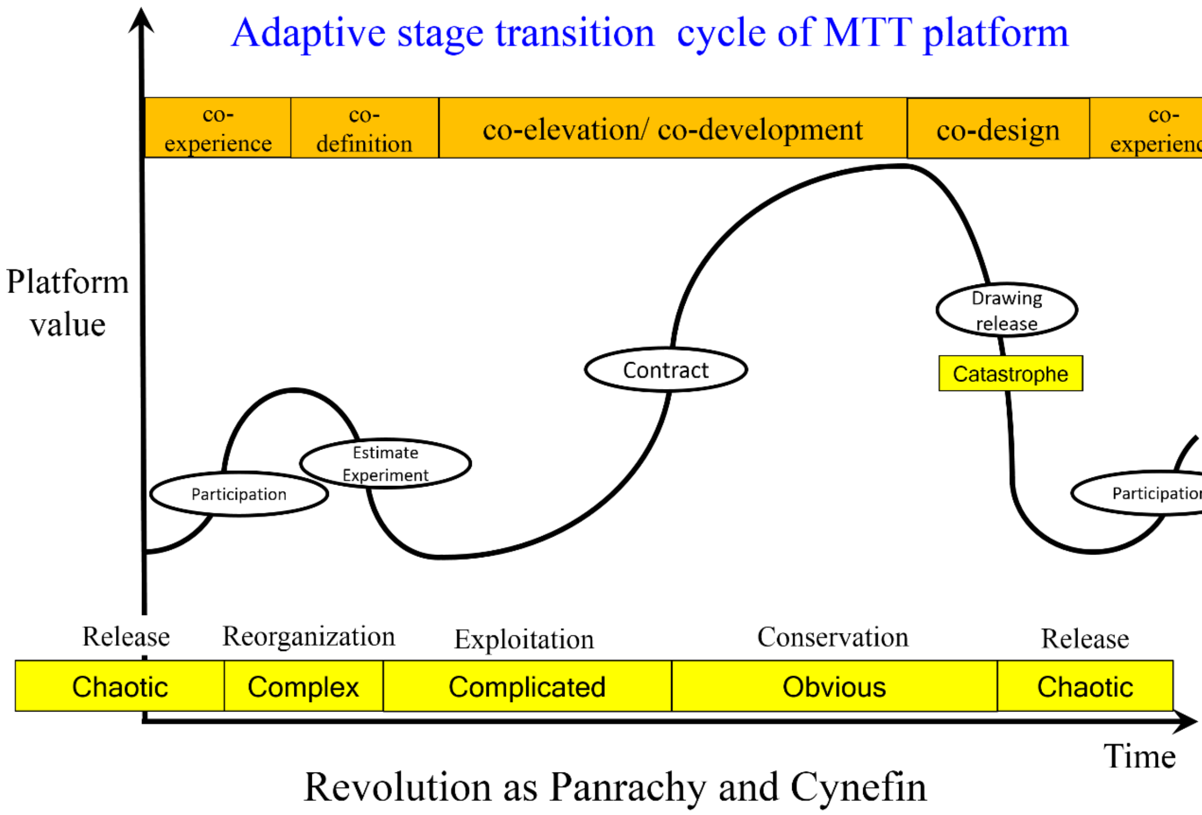


Figure 32 Signals of Adaptive transition

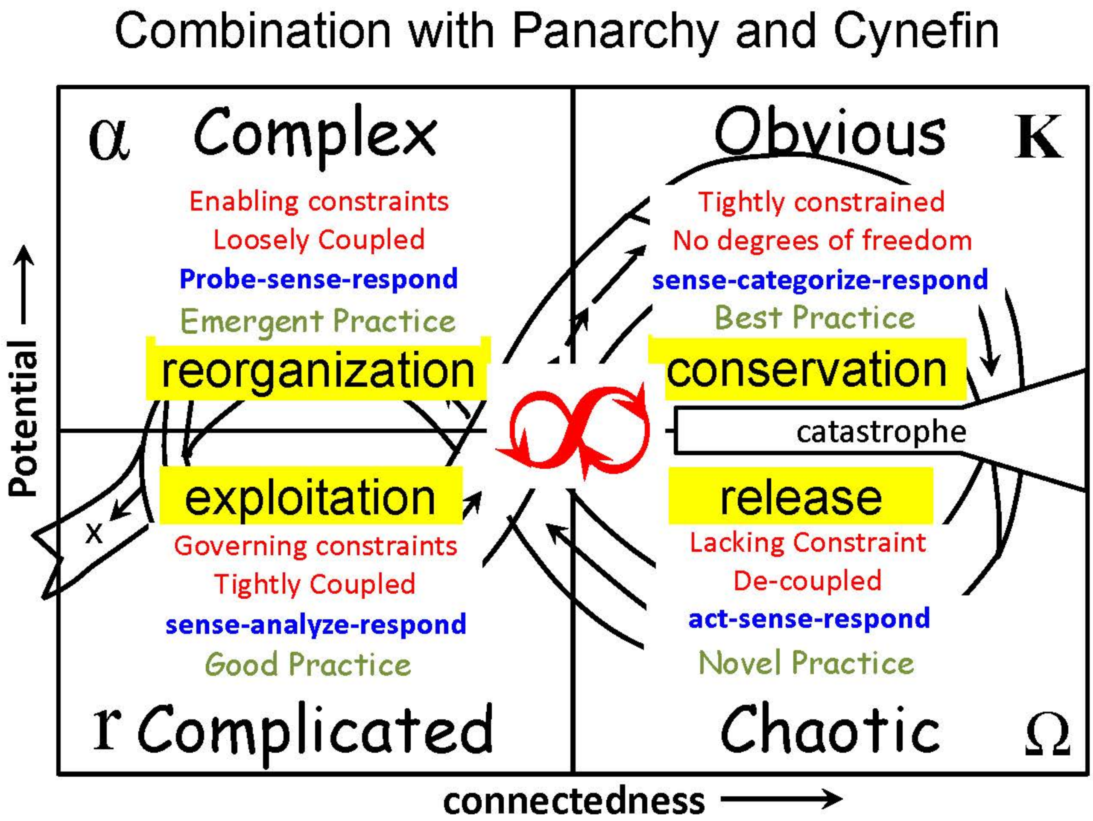


Figure 33 Cynefin prescriptions as Panachy

Let us discuss transmission of service design information at the release (Chaotic) stage after *drawing release* (Figure 32, 33). In the Chaotic stage, there is turmoil, causal relationships are not clearly understood, and groping for solutions is meaningless. Since feedback measurement is inaccurate if the transmitted design information is also vague, in the co-experience phase following new model drawing release, an MTT company repeatedly engages in face-to-face selling with customers on the assumption that, to some degree, understanding is impossible. Rather than consider effectiveness in event invitation, it invites a variety of stakeholders to a variety of events. Taking a command-and-control approach, it continues mutual sense-respond from the Cynefin Framework graph by means of cyclic repletion of *invitation* value co-creation. By communicating directly, it attempts to avoid loss of opportunity to acquire new production technology effective in new model drawings.

In the reorganization (Complex) stage after *participation*, transmission of service design information is defined as progress with internal model identification and visualization. An MTT company transmits an internal model fishbone in which stakeholders have mutually added expected values and capabilities and repeats deviation feedback measurement. Cyclic repetition of internal model identification increases internal model accuracy and degree of visualization and clearly hones in on single goal to which diverse stakeholders aspire. Identification proceeds while fluctuating due to the impact of the environment and stakeholders. Furthermore, since this is a stage at which the company is unable to charge customers, inexperienced sales representatives tend not to want to be actively involved. However, this is due to mistaken preconceptions. Capable sales representatives tenaciously bring about cyclic repetition of internal model and service design information matching. The company devises a prescription at the Complex stage by bringing onboard stakeholders who can potentially support the production technology acquired in the co-experience phase, regardless of whether they are customers or providers. It facilitates emergence of production technology through experiment proposals and simulations at limited cost. There is no appropriate solution, and the company patiently waits until a pattern emerges. Here, there is no order, and problems and solutions evolve. There are no correct answers. The company conducts experiments. Activities are lightly constrained. The order of response is probe → sense. Skill acquisition takes years. Practices emerge.

The exploitation stage following *estimate/experiment* (corresponding to Complicated in the Cynefin framework), continues until a *contracting* signal is observed. On the basis of an internal model that has been almost identified, the company transmits production technology service design information having potential to enhance productivity. This is a phase from co-definition into co-advancement/co-development and the company is not yet able to definitely promise productivity improvement. Platform value decreases slightly due to the cost of trial and error. The objective-function identification strategy and relation-matrix strategy in Chapter 3 are employed to aim for maximum effectiveness at minimum cost. Since internal model degree of sharing is high, transmission of service design information that significantly diverges from the customer's prior expected value is unacceptable. There is no possibility of recovery from submission of high price estimates or late time studies.

Unlike in the previous two stages, there is order in the complicated stage. Analysis by experts is given the highest priority. It is necessary to arrange *ba* for collaborating with engineers from machine tool and peripheral equipment manufacturers. The process enters the co-elevation/co-development phase, and it is desirable to establish methodologies for the use of questionnaires or portable information devices that visualize the customer's deviation feedback so that superiors can judge it to be at the step before *contracting*. In the Complicated stage, although searching for causal relationships can result in discovery, they are unclear and there are multiple appropriate production technology solutions. Since there is recognition among the stakeholders that they are in a state of mutual incomprehension, fact-based management becomes necessary, and experiments and simulations are useful. The company engages in studies and analysis. There are governing constraints. The order of response is recognition → analysis. Skill acquisition takes months.

As in the Complicated stage, order exists in the conservation stage (corresponding to Obvious in the Cynefin framework) following *contracting*. This is a phase from co-advancement/co-development to co-design. Transmission of value co-created production technology is cyclically repeated and shared, there is some degree of mutual understanding, and nearly the same pattern is repeated. At the Obvious stage, causal relationships begin to become obvious, and a state of recognition of mutual understanding is reached. Optimal solutions exist, and the company can rely on best practice theory. Matters can be delegated to subordinates. So long as concrete, direct communication is maintained, two-way communication with a wide range of stakeholders becomes unnecessary. Problems and solutions are well known. Bureaucratic practices are acceptable. Written instructions are relied on. Activities are constrained. The order of response is recognition → analysis. Skill acquisition takes a matter of hours. Best practices exist.

Next, we discuss a prescription concerning the *drawing release* signal. The release (Chaotic) stage continues until a *participation* signal emerges. In the conservation (Obvious) stage, since as noted above it is acceptable to maintain simple communication in accordance with best practices theory, a monotonous response is acceptable. However, the company must not neglect information gathering in preparation for the next new model. If there are minor changes from previous drawings, an adaptive transition to the Chaotic stage occurs. Customers who have obtained new drawings act and sense from the Cyenfin Framework graph in search of completely new production technology. In addition, since the elements of production technology are disconnected, control is not possible. Since there is turmoil and causal relationships are unclear, searching for appropriate solutions is meaningless. The platform repeats *invitation* based on a pattern. At all events, the company acts and seeks to restore order through command and control. This situation continues until *participation* begins.

New model *drawing release* causes a phase transition. Sudden full model change information nullifies customers' existing facilities and existing technologies and the company falls into Catastrophe. Expensive facilities investment becomes necessary, and if the company cannot cope, customers take their business to competitors. MTT companies, regardless of company size, strive for networking that transcends boundaries between companies and departments without focusing solely on production sites, the *ba* of their main business. Implementation of Toyota's "frontloading" (Figure 34), known as a co-design strategy, is effective.

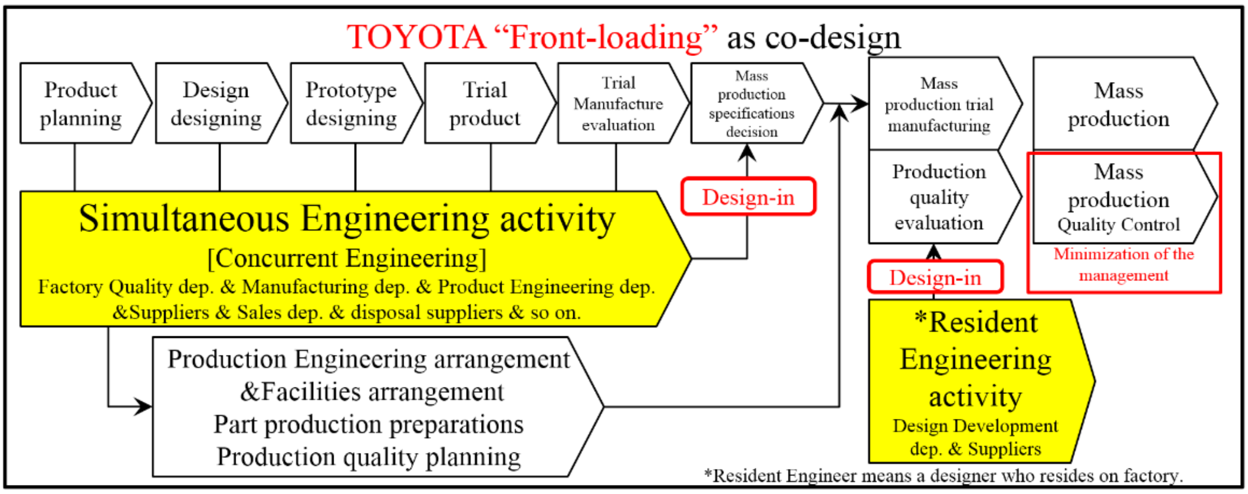


Figure 34 TOYOTA front-loading

This concludes the discussion of MTT companies' four adaptive transitions at production sites and concrete prescriptions.

The concept "design" includes "product" and "production technology" (T. Fujimoto 2004a). At the macro-level of product, there is the product concept, at the meso-level, there are the product design and module design, and at the micro-level, there are the machined parts design. To illustrate this using the automotive industry, an example of a product concept is the Prius concept as a C-segment hybrid vehicle concept. Below the product concept are the Prius product design drawings (assembly drawings). Below those are module design drawings for the engine, hybrid system, and other modules, below which are constituent parts drawings. Machine tools have to do with parts drawings. At the macro-level of production technology there is the global supply chain, at the meso-level, there are production plants and supply chains in various countries, and at the micro-level, there are production plants and their production sites in various regions, where machine tools are used. Furthermore, there are two types of drawing release: a new model drawing release, signifying a full model change, and a design change, signifying a minor change. Based on the foregoing, drawing release can be divided into twelve categories: new model drawing release and design change based on the two concepts product and production technology, each having micro-, meso-, and macro-levels. Although even these are broad categories, they generate and regulate in mutual interrelationship.

To MTT companies, “generation” refers to cases of small improvements at the parts level at production sites where they are involved affecting products as a whole. Let us take automotive industry engine machining as an example. A certain micro-level production site realizes precision improvement in conventional in-line four-cylinder engine machining and increases the degree of automation. Engine module design at the regime level corresponding to that production technology also changes, and a fuel-efficient new four-cylinder engine with lower friction loss is developed thanks to the higher level of precision. This is generation. In addition, if the automaker has developed a deluxe multi-cylinder V6 cylinder engine at the regime level, it will seek similar high-precision machining and request the same micro-level production site that was performing the conventional four-cylinder high-precision machining to perform machining for the V6 engine. This is regulation. It is connected in the mutual relationship between micro-level production technology and regime-level design and assembly. The transition of this in-line four-cylinder engine production site to V6 engine production is a phase transition.

In addition, the current worldwide heightening of environmental awareness and desire for fuel efficiency is prompting development of models in five vehicle segments: fuel-efficient vehicles, hybrid vehicles, downsized turbocharged vehicles, clean diesel vehicles, and electric vehicles. This is regulating regime-level module design and module production. At the micro-level, not only regulation at the production site machining level but also cross-industry technology evolution and social capital coevolution are required: for instance, high-precision machining for fuel-efficient vehicles; high-precision machining, battery and electrical systems control, and reduction in the number of engine cylinders for hybrid vehicles; reduction in the number of engine cylinders and the use of superchargers for downsized turbocharged vehicles; difficult machining and assembly complication for clean diesel vehicles; and elimination of machining and social infrastructure development for electric vehicles.

We have discussed service ecosystem model rotation, revolution, generation, and regulation with respect to value orchestration of MTT companies and have considered a cyclic repetition strategy and indicated stage response prescriptions from a design information transmission theory perspective. We have visualized a value co-creation model for typical service industries and while introducing a dynamic model have indicated a cyclic transmission strategy and prescriptions for revolution stage analysis. We have confirmed that prescription implementation using a complex systems model is effective in the business of trading companies.

Chapter 5. Discussion: Management and systems science

5.1 Translational systems science

Business managers strive day and night to practice good management. This is true of global corporations and small businesses alike. Managers are keenly attuned to success stories and also eager to apply them to their own companies. However, because of time constraints, managers expect application of theories at workplaces "as is" with no modification and not infrequently cause confusion in workplace decision-making. A unified scientific framework for management theory is necessary. "Translational systems science", a new trend in systems science, may be considered effective.

"Translational research" primarily translates promising basic research in the medical field to diagnosis and treatment on the front lines of medicine through clinical research (bedside to bench). It simultaneously seeks to increase the efficiency of all production technology, including pharmaceuticals and medical equipment development. It analyzes *a priori* objective theoretical social approval and *ex post facto* efficacy, safety, and economy. Owing to human heterogeneity and polymorphism, translation not only in the basic to clinical direction but also in the reverse clinical to basic direction becomes necessary. Thus, translation is a bidirectional process. A promotion program of the Ministry of Education, Culture, Sports, Science and Technology is a permanent program conducted since 2004. Its current embodiment, the Translational Research Network Program, is emphasizing networking and aspires to develop personnel to achieve shortening of development lead times.

Translational systems science engages in broader translation based on three-dimensional systems thinking (Figure 35)(K. Kijima 2014). The three axes are episteme (Z-axis), techne (Y-axis), and phronesis (X-axis). Each axis requires deep understanding through systems thinking originating in the *Nicomachean Ethics* (Table 7). One conceivable concrete example of this might involve translation of systems concepts (Z), systems methodologies (Y), and systems practice (X). Systems concepts may be replaced with systems models or systems theories. The approach is characterized by a three-dimensional bird's-eye view of the bidirectional translation of each axis.

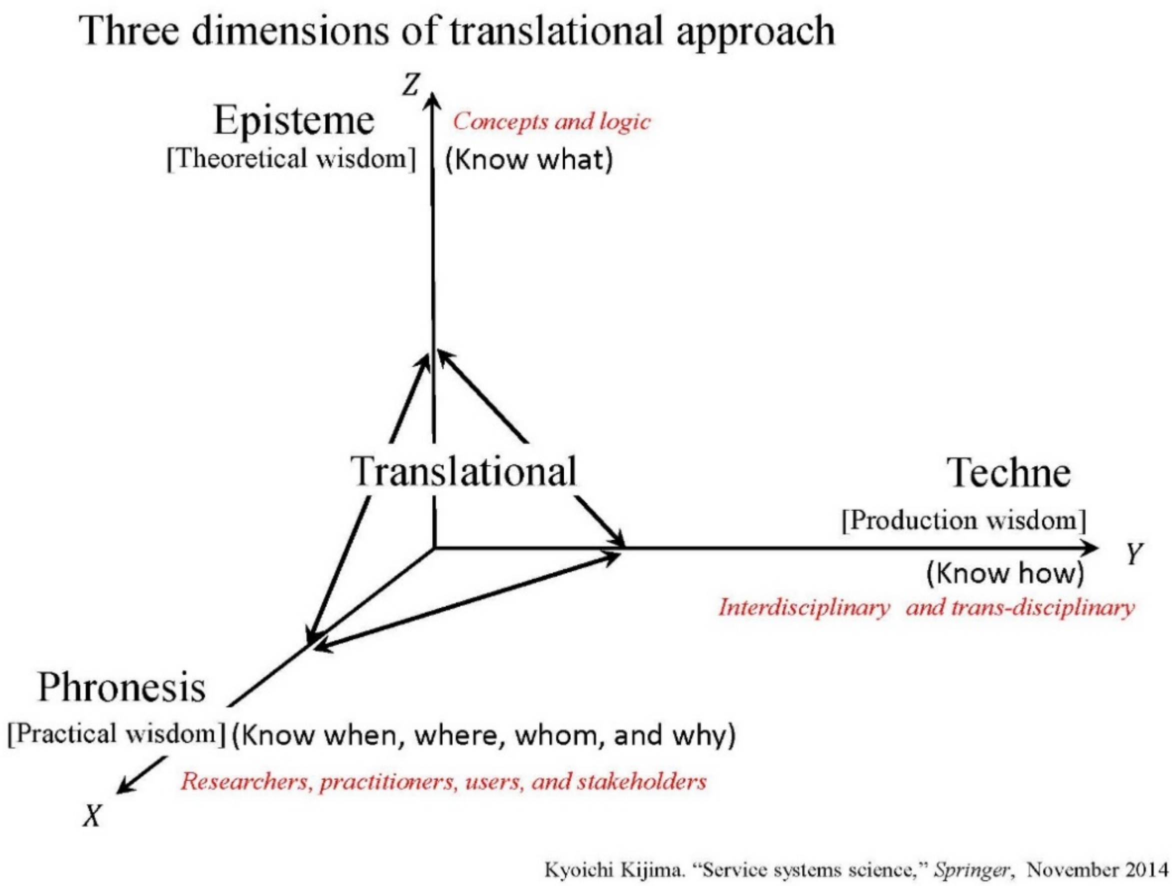


Figure 35 The three-dimensional approach of the translational systems science (Kijima 2014)

Table 7 Episteme, techne, and phronesis

Episteme, techne, phronesis as primary intellectual virtues				
I. Thinking in general				
1	primary intellectual virtues *Nicomachean Ethics*	Episteme (Theoretical wisdom)	Techne (Production wisdom)	Phronesis (Practical wisdom)
2	Tacit/Explicit knowledge	Explicit knowledge (objective knowledge)	Tacit knowledge (practical knowledge)	Tacit knowledge (residing in virtuous artisans)
3	Activity	Theoria [Theory]	Poiesis [Production]	Praxis [Practice]
4	Pursuit	Generalization to reveal universal truth	Instrumental rationality toward a conscious goal	Values in practice based on judgement and experience
5	Nature	Universal	Inter/trans-disciplinary	Pragmatic
6	Colloquial description	Know what	Know how	Know when, where, whom, why
7	Translation	Science	Art (Craft)	Prudence
8	Interpretation	Epistemology	Technique, Skill	Common sense, ethics
9	Meta/physical	Metaphysical	Physical	Metaphysical
10	Type of virtue	Analytic scientific knowledge	Technical knowledge	Action
11	Orientation	Research	Production	Action
12	In time and space	Invariable	variable	variable
13	Context	independent	dependent	dependent
II. Systems thinking				
1	Categories of systems thinking	Systems models/theories (e.g., living systems theory, open systems theory)	Systems methodologies (e.g., hard systems approach, soft systems approach)	Systems practice (e.g., action research, structured dialogic design)

Author correction partial change from Kyoichi Kijima. "Service systems science," *Springer*, November 2014

5.2 Management theories in translational systems science perspective

Here, we show that the framework of translational systems science provides a unified understanding of management theories. We attempt to provide a unified overview that extends to management philosophy, engineering personnel development, production site productivity improvement, and organizational capability in manufacturing. Incidentally, phronesis (X-axis) has spread to multiple managers through the activities of the Mitsubishi Research Institute, Fujitsu Research Institute, Honda Foundation, and other organizations.

Firstly, we take up the “Inamori’s Kyocera management philosophy” as a management philosophy. Kyocera founder Kazuo Inamori is currently considered Japan’s most influential business manager. Inamori also founded KDDI (au) and has succeeded in the rehabilitation of Japan Airlines (JAL). Aside from his corporate management work, as head of Seiwajyuku, he mentors more than 10,000 managers worldwide. Here we focus on his “formula of life (work)”, expressed as follows:

Result of Life or Work = Ability × Effort × Attitude (Kyocera corp. website 2015)

The Result is the product of three capabilities. These are Ability, construed as mental, Effort, construed as as physical, and Attitude construed as spiritual (K. Inamori 2004). Ability corresponds to the Z-axis, Effort to the Y-axis, and Attitude to the X-axis. Here, we define the value function $V(x, y, z)$ as zyx (the Cobb–Douglas production function). Since value V is expressed using a cuboid, we call it the Translational Cuboid (Table 8).

Table 8 Translational cuboid

"Translational Cuboid"

as translational value function

Translational Service System Model	"Translational Cuboid" is defined to be the form of the Cobb-Douglas production function as translational value function: $V(x, y, z) = zyx$ z: *Episteme*, y: *Techne*, x: *Phronesis*; ◆ Cobb–Douglas production function $\tilde{u}\ (x) = \prod_{i=1}^{L} x_i^{\lambda_i}$, $x=(x_1 \cdots, x_L)$: subject to $L=3$, $\lambda_i=1$)

Since the values of Ability (z) and Effort (y) range from 0 to 100 and the value of Attitude (x) ranges from −100 to 100 (K. Inamori 2014), the cuboid is as shown below (Figure 36)

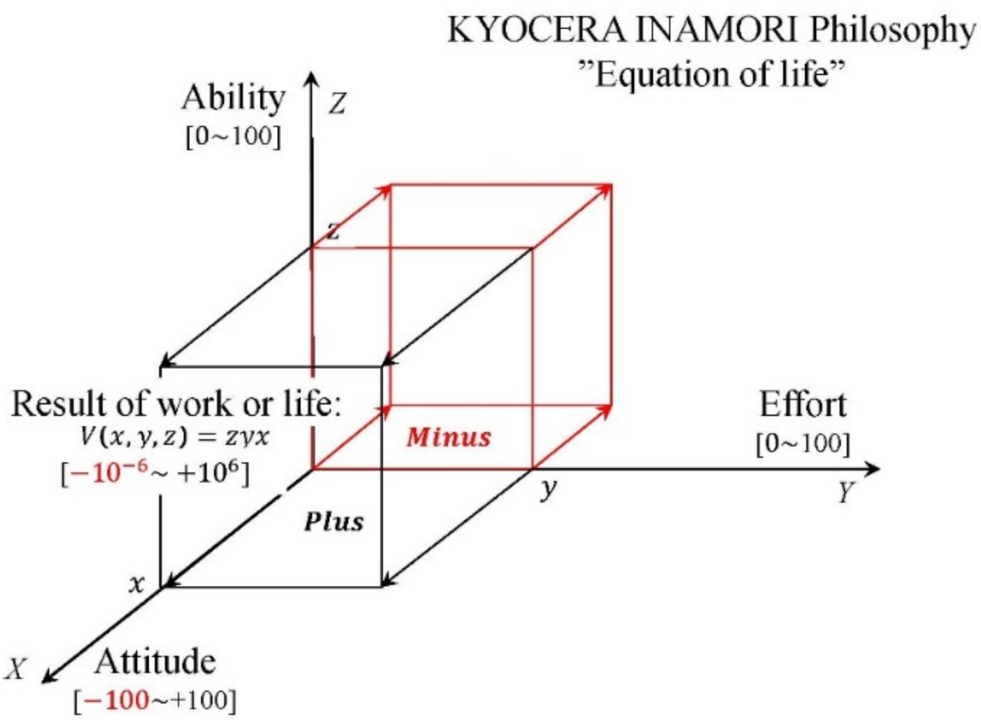
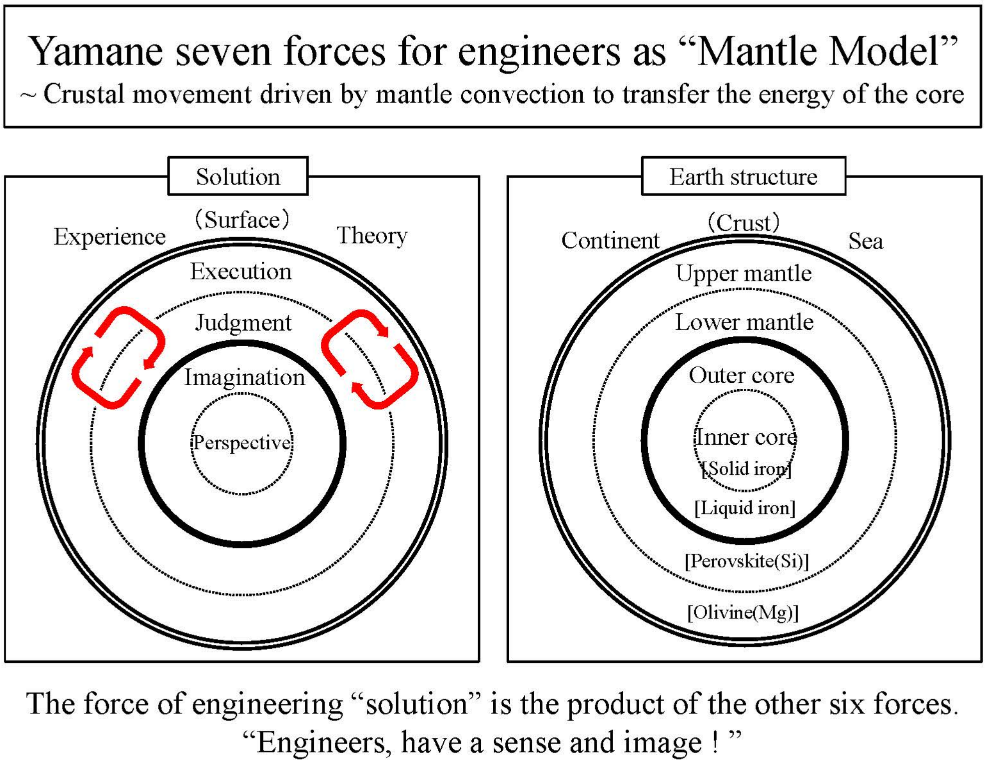


Figure 36 Inamori's Kyocera management philosophy

Even if Ability is slightly inferior, provided exceptional Effort is made, the result V (the result of life or work) has a high value. No matter how high Ability and Effort may be, if Attitude is wrong, the result is negative. The direction of life is on a straight line from positive to negative, and positive/negative in Attitude influences the direction (K. Inamori 2014). In light of this, hereafter we set the range of variables as follows: z, y, x are real numbers, $y \geq 0$, and $z \geq 0$. Long before the birth of translational systems science, Inamori foresaw the difficulty of phronesis and defined x as positive/negative.

Secondly, we consider ability, focusing on human resource development. Seven abilities required of engineers have been suggested in the field of mechanical engineering. The problem-solving ability required of engineers is defined as a percentage of correct answers. Problem-solving ability is expressed as the product of six abilities: Imagination, Perspective, Theory, Experience, Execution, and Judgement. This product is similar to that referred to above. It is called the Yamane seven-force mantle model and is expressed using a model of the Earth's interior structure (Y. Yamane 2015) (Figure 37)(Table 9).



Yasuo Yamane, “Japanese human resource development for Japanese *“Monozukuri”* manufacturing”, *NIKKAN KOGYO SHIMBUN,LTD.* February 20, 2015

Figure 37 Yamane seven forces mantle model

Table 9 Yamane seven forces mantle model

Yamane seven forces as "mantle model"
~ Multi-layered structure of the Earth that shape engineering solution

№	Force	Definition	Model		Feature
1	Theory	Comprehension & application of theory.	Sea	**Crust**	Basic Capability and applied to the sequential analysis.
2	Experience	Accumulation & utilization of experience.	continent		
3	Execution	Implementation of the optimal answer found.	Upper	**Mantle**	Need for courage & strict discipline. These two mantle forces convey the core's energy as a driving source of continental drift.
4	Judgement	Finding the optimal answer and sense of responsibility for it.	Lower		
5	Imagination	Imagination on the structure (of artifacts, theory and formulas, story and concept).	Outer	**Core**	Natural talent, the personality influences considerably, is necessary and applied to the inverse analysis, reverse engineering or feedback. To build an image while exporting the block diagram specifically, we will be able to develop our own natural talent.
6	Perspective	Elucidation of the true nature of the phenomenon and the relationship of various factors with insight.	Inner		
7	Solution	Validity	Earth		Integrated multi-layer capability to discover solution and to create goal & objective evolving into challenge new target. Solution is represented by the product of above 6 forces multiplication.

The author summarized and wrote this table from the following source description.
Yasuo Yamane, "Japanese human resource development for Japanese *"Monozukuri"* manufacturing", *NIKKAN KOGYO SHIMBUN,LTD.* February 20, 2015

Since Imagination and Perspective, subsisting in the Earth's core, are scientific epistemological explicit knowledge, they are episteme (Z). Imagination is the ability to construct images based on theory, stories, or concepts. Perspective is the ability to elucidate the true nature of phenomena and analyze causal relationships. Both are effective in inverse analysis of phenomena. Since Theory and Experience, which appear on the surface as the Earth's crust, are material tacit knowledge that creates things, they are techne (Y). Mantle convection transmits energy from the core to the crust and realizes tangible things. As the Earth's mantle, Execution is the ability to implement answers, and Judgement is the ability to find answers and a sense of responsibility for the answers. These two abilities, which require courage and suitable training to acquire, are phronesis (X). Imagination × Perspective = z, Theory × Experience = y, and Execution × Judgement = x (Figure 38).

$V(x, y, z) = \mathrm{zyx}$

= (Imagination × Perspective) × (Theory × Experience) × (Execution × Judgement)
As is the case with the Kyocera management philosophy, problem-solving ability is expressed as the product of three factors.

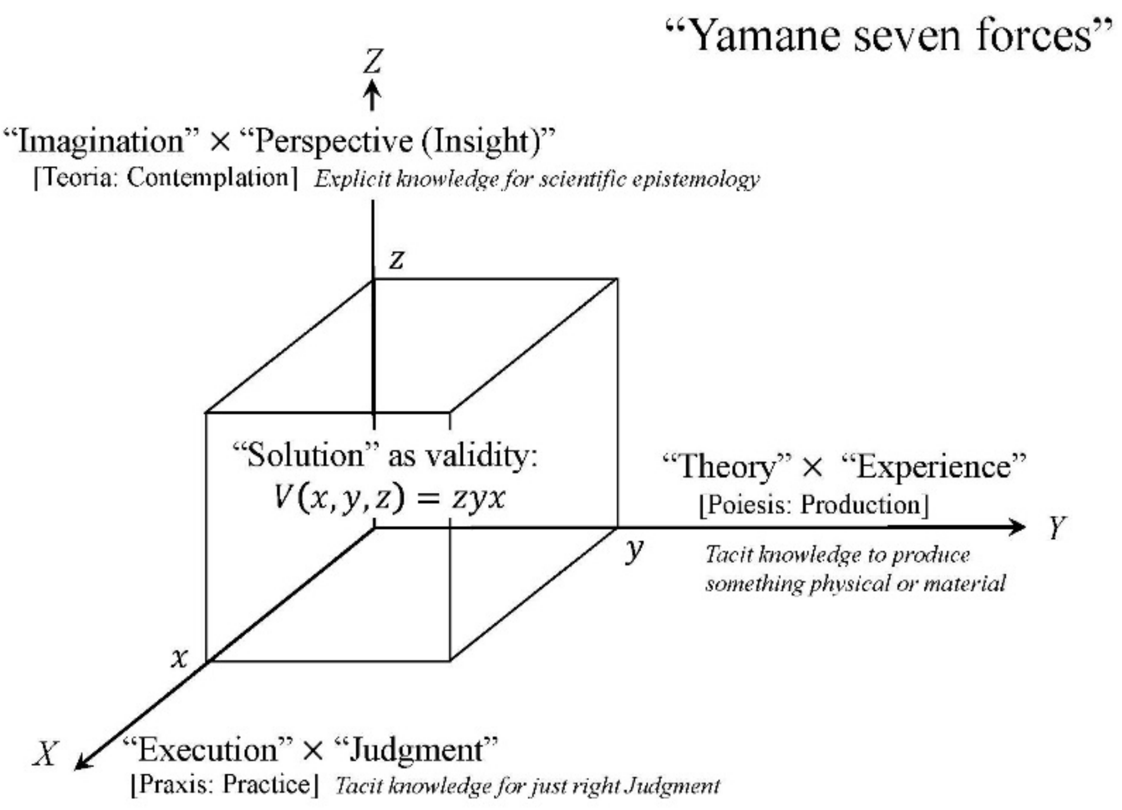


Figure 38 Yamane seven forces

Let us discuss the three translations among the axes. Firstly, we apply the SECI model (I. Nonaka2014) to translation between episteme (Z) and techne (Y) (Figure 39). Individuals externalize tacit knowledge subsisting in a company as explicit knowledge. This knowledge is combined and systematized, and individuals internalize it. The knowledge is socialized and shared within the company as tacit knowledge. This process is cyclically repeated, and knowledge is made to rise in an upward spiral. In the positive YZ quadrant, $x1 \times z1 < x2 \times z2$ (Figure 40).

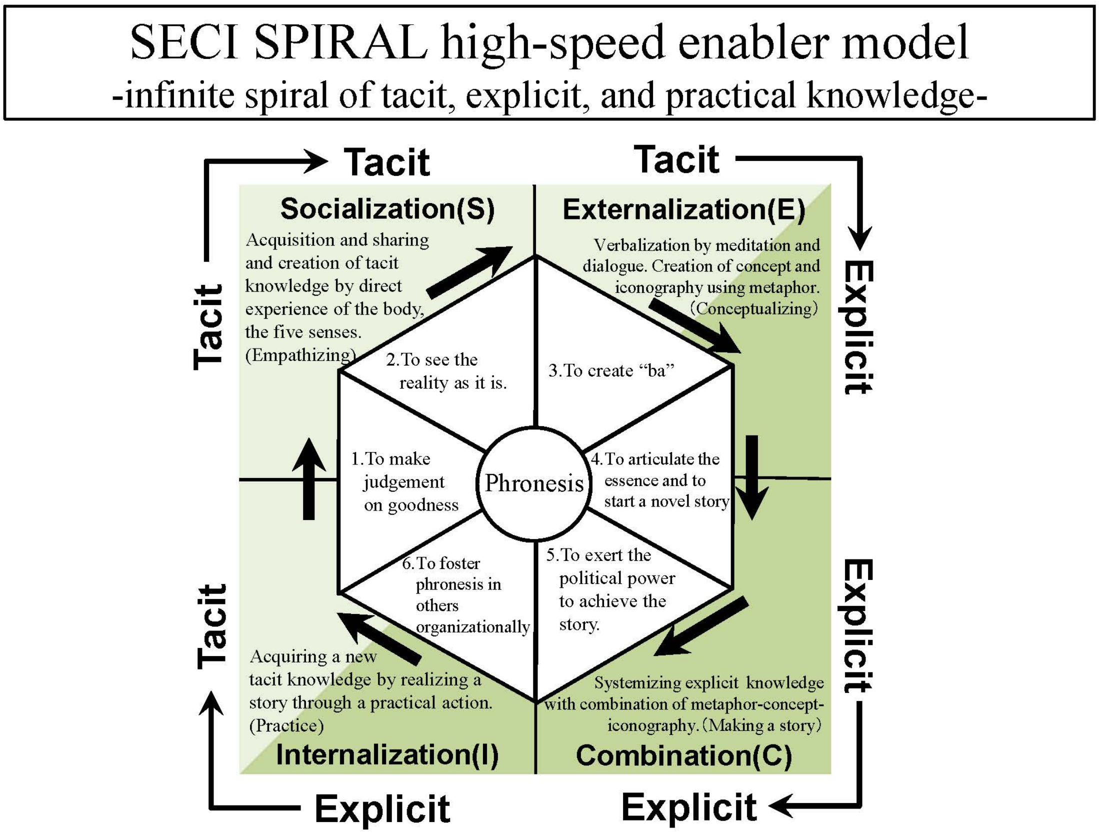


Figure 39　SECI model (I. Nonaka 2014)

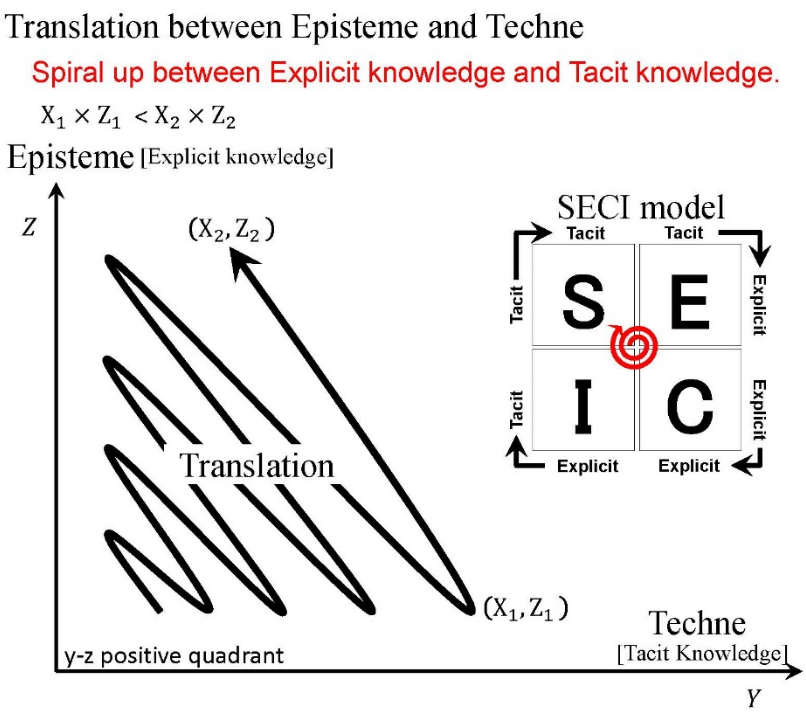


Figure 40　Translation between episteme and techne

We consider a similar method for translation between episteme (Z) and phronesis (X). Since phronesis (X) takes both positive and negative values, it is not necessarily valid. A precondition in the SECI model is that all stakeholders aspire to the common good. Phronesis can be considered to always have a positive value. In translation in which common good is not mentioned, SECI between the X- and Z-axes is invalid.

The SECI model is unsuitable for translation between techne (Y) and phronesis (X), since both are tacit knowledge. Let us focus attention on the fact that at the center of the most recent version of latest SECI model, a cycle of six abilities of phronesis has been proposed (Figure 39). Three types of translation to phronesis are conceivable: (1) techne → phronesis, (2) techne → episteme → phronesis, and (3) independent expansion of phronesis. One of these types can be supposed to subsist. We approach the phronesis six-abilities cycle from the perspective of the Yamane seven forces and visualization of the value orchestration platform (Table 10).

Table 10 Phronesis six abilities

Cycle of "Phronesis six abilities"

Approach from "YAMANE Seven Force" and "Value Orchestration Platform"

№	Nonaka leadership cycle	Interpretation	YAMANE Seven Force		Value Orchestration Platform
	"Phronesis six abilities"		Force	Dimension	Specific strategies
definition	Phronesis is virtuous habit of making judgements and taking actions that serve the common good.	Judgement and actions as common good	Judgement and Execution	Phronesis	"CSR business ethics strategy" as Quration
1	Ability to make judgement on goodness for setting a goal.	Judgement on goodness	Judgement	Phronesis	"CSR business ethics strategy"
2	Ability to see the reality as it is.	Obedient perspective without bias	Imagination on the structure	Episteme	Visualization strategy such as "Internal model fish-bone strategy"
3	Ability to create "ba".	Platform development	Experience	Techne	Development of platform based on "involvement strategy"
4	Ability to articulate the essence and to start a novel story.	Elucidation of the true nature to start a novel story	Perspective as insight	Episteme	"Orchestrator strategy," "objective-function identification strategy," and "relation matrix strategy"
5	Ability to exercise political power to achieve the story	Political execution of story	Execution	Phronesis	To take Involvement strategy and empowerment strategy on VO Platform. To apply Cynefin framework in accordance with an aspect in service ecosystem.
6	Ability to foster Phronesis in others organizationally	Organizational implementation			

"1. Ability to make judgement on goodness for setting a goal" is the setting of a good goal and its pursuit. The courage and sense of responsibility to implement answers in Yamane seven forces underpin this. In value orchestration, this corresponds to a corporate social responsibility (CSR) strategy. In the Inamori's Kyocera management philosophy "Is my motive virtuous or selfish?" is said to have been Inamori's frame of mind at the time of the founding of DDI (the former KDDI). "2. Ability to see the reality as it is" corresponds to the reverse engineering force in the Yamane model and the internal model fishbone strategy in value co-creation. *Ba* in "3. Ability to create *ba*" can be thought of as a platform. "4. Ability to articulate the essence and to start a novel story" is perspective in the Yamane model. Mediation in the value orchestration platform model orchestrator strategy corresponds to this. Execution in the Yamane model corresponds to "5. Ability to exercise political power to achieve the story" and "6. Ability to foster phronesis in others organizationally." In value orchestration, involvement strategy and empowerment strategy must comprehensively correspond. Political power can be addressed using service ecosystem stage analysis and the Cynefin framework. However, organization poses difficulties. The above approach shows that three abilities, half of the abilities in the cycle of phronesis six abilities, are episteme and techne. It is possible to apply a visualization strategy to episteme. *Ba* is the platform itself. The orchestrator strategy corresponds to making a story. Highly experienced sales representatives coach young sales representatives to "become a professional storyteller". An advanced human resource development program by which sales representatives are not alienated by being treated as no more than intermediate exploiters of both customers and providers but are rather given a responsible role as living witnesses of business dealings is required. The remaining three phronesis abilities are common good, political power, and organizational theory. CSR corresponds to common good. The doubt that top executives are involved in Toshiba's inappropriate accounting problem in the fiscal year ended March 2014 has been reported in the media. The existence of corporate psychopaths was foreseen, and the danger of a single individual suddenly leading a company that had operated stably for many years to its destruction was pointed out in 2011. Psychopaths more often exist in upper levels of companies than in lower levels (Clive R. Boddy, 2011). Development of organizational theory requires consideration of the decision-making process of organizations that overcome the bounded rationality of actors (H. A. Simon 1993).

Thirdly, we consider production technology competitiveness *V* in production sites (Table 11). Production technology is divided into technology, which is explicit knowledge, and skills, which are tacit knowledge (Kazuo Mori 2005). Episteme (Z) is combinational modular technology, and techne (Y) is the production technology competitiveness of production sites, which is an integral skill. The modular customization strategy in Chapter 3 is ZY translation itself. The design information transmission ability of production sites consists of accuracy and density improvement capability and design involvement force. *Kaizen* is the former, and co-design strategy and "frontloading" are the latter. Phronesis (X) is said to be tacit knowledge that resides in virtuous artisans (I. Nonaka 2008). It subsists in workplace technicians.

Phronesis is tacit knowledge expressed as common good, philosophy, spirit, attitude, government, organization, and story. Phronesis determines whether production technology competitiveness V is positive or negative. Production site phronesis can be considered a production philosophy that supports *kaizen* and "frontloading" (Figure 41).

Table 11 Production technology, integral skills and philosophy

Production technology competitiveness of Japanese production sites

Value function	Production technology competitiveness: $V(x,y,z) = zyx$		
Axis	z	y	x
Common name	Modular technology (Production technology design force)	Integral skills	Production philosophy
Primary intellectual virtue	Episteme (Theoretical wisdom)	Techne (Production wisdom)	Pronesis (Practical wisdom)
Architecture of design information	Modular	Integral	Integral
Tacit / explicit	Explicit knowledge	Tacit knowledge	Tacit knowledge but action
Reflection to design	Possible reflect	Impossible reflect	Expected to "co-design"
Individual-dependence	Individual-independent	Individual-dependent	Individual-dependent
Universality	Universal	Variable (disappearance)	Variable(time or space)
Visualization	Visualization Possible	Visualization impossible	Visualization difficult
Interpretation	Theory (cognitive language, document, formula, program)	Experience, intuition (sense), courage, tips (know-how)	Practice, ethics, adaptation and response to environment
Analogy	Digital	Analogue	Philosophy
Execution	Sequential (Step-by-step)	All-at-once (Moment art, Virtuosity)	Iterative (Cyclic)
Property	Rational	Intuitive	Practical
Issue	Skill inheritance through technology conversion		Human resource development of virtuous artisan

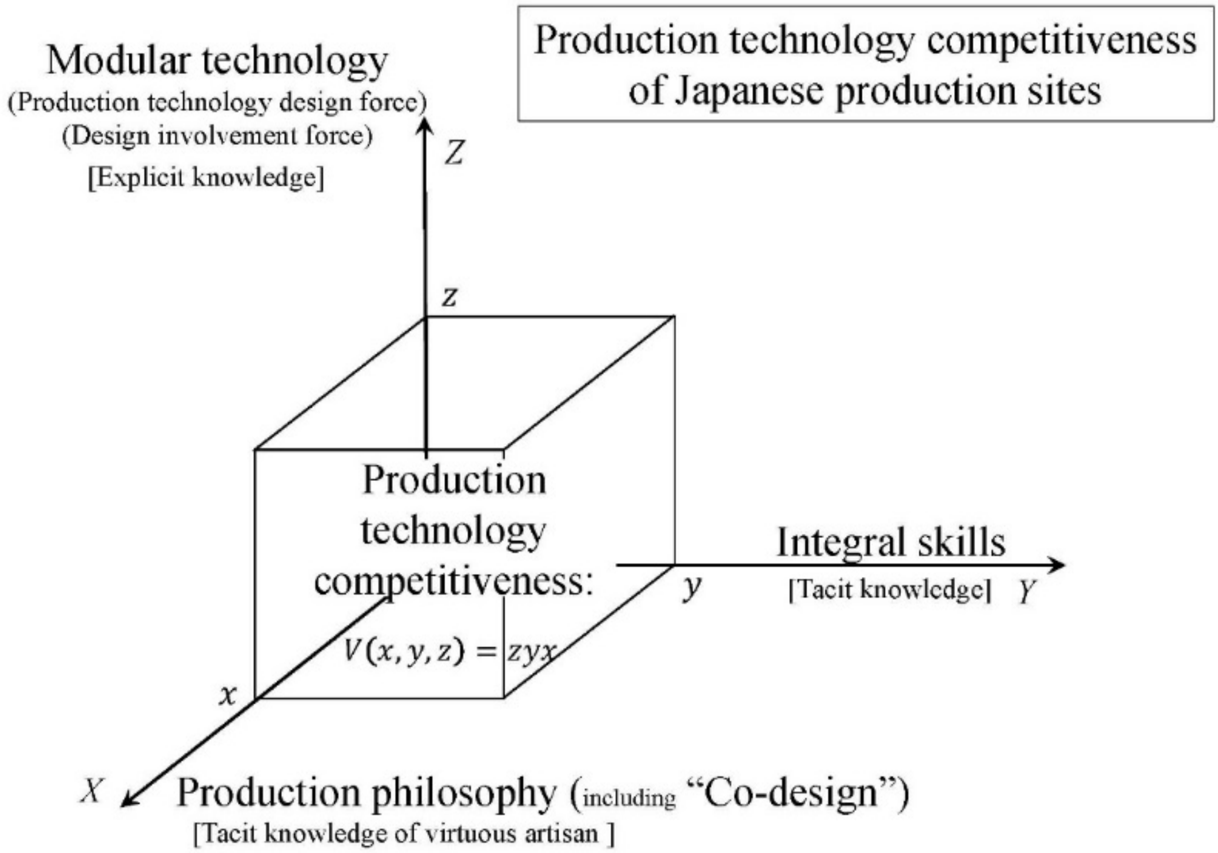


Figure 41 Three dimensional production technology

Fourthly, we focus on organizational capability in manufacturing (figure 41). In design information transmission theory, "The essence of manufacturing is creation and transmission of design information." Organizational capability in manufacturing is defined as "a company's unique ability to skillfully create product design information that attracts and satisfies customers and to skillfully transmit it to a medium" (T. Fujimoto 2003). Creation of design information is design itself, which renders production technology, a form of transmission technology, into explicit knowledge. Episteme (Z) (explicit knowledge) is both design force and production technology design force. We call the remaining integral transmission ability, which cannot be visualized, production skills force. It is a source of Japan's competitiveness. Since design philosophy is an organizational capability, we take it as phronesis. Judgement based on correct design philosophy X, which depends on context, leaves a good production site Y, and releases good drawings Z.

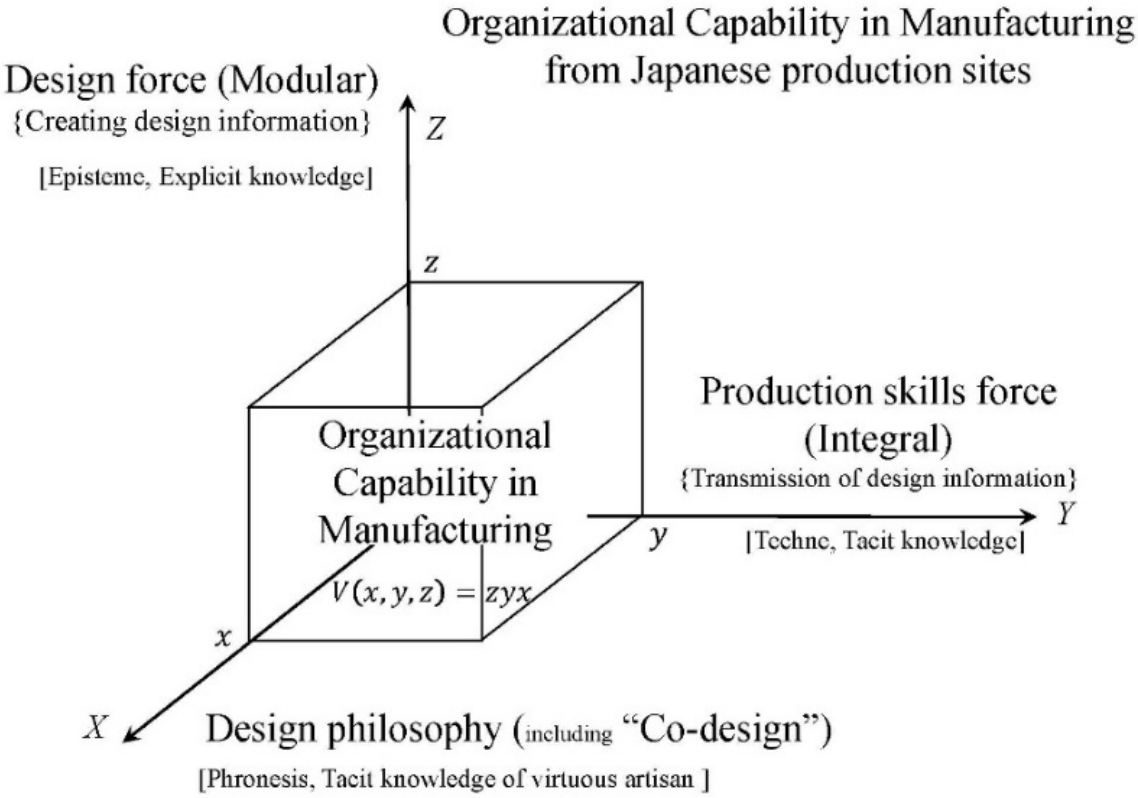


Figure 42 Organizational capability of manufacturing

Fifthly and lastly, we discuss MTT company co-created value as a value orchestration platform. Adopting a similar approach to the one used for organizational capability in manufacturing, we consider episteme (Z) to be service design force, techne (Y) to be service transmission force, and phronesis (X) to be service design philosophy (Figure 43). This is because according to "open manufacturing", the difference is only a difference in medium. Episteme is design force for trading companies as well. Even now, there has not been recognition that service design is necessary for trading companies. However, the strategies and prescriptions devised using the value orchestration platform and Hierarchical Model of Service Ecosystems Innovation (HMSEI) that we have discussed heretofore are nothing other than service design.

The new concept of service design information transmission to intangible ephemeral media and deviation feedback measurement is important. Here, we mention True Service, Panasonic's service philosophy. "Service is an integral part of any business. A business that does not provide service is no business at all. Service, therefore, is the duty and obligation of any business person. But there's nothing more aggravating than service provided only out of a sense of duty. Customers can sense it. Service means satisfying customers, and when we satisfy our customers, we in turn find satisfaction in a job well done. Satisfied customers and satisfied employees: This is what constitutes true service." (K. Matsushita 1967) From this we can confirm that the proposition "Service is the basis of all exchange" was already being asserted and the notion of instantaneous positive feedback existed fifty years ago. Konosuke Matsushita described the ultimate form of service exchange.

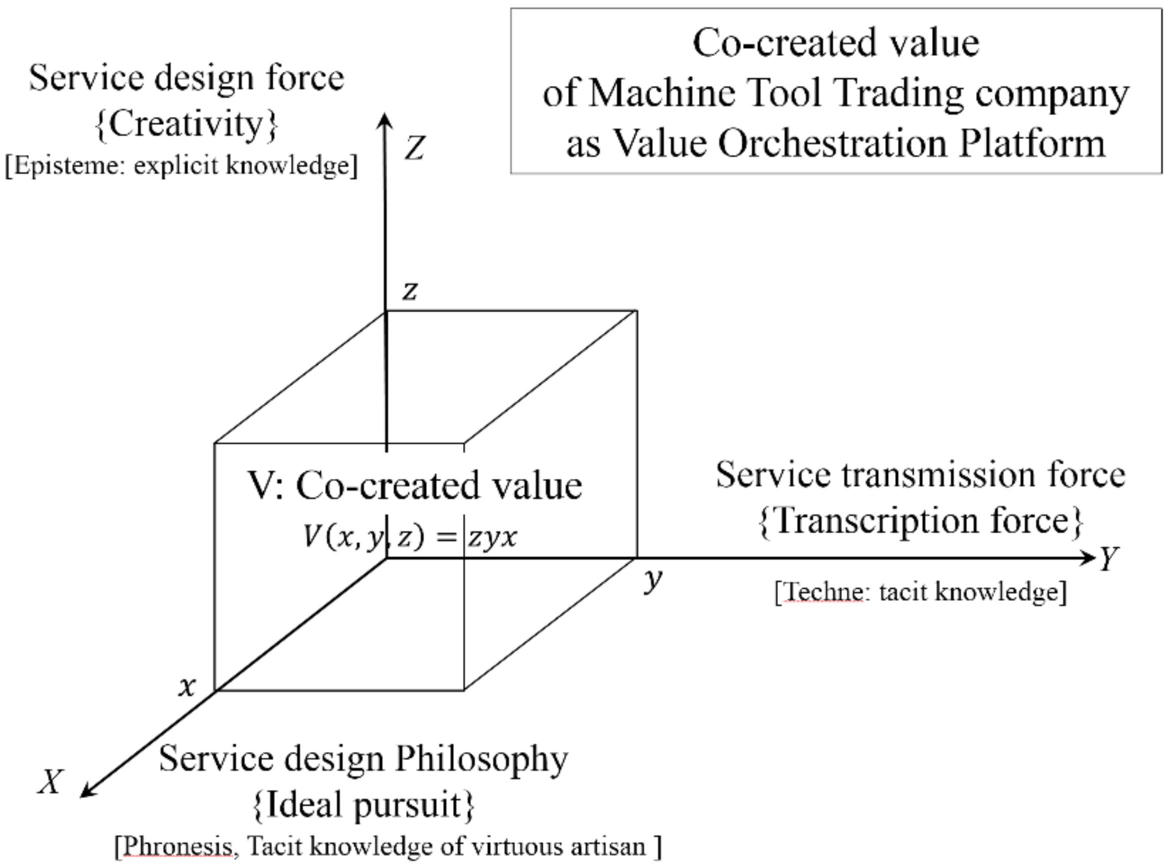


Figure 43 Co-created value of MTT as value orchestration platform

We have considered five three-dimensional approaches based on translational system science. They provide a consistent overview of management philosophy, human resource development, production site competitiveness, Japan’s organizational capability in manufacturing, and face-to-face selling of MTT companies, which are typical service industries. Value resides in design information. Translation between techne (Y) and episteme (Z) is cyclically repeated, and episteme (Z) is elevated to design information and visualized. Cyclic repetition of translation between techne and episteme clarifies phronesis (X) and facilitates consideration of its direction.

Chapter 6. Conclusion and further research

6.1 Summary

After "Introduction" and "Literature Survey", Chapter 3 "Productization of Machine Tool Trading (MTT) Companies" considered servitization by means of a service industry productization strategy. Production technology was treated from the perspective of the design information transmission theory "architecture of design information". By using the value orchestration platform model as a reference framework, we derived strategies and prescriptions through an approach involving four-phase value co-creation and three strategies. Seven quality control (QC) tools were also invoked as a means of transmitting production technology to machine tools with attached peripheral equipment.

Each of these strategies is servitization strategy that places emphasis on networking and resource integration. Trading companies mediate the trading of goods. The strategy was characterized by mediation, the orchestrator strategy in the co-elevation phase limited to two stakeholders. Even if a trading company is connected to stakeholders in the background that differ each time, trading is continuous, as if the customer has a single provider. This is a modular strategy.

The platform's historical memory is important. The same is true in cases where a trading company acts as a customer, not a provider. In co-development, we indicated the relation-matrix strategy, which attempts to continuously coordinate multiple stakeholders and elevate value all at once. Pinpointing supports the platform's integration capability. This is an integral strategy.

The value orchestration strategy was devised as a servitization- productization roadmap. It is a rational, static, linear guideline. It has been pointed out that "Manufacturing is an activity that creates an accurate, smooth flow of design information toward the customer" (Fujimoto 2007). Smoothly engaging in transmission of production technology based on a roadmap is ideal.

Chapter 4 "Servitization of Machine Tool Trading (MTT) Companies" considered servitization by means of a service industry servitization strategy. Based on the design information transmission theory "open manufacturing" and Hierarchical Model of Service Ecosystems Innovation (HMSEI) was developed, and then adaptive transition and phase transition were discussed.

That is a servitization strategy that emphasizes the service exchange process. It is the transmission to an unstable medium that does not go through a tangible artifact. We adopt a strategy of cyclical repetition with the objective of countering instantaneous decaying and perishing of design information and engaging in QC through feedback measurement of deviation from prior expected value. This is rotation. The model determines adaptive transition by discriminating service exchanges that become the signals that we considered in value co-creation.

We devised prescriptions by applying the Cynefin framework according to adaptive transition. Then phase transition is type transition. In the co-design strategy, we use Ito's co-design or Toyota's "frontloading". A framework of regulation and generation between the micro-, meso-, and macro-levels in society suggests the importance of gathering information not only concerning production technology but also concerning global society and culture and social settings.

Since MTT companies fulfill the four roles of service industry, manufacturing industry, customer, and platform, they were effective as a subject of unified servitization research. Both productization and servitization are integrated in the rotation model, which is a definition of servitization.

Chapter 5 "Discussion" attempted an approach to management in general based on service science. The three-dimensional approach of the translational systems science was shown to be effective. In addition, it provides a unified framework extending from management to MTT company value orchestration. In any field, elevating *episteme* to design information is important. Through an upward spiral from visualization of *techne*, we three-dimensionally classified each type of knowledge. Finally, we examined *phronesis*, the remaining knowledge type, and determined whether it really is mired in philosophical–ethical difficulty.

We have applied value orchestration strategies and prescriptions and HMSEI stage response to practical business, and have confirmed their effectiveness. A scientific framework has led to an increase in the rate of negotiation and contracting, and our trading company have been able to increase its order volume. Finally, it is shown in the table on the direction and progress of the generalization of servitization in this thesis (Table 12).

Table 12 Direction of servitization

Direction of Servitization								Further research
Category			Old-fashioned Service	Productization	Servitization in a broad sense	Servitization in a narrow sense	Conventional Japanese Manufacturing	Six primary industrialization
Sector			Tertiary				Secondary	Primary
Industry			Service Developed →		Generalized	← Previous	Manufacturing	Agriculture, forestry and fisheries
Orientation			Goods	Processes	Service system	Product-Service	Goods	Nature
Focused on design information	Medium		Human: Intangible and ephemeral	Goods: Tangible and durable	Intangible and ephemeral	Human: Intangible and ephemeral	Goods: Tangible and durable	Natural products
Focused on design information	Transmission		In-exchange (Transmission2)	Emergence on the platform	In-context (Face-to-face selling)	In-use (Transmission3)	Flow in factories (transmission1)	On earth
Model			Static	Static	Dynamic	Static	Static	Static
Model			ex. Five forces or Resource Based View	Value Orchestration Platform	Hierarchical Model of Service Ecosystem Innovation (HMSEI)	ex. Power by the Hour (Jet engine)	TOYOTA lean production	Value Orchestration Platform
Strategies	Rotation	Network -ing	Experience, intuition and courage	Involvement		Finance leasing affiliates	SCM	Involvement
Strategies	Rotation	Resource integration		Empowerment and Quration		Customization with product options (BTO)	Simultaneous Engineering	Empowerment and Quration
Strategies	Rotation	Service exchange		Matching	Design information transmission and Measurement of feedback deviation	Bundles of combination of products and after sales service	QC and IE	Matching
Strategies	"Revolution" and "Phase transition"		Big ears	Co-design for type transition	Cynefin	Institutional innovation	Front-loading	Panarchy

Rightmost column of the table is a traditional strategy of Japanese manufacturing (monozukuri) corresponding to TOYOTA lean production system to raise the accuracy and density of the transmission to the tangible durable medium in factories. Then in one of the left column, it has been studied conventionally as the sevitization in a narrow sense to convert the media from tangible- durable to intangible-ephemeral where “value in use” is emphasized. Power By the Hour is the typical example. From the right column of the manufacturing industry traditional servitisation has been approached to left. On the other hand the leftmost column is the traditional service industry corresponding to face-to-face selling business as trading companies where medium is the intangible ephemeral as customers. In this thesis servitizasion approaches to right. In chapter 3 we convert the media to tangible-durable machine tool with peripheral equipment and discussed productization as a strategy of servitization from trading company from opposite direction to servitization from in a narrow sense where design information is production technology. We introduce value orchestration platform model and describe prescriptions to emergence of it. Then we convert the media to intangible-ephemeral as customer and develop HMESI to oppose to the perishability of design information. We discuss the sevitization in a broad sense to describe cyclic repetition of design information transmission and prescriptions of adaptive transition. Because servitization is the provision of services through value co-creation, both of them are integrated into the "rotation" of HMSEI.

6.2 Conclusion

In this thesis there is geopolitics of manufacturing in design information transmission theory where Japan has excelled in the production of integral products. We showed the modular customizing strategy that is conversion from integral skills of baby boomers artisan to modular production technology to produce integral products as a Japanese manufacturing (*monozukuri*) revival strategy.

We have achieved the two purposes of this thesis in the following way. For analyzing and describing machine tool trading (MTT) companies from service systems science perspective, we introduced the value orchestration platform model and developed Hierarchical Model of Service Ecosystems Innovation (HMSEI) model as frameworks. The former is static and the latter is dynamic. Then, we proposed some unified servitization and productization strategies for MTT companies to become one of the crucial players contributing to Japanese manufacturing revival. Value orchestration platform model described productization strategies, while HMSEI proposed servitization strategies. Furthermore, based on the author's business experiences, the validity of two models is confirmed. We now claim theories of service systems science are effective in practice.

We develop "PDCA-PDP Chart" (Table13) and "Weekly PDCA Chart" (table14) for validation of our model and prescriptions. PDCA-PDP Chart is PDPC (Process Decision Program Chart) turning PDCA cycle based on QC perspective. In one of the business it links all progress of strategies together. The other hand Weekly PDCA Chart turns the cycle of PDCA in individual strategy. We have to file these charts with serial number one by one for share and accumulation of our knowledge.

Vertical axis of PDCA-PDP Chart shows all fourteen species of prescriptions. Horizontal axis as PDCA contains that Prior state (conditions before implementation of prescriptions) Plan (Program prepared by Sales Representative (SR)) → Do (Execution contents by SR) → Check (Evaluation: Comments by SR, Customer (CT) or Manager) → Action (Improvement; Kaizen: Proposal for improvement by SR, CT or Manager) →Actual Improvement of this model or prescriptions.

We use Weekly PDCA Chart with business diary turning the cycle twice on the A4 format.

These charts are examples of a metal mold manufacturer inquiring multi-piece production by new U-axis composite processing machine. In this case two facts have been revealed. One is that the fish-bone has to be shown partially because the whole of fish-bone is too complicated for ordinary customers. Another is that signals list for stage transition will be updated each stratified customer. Since the customer of a long trading period seems to neglect “participation” due to its cost, we have to pay attention to “Estimate/ verification.” Just because there was no signal of participation, not the stage of complex as emergence of technology is over. Loyal customers that trust us expects our potential for production technology as usual.

In this way we improve our model and adjust each prescription turning PDCA cycle with both Charts for its validation.

Table 13 PDCA-PDP Chart

Goda-Kijima Service system model

【PDCA-PDP Chart】 for Models Validation

09-Jan-16 [SR: A. Anzai]

【Customer】SK Metal-Mold ***【Theme】Improvement of the finishing quality of surfaces for multi-piece metal mold processing*** ***Serial № X1***

Model	Strategies	Process	№	Strategies (for value orchestration platform or HMSEI)		Prior state (Status) Sales Representative	Plan→ (Program) Sales Representative	Do→ (Execution) Sales Representative	Check→ (Evaluation) Customer or Sales Representative			Action→ (Improvement (Kaizen)) Manager or Customer or Sales Representative			Models improvement (Inspection)
Value Orchestration Platform model	Involvement	co-experience	1	Matching (Ribbon Chart)	We have to increase the number of inquiring customers and promoting providers on platform	We use to visit the customer with the provider who happens to accompany on our sales.	I checked the latest product information and pick up customers to visit.	I visit this customer with the provider of semi-finish high-speed end mill cutter which seems to be needed.	Customer	×	This time he knew the product information well, but the provider didn't have the program we need.	Manager	Kaizen	During matching period we need to coordinate stakeholders with our "fish-bone internal model diagram".	-
									SR	×	I did not know the exact size of the target work.	SR	○	I received some accurate drawings to find the target dimensions.	-
			2	Segmented on board	Stratified Customer Solicitation	Invitation to events was based on the platform schedule.	I select and invite a metal mold factory machining with high accuracy that the customer will be interested in.	I invited customers to observe the metal mold machining at the manufacturer's factory.	Customer	×	It was too far to go.	Manager	Kaizen	You have to show a movie on the iPad to evaluate the finishing quality of the surface.	-
			3	SIPS	Start from the participation of the customer.	The same as above	The same as above	The same as above	SR	×	We didn't get the participation of the customer.	Manager	Kaizen	You should put more emphasis on the signal of "Estimate/ verification" than "participation" because of our continued trading of 70 years	-
		co-definition	4	Internal model fish-bone	Visualization of the goal vision	The goal vision is not drawn to detail just talk.	I write and show the customer the fish-bone to share the goal vision.	I showed the customer the fish-bone as it was.	CT	×	It was confusing and complicated.	CT	△	This negotiation isn't brand-oriented but puts emphasis on finishing surfaces.	Because fish-bone is too complicated, we may show only the big-bone partially.
									SR	×	We should not show it abruptly.	SR	Kzn	I should show the fish-bone only a portion after writing myself on it.	
	Empowerment	co-elevation	5	Objective functions identification	Choosing two stakeholders with objective function.	I change a cutting condition depending on intuition at the production site.	I have to calculate the conditions based on the theoretical formula to achieve the finished surface accuracy.	I calculated experimental machining condition with "SURFACE ROUGHNESS Formula."	SR	△	I didn't know how to apply calculated theoretical value to the actual condition.	Manager	Kaizen	Theoretical value of the surface roughness should be in one-third of the target value.	-
			6	Orchestrator	Platform as a mediator	Don't deny the customer's production skills.	Although the customer dislikes the tool and method, I recommend it because of its effectiveness.	I offered the latest cutting tool just adapted to the customer but to be disliked.	SR	△	The veteran skilled foreman defied me to do.	Manager	○	We should not deny the customer's production skills but promote them to higher positon of production technology.	-
		co-development	7	Relation matrix	Coordinate stakeholders more than three and rise as an upward spiral all at once	We engage each stakeholders with progress.	I want to demonstrate the machining a mold with recommended cutting tool in the machine tool manufacturer.	In advance I asked machine-tool manufacturer to ensure the demonstrating machine [TANGIBLE].	SR	△	I missed ensuring an engineer of the manufacturer [HUMAN].	Manager	○	That is a very good thing for you to notice your oversight by applying "Relation matrix."	-
			8	Co-design	No design, no gain.	Don't concern yourself with such troublesome design change.	I inquired of the holding-tool provider the short special tool.	I request an estimate of the custom short tool.	SR	△	It takes a long time before drawing release.	Manager	Kaizen	Cut the tool short and replace the special tool for the combination of standard tools and the cut-tool.	-
	Curation		9	Dynamic curation	Yesterday's enemy is today's friend.	We put emphasis on the provider in an agency agreement.	I request an estimate of the custom short tool.	I found an suitable tool in the catalog of another provider in an agency.	SR	○	There are no competitors in this transaction because of high proprietary technology	Manager	○	We should use the standard as much as possible.	-
			10	IP-Ethics	Confidentiality Obligation	Customers show no drawings without reliability.	I want to see more existing drawings because I have to deduce the prospective dimension of the molds to determine the machine.	I asked the customer to show more target drawings.	SR	○	I received some accurate drawings to find the target dimensions.	Manager	○	We have to delete unnecessary portion relating to IP in drawings immediately	-
HMSEI	Stage transition		11	Chaos / Complex / Complicated / Obvious	"Drawing release" / "Participation" / "Estimate/verification" / "Contract"	I think current status is "Complicated" of estimation request, but the customer is anxious to the finishing.	We will demonstrate the experimental processing for emergence of finishing technology.	We performed pseudo-processing since the received shape can not be processed by some restrictions.	CT	○	We have gained confidence of the U-axis processing method.	Manager	Kaizen	SR could not promote the emergence of technology since there was no signal of "Participation." Then we need to correct signal list.	We have to improve signal list of each customer as trading period.
									SR	×	I didn't know which stage I was on.				
	Phase transition		12	Co-design	No design, no gain.	SR is indifferent to design change.	I examined constraints for malti-cavity mold processing through the experiment.	I notice we have to check each mold's accuracy by multi-cavity processing.	SR	○	We have to check vertical accuracy of jig because it affects each mold's accuracy directly.	Manager	Kaizen	You have to discuss the dimensions of material and jig immediately.	-
	Regulation		13	Co-design	Constraints from high order hierarchy	Indifference to the higher position in the hierarchy	We noticed equivalent accuracy might be kept one by one.	We must discuss to try multi-cavity with no confidence.	SR	○	Each accuracy of cavity is affected of all.	Manager	Kaizen	First of all we must choose the size of installed machine tool by the area, then we can determine mold material dimension.	-
	Generation		14	Co-design	Ability to respond new model		We have to decide the quantity of multi-cavity for each mold.	We discuss everything to cope with enlargement of the mold.	SR	○	We will discuss the number of multi-cavity to reduce total cost.				

Table 14 Weekly PDCA Chart

【Weekly PDCA Chart】

【Customer】SK Metal-Mold Ltd. **SR: Akihiro Anzai**

【Theme】Improvement of the finishing quality of surfaces for multi-piece metal mold processing

【Strategy 11】for Stage Transition "Complicated" →"Complex" *№ A1*

Program **Plan** *Fri,4-Dec-15*		Execution **Do** *Tue,15-Dec-15*
I think current status is "Complicated" of estimation request, but the customer is anxious to the finishing on the stage of "Complex" for emergence of new production technology. Then we will demonstrate the experimental processing for emergence of finishing technology.	⇒	We performed pseudo-processing since the received shape can not be processed by some restrictions.

⇓

Improvement (Kaizen) **Action** *Sat,9-Jan-16*		Evaluation **Check** *Thu,24-Dec-15*
(i) We have to improve signal list of each customer as trading period. (ii) We have to perform actual multi-cavity processing.	⇐	【×】I didn't know which stage I was on. 【○】We got good finishing in pseudo-processing.
Customer's or manager's advice [Manager] SR could not promote the emergence of technology since there was no signal of "Participation." Then we need to correct signal list.		***Customer's or manager's comments*** [Customer] We have gained confidence of the U-axis processing method.

⇓*Upward spiral*

Program **Plan** *Sat,9-Jan-16*		Execution **Do** *Fri,15-Jan-16*
(i) I'm going to interview our sales representative which signal is appropriate for "complex" of each customers. (ii) I arrange the tooling list for multi-cavity processing with my customer.	⇒	(i) The summary of the interviews is as follows; generally customers of long trading period seem to be on the stage of emergence as complex from "drawing release" to "contract" expecting our potential for production technology as usual. (ii) Although I visited my customer for tooling, he had not written multi-cavity drawings.

⇓

Improvement (Kaizen) **Action**		Evaluation **Check** *Tue,22-Nov-16*
	⇐	(i) We should determine the representative to make a listing to cover all customers. (ii) We will decide dimensions of installation, machine tool, molds, and materials sequentially.
Customer's or manager's advice		***Customer's or manager's comments*** [Manager](i) You should hold a meeting to modify list of signals about our customers. (ii) They may choose "630 spec." from constraints of initial cost, so you should design in 500 square material.

Upward spiral (next sheet №)

At the outset, we defined servitization as “the provision of services through value co-creation”. This is equivalent to the definition of rotation in HMSEI. We visualized this by developing some systemic models. The productization strategiers in service industries are for the transmission of services design information to tangible-durable medium in "design information transmission theory," while its servitization strategies are for the transmission to intangible-ephemeral medium.

Then, we considered the strategies for four roles of MTT companies; (1) productization strategies as manufacturing providers, (2) sevitization strategies as service industry providers, (3) orchestrator strategy as a continual customer, (4) strategies of adaptive transition or phase transition for a platform. These strategies invoked the potential of both productization and sevitization of MTT companies.

Some of main contributions of the thesis are as follows; First we analyze and examine MTT companies based on systemic models in service systems science perspective to find what is required of MTT companies in the future is servitization in a broad sense aimed at promoting increased emphasis on providing services and adding value through services in service industries. In addition, we derive strategies and prescriptions for both strategies—productization and servitization in a broad sense.

6.3 Further research

Although we made the start of transition by means of the four value orchestration signals, the criterion for judging service ecosystem adaptive transition, we consider further generalization of the method of observing stage change to be necessary. It is necessary to further progress generalization as far as possible and clearly specify a feedback measurement method. Although Cynefin framework prescriptions are highly effective when stage matches prescription, they are meaningless when a stage is incorrectly judged.

We reported an increase in order amount resulting from a service science approach at trading companies, but a profit increase has not been achieved. Companies have fallen into the servitization paradox. The reason is that enormous man-hours and expense are required. Another problem is the long time until results are obtained. Active customer involvement is required for shortening of lead times. Formulation of tactics for man-hour reduction and customer involvement is a task. Development of personnel capable of strategy execution is an issue. A human resource development program aligned with the service process blueprint must be created.

Although we focused attention on the co-design process as a fifth value co-creation process, no concrete prescription for its design strategy has been devised. A co-creation approach involving a relational analysis of shared technology subsisting in the platform and market demand that applies, for instance, the I-PASS matrix (Jay Lee & Mohamed AbuAli 2011) is a task for further research.

References

1. W. J. Abernathy & J. M. Utterback. Patterns of industrial innovation. Technology Review, 80(7), pp40–47.1978
2. Allen, C.R. & Holling, C.S.,Discontinuities in Ecosystems and Other Complex Systems, Columbia University Press, 2013
3. Ander, R., From Walkman to iPod: What Music Tech Teaches Us About Innovation. pp.1–4. Available at: http://www.theatlantic.com/business/archive/2012/03/from-walkman-to-ipod-what-music-tech-teaches-us-about-innovation/253158/ ,2012
4. Tetsukazu Asaka. Quality Control ｉn Japanese. Japan Standards Association, March 1980
5. Tim Baines & Howard Lightfood. "The servitization of manufacturing: A review of literature and reflectoin on future challenges. Journal of Manufacturing technology Managenent Review, pp547-67 20(5) 2009
6. Clive R. Boddy. The Corporate Psychopaths Theory of the Global Financial Crisis, Journal of Business Ethics 102:pp.255–259, 2011
7. Tim Brown. Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation, Harper Collins/Harper Business, September 2009
8. Chesbrough, H.,Open Services Innovation, John Wiley & Sons, 2010
9. Chesbrough, H.,Open Business Models, Harvard Business Press.2013
10. Masato Chino. Does “the Problem in 2012 “of a post-baby boom generation occur? in Japaese. The Bureau of Statistics of the Ministry of Internal Affairs and Communications Website, December 2010
11. Christensen, C., The Innovator's Dilemma. Harvard Business Review Press,2013
12. Djalante, R. & Djalante, S., Transition management, new mode of governance for sustainable development. Natural Hazards, 62(3), pp.1339–1341, 2012
13. Fraser, E., Panarchy. pp.1–5. Available at: http://books.google.co.jp/books/about/Discontinuities_in_Ecosystems_and_Other.html?, 2014

14. John Friedmann. For a citizen, by the government and NGO from "deprivation of the power" to Empowerment. SHINHYOHRON, May 1995
15. Takahiro Fujimoto. Competing to Be Really, Really Good: The Behind the Scenes Drama of Capability-Building Competition in the Automobile Industry. CHUOKORON-SHINSHA, INC., June 2003
16. Takahiro Fujimoto. Japanese manufacturing philosophy in Japanese. Nihon Keizai Shimbun, Inc., June 2004.
17. Takahiro Fujimoto. Japanese manufacturing industry strategy and cooperation between companies –from a viewpoint of organization capability and architecture- in Japanese. Document of the second management support sectional meeting of Ministry of Economy, Trade and Industry, October 2004
18. Takashi Ohshika &Takahiro Fujimoto. Proof analysis of an architecture theory and the international trade theory. AKAMON management review vol5-4, April 2006
19. Takahiro Fujimoto. Business Administration of Japanse manufacturing "Monozukuri" - Manufacturing concept exceeding manufacturer in Japanese. Kohbunsha Sinsyo, March 2007
20. Takahiro Fujimoto. Open Manufacturing - Local economy and small and medium-sized enterprises in japanese. http://www.rieti.go.jp/jp/events/08020401/pdf/fujimoto.pdf, February 2008
21. Takahiro Fujimoto. The prospects to manufacturing 2030 in Japan in Japanese. Harvard Business Review Japan, March 2013
22. Takahiro Fujimoto. "Underlying strength of Japanese Manufacturing" in Japanese. HITOTSUBASHI Business Review Books, February March 2015
23. Giddens, A., Central Problems in Social Theory, Univ of California Press, 1979
24. Gunderson, L.H. & Holling, C.S., Panarchy: Understanding Transformations in Human and Natural Systems. Island Press,2001
25. Hagel, J., Brown, J. and Davison, L, The Power of Pull: How Small Moves, Smartly Made, Can Set Big Things in Motion, Basic Books, 2010
26. C.K.Prahalad & Gary Hamel. The Core Competence of the Corporation. Harvard Business Review, May-June 1990

27. C. S. Holling. Panarchy: Understanding Transformations in Human and Natural Systems. ISLAND PRESS December 2001
28. Holling, C., Gunderson, L.H. & Ludwig, D., In Search of a Theory of Adaptive Change. In Panarchy Understanding transformations in Human and Natural Systems. pp. 1–3. Available at: http://www.resalliance.org/index.php/panarchy, 2014
29. Kazuo Inamori. Way of life in Japanese. Sunmark Publishing,Inc, August 2004
30. Kazuo Inamori. Kyocera　Philosophy in Japanese. Sunmark Publishing,Inc, June 2014
31. Yoshimi Ito. Machine tool Engineering (revised edition) in Japanese. CORONA PUBLISHING CO.,LTD, March 2004
32. Joi Ito. Practice of "the learning" to begin with deviation: Chapter 6: Change a town by power of the innovation in Japanese. MIT Media Lab CREATIVE TALK" Learning Creative Learning" academyhills website, July 31 2013
33. Joi Ito. The Art of Serendipity in Japanese. KADOKAWA EPUB Selected books 005, December 10, 2013
34. Noriaki　Kano. the Task-Achieving QC Story for QC circle in Japanese. JUSE Press, April 1999
35. Kemp, R., Loorbach, D. & Rotmans, J., Transition management as a model for managing processes of co-evolution towards sustainable development. International Journal of Sustainable Development & World Ecology 14 (2007) 78–91,2009
36. Kyoichi Kijima. Why Stratification of Networks Emerges in Innovative Society: Intelligent Poly-Agent Systems Approach. Computational & Mathematical Organization Theory 7, 2001
37. Kyoichi Kijima. Service Systems Science. Springer, November 2014
38. KYOCERA Corp., http://global.kyocera.com/inamori/management/philosophy/, October 2015
39. Jay Lee & Mohamed AbuAli. Innovative Product Advanced Service Systems (I-PASS): methodology, tools, and applications for dominant service design. Int J

Adv Manuf Technol 52, 2011
40. Loorbach, D., Transition Management, International Books, 2007
41. Lush, H., Vargo, S. & Lusch, R., Reducing the Fear of Crime in a Community: A Logic of Systems & System of Logics Perspective. In Proceedings of the Grand Challenge in Service Week Understanding Complex Service Systems Through Different Lens, Cambridge, UK. Cambridge, pp. 1–25,2015
42. Maglio, P.P. et al.,The service system is the basic abstraction of service science. Information Systems and e-Business Management, 7(4), pp.395–406, 2009
43. Masakazu Matsumoto. NIKKEN HARMONY in Japanese. Nikken Kosakusho Works Ltd. , 2012
44. Konosuke Matsushita. "http://www.panasonic.com/global/corporate/sustainability/customer.html." PHP Magazine, August 1967
45. John Winslade & Gerald Monk. Narrative Mediation-A New Approach to Conflict Resolution. Jossey-Bass Inc.,February 2000
46. Kazuo Mori. Handbook of Transmission of technology and skill in Japanese. JIPM solution, May 2005
47. Kazuo Mori. Handbook of Transmission of technology and skill. JIPM solution in Japanese, May 2005
48. MORI SEIKI Annual Report on final accounts of MORI SEIKI co., Ltd. in Japanese. MORI SEIKI CO., LTD., March 2004
49. Nihon Keizai Shimbun, Inc. Whereabouts of the high profit of Recruit Corporation (the second volume).The Nihon Keizai Shimbun, September 30 2004
50. Ikujiro Nonaka & Hirotaka Takeuchi. The Knowledge-Creating Company: How Japanese Companies Create the Dynamics of Innovation. OXFORD UNIVERSITY PRESS, May 1995
51. Ikujiro Nonaka. Managing Flow - A Process Theory of the Knowledge-Based Firm. Palgrave Macmillan, August 2008
52. Ikujiro Nonaka. Worksigit intervierw "http://www.worksight.jp/issues/473.html",September 2014

53. Panth, S.,Technological Innovation, Industrial Evolution, and Economic Growth, Routledge, 2013
54. Ricciardi, F., Innovation Processes in Business Networks, Wiesbaden: Springer Science & Business Media., 2013
55. Steven Rosenbaum. Curation Nation. the McGraw･Hill companies, 2011
56. Rotmans, J. & Loorbach, D., Complexity and Transition Management. Journal of Industrial Ecology, 13(2), pp.184–196, 2009
57. SANDVIK Coromant company. Technology Information-Materials of chips and works. SANDVIK coromant company website, September 2013
58. SANNO UNIVERSITY Research Institute -Business Ethics Research Project-. “Practice” -business ethics and corporation compliance. SANNNO Institute of Management Publication dept., October 2008
59. Hosaomi Sasaki. Organizational Capability of Japanese Manufacturing in Japanese. NIKKAN KOGYO SHIMBUN,LTD. August 2008
60. Naoyuki Sato. Tomorrow communication in　Japanese. ASCHII SHINSHO, October 2011
61. H.A. Simon. Organizations, BLACKWELL Publishing, May 1993
62. David J. Snowden & Mary E. Boone. A Leader’s Framework for Decision Making. Harvard Business Review, November 2007"
63. Squazzoni, F.,The Micro-Macro Link in Social Simulation. Sociologica, II(1), doi: 10.2383/26578, 2008
64. General catalogue of Sumitomo Electric Hardmetal Corp.2013.Sumitomo Electric Hardmetal Corp. website, September 2013
65. Naomasa Takeyama. Service Design and Its Visualization Techniques in Japanese. The Hiyoshi review of the social sciences No.23-2012(Keio University Hiyoshi bulletin publication Committee), June 6, 2012
66. Toivonen, M., Starting points for the comparison of SDL and neo-Schumpeterian views on innovation. Proceedings of 1st workshop on Service Innovation Research, 18-20 September 2013,　Catanzaro, Italy. pp. 1–6., 2013
67. University of Cambridge & IBM, Succeeding through service innovation, 2008

68. Stephene Vargo & Robert Lusch. Service-Dmominant logic. CAMBRIDGE university presss, January 2014
69. Vargo, S., Insights on Innovation from an Institutional and Ecosystem Perspective. In the Annual International RESER Conference. Helsinki, 2014
70. Vargo, S. & Lusch, R.F., It's all B2B…and beyond: Toward a systems perspective of the market. Industrial Marketing Management, 40(2), pp.181–187, 2011
71. Vargo, S.L., Wieland, H. & Akaka, M.A., Innovation through institutionalization: A service ecosystems perspective. Industrial Marketing Management, 44, pp.63–72, 2015
72. Wieland, H. et al., Toward a Service (Eco)Systems Perspective on Value Creation. International Journal of Service Science, Management, Engineering, and Technology, 3(3), pp.12–25, 2012
73. Yasuo Yamane. Basic knowledge to perform the cutting of difficulty cut materials in Japanese. Monthly Journal “Machine Technology” NIKKAN KOGYO SHIMBUN,LTD., April 2013.
74. Yasuo Yamane. Human resource development for Japanese Manufacturing "Monozukuri" in Japanese,　February 2015
75. Akiyoshi Yokoyama. Basic knowledge of steel materials and the cutting from the viewpoint of elements in Japanese. NIKKAN KOGYO SHIMBUN,LTD, October 2012