Service as a Fundamental of Engineering

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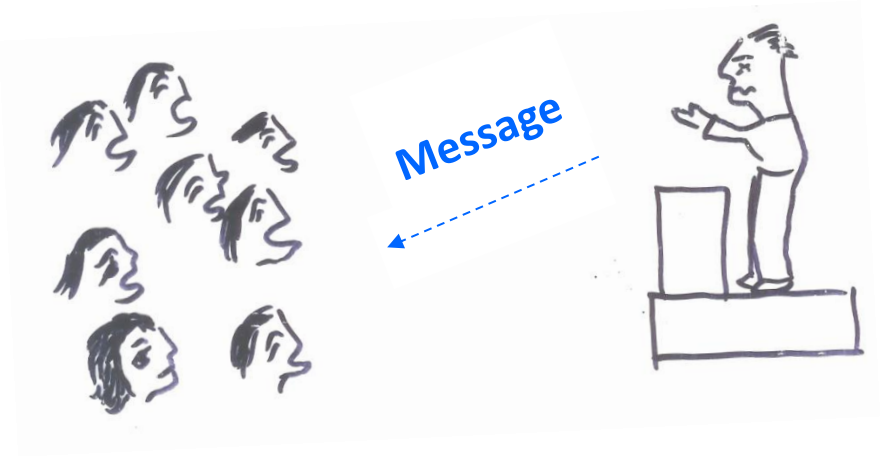
CONTENTS

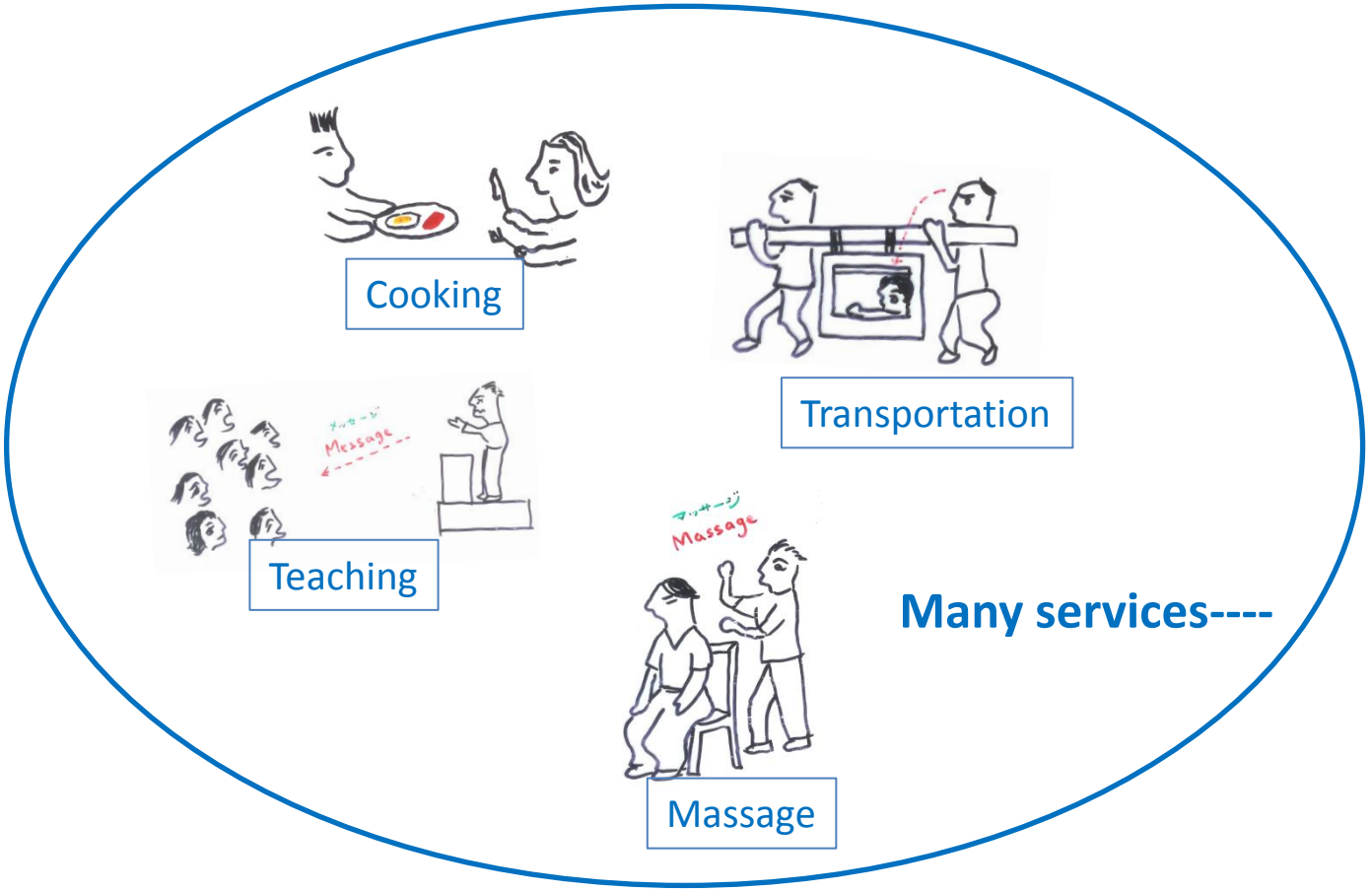
1.Service as a fundamental activity of human beings

Services



There are many services among people. If we think that service is a human activity by which one gives some effects to another or others, including oneself, we may say that almost human actions are service. It is sometimes informational (**message type service**) and sometimes physical (**massage type service**).

Service and Society



Set of Service=Set of relations among humans

Humans help each other through services consequently building a society.

Examples of primitive service (no business)

Effects : physiological, mental, material

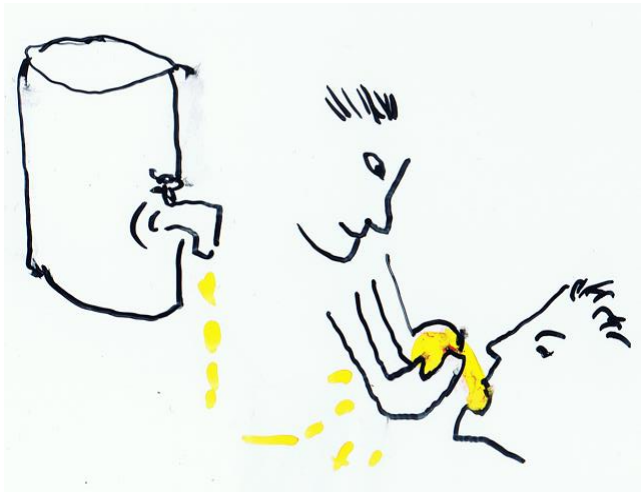
D : donor R : receptor

Meaning (contents)	Prepare by D (design)	Action by D (donation)	Action by R (reception)	Examples of D	Examples of R	Effects on R (functionality)
medical service	diagnosis	cure	accept	mother	child	health
care	judge	care	rely	youth	aged	activity
support	request	help	cooperation	mighty man	weak man	power
move	designate	conveyance	obey	driver	rider	distance
meal	cook	serve	eat	husband	wife	nutrition
esthetic	decision	cosmetic	cosmetic	self	self	looks
lodging	prepare	offer	sleep	host	guest	recover
education	assess	teaching	understand	parent	child	knowledge
information	fabricate	offeror	receive	receiver	friend	information
consultation	analysis	propose	solve	elder	sufferer	release
music	plan	play	listen	player	listener	pleasure
story tell	production	speak	listen	teller	listener	sight
amusement	direction	perform	appreciate	performer	family	relax
keeping	valuation	keep	leave	keeper	leaver	period
transport	packing	distribute	entrust	carrier	receiver	distance
maintenance	diagnosis	repair	renewal	repairer	clumsy	recovery
manufacturing	*design*	*manufacture*	*use*	*bricoleur*	*user*	*usefulness*

Service is the Target of All Industry

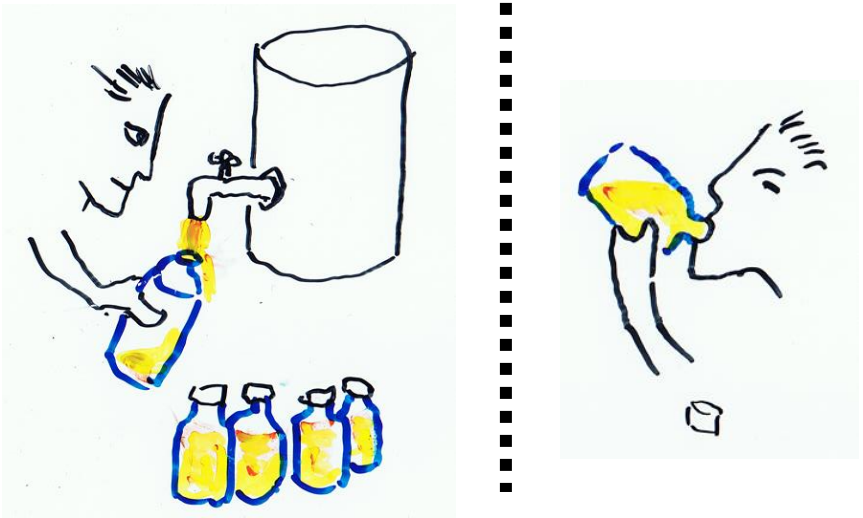
Manufacturing industry is a part of service industry

Service industry



Design/manufacturing and use of product occur simultaneously.

Manufacturing Industry



After design/manufacture, the product goes to use through stock, transport and sale.

In service industry the service by a donor reaches a receptor directly. In manufacturing industry the service reaches indirectly through stock, transport and sale. The difference between them is only directedness and thus there is no fundamental distinction from the viewpoint of transmission of service which is substantial for both industries.

Position of this paper

1. **Service is a fundamental activity of human beings. It existed from old days since they live collectively. The necessary medium to organize a good society is friendly mutual help among members, which is essential for humans to survive by making a group or society compensating humans' weakness. The mutual help is the service.**

2. **Therefore, the scientific study on service should not be limited within services found in service industries in modern society which are dealt with economically, but the study must be based on the fundamental activities of humans which might be observed in wider range of human activities in various occasions including everyday life.**

3. **This view indicates that we cannot make real innovations of new or unprecedented services keenly desired for realising sustainable society, as long as we stick to the improvement of services already observed in service industry.**

2.Quantitative theory of service

2.1 Basic concept of service
2.2 Primitive services
2.3 Donor and Receptor
2.4 A mathematical model of service in society

2.1 Basic Concepts in Service

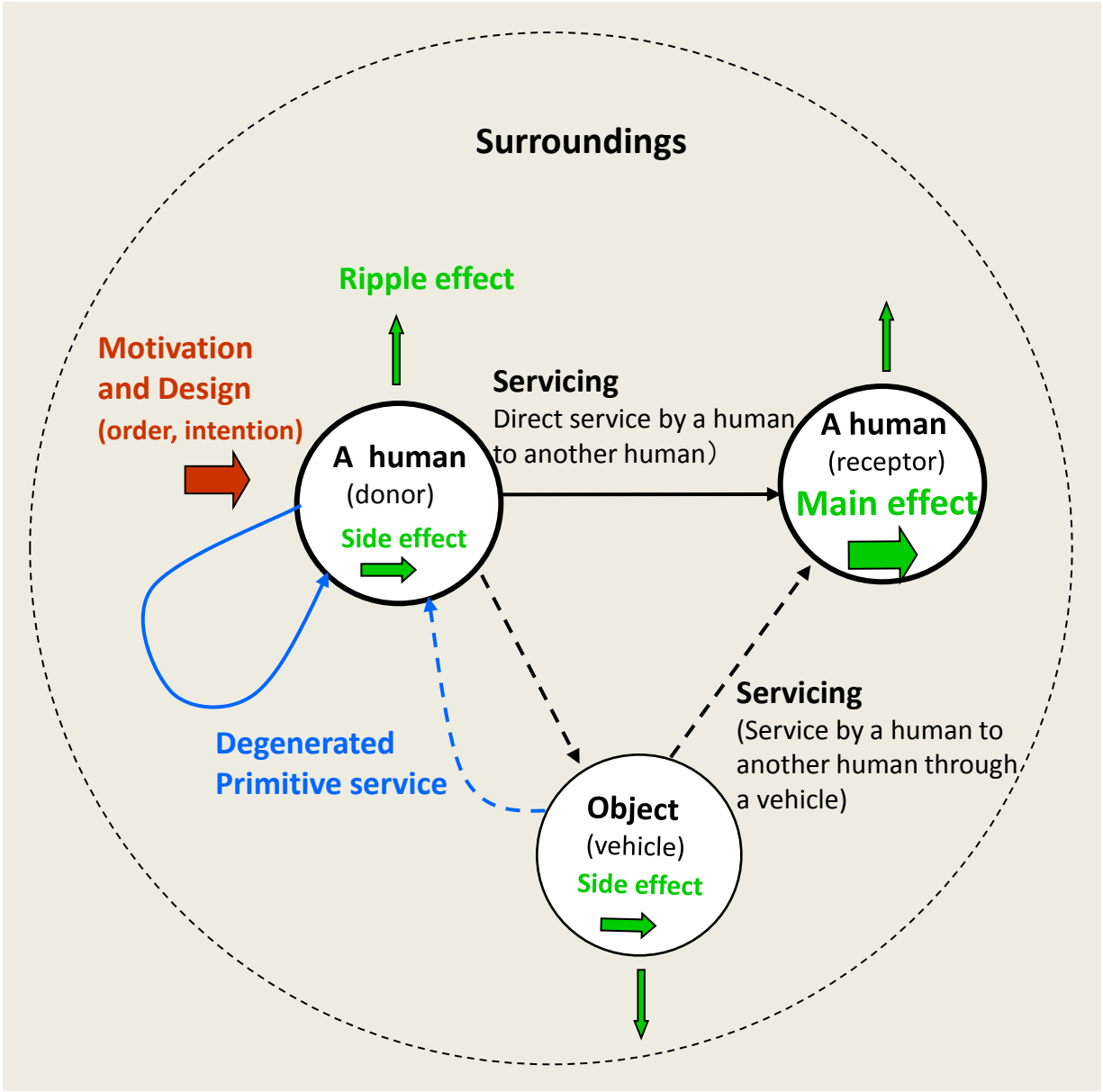
Basic Concepts in Service

Service is an action by a human who intends to give some effects to another human according to definite motivation or intention. Generally it is a time consuming process. It does not exist when a human lives alone. It occurs in society. It seems to be the purpose of making a society by human. Service to selves is possible but it is a special case which is called degenerated.

When a human, a donor of service, donates a service to another human, a receptor of service, then the latter starts a particular action corresponding to the received service. The action creates an effect in the receptor. After all actions terminate, some changes of states remain not only in the receptor but also in the donor and the surroundings.

When donor and receptor are single respectively, the service is called a primitive service. Primitive service is donated directly by a donor or through a vehicle. Primitive services sometimes make a chain. When a donor donates services to more than two receptors simultaneously, the service is called distributed. When more than two donors donate a service to a receptor cooperatively, the service is called socialized . By integrating these services: distributed and socialized, service will make a network.

Basic Structure of Primitive Service



Donation of service by a donor raises a receiving action by a receptor.

Service reaches from a donor to a receptor, either directly or through vehicles. This is called primitive service.

As a result of receiving action, the main effect of service appears in receptor, which is the main purpose of the service. It should be noted that some effects appear simultaneously in donor, vehicle and surroundings.

In case where effects appear in donor themselves as a result of service which donor donates themselves or to vehicle, it is also called primitive service or degenerated primitive service.

Degenerated primitive service corresponds to the use of an object.

2.2 Primitive Service

Primitive Service

Examples of primitive service (no business)

D : donor R : receptor

Effects : physiological, mental, material

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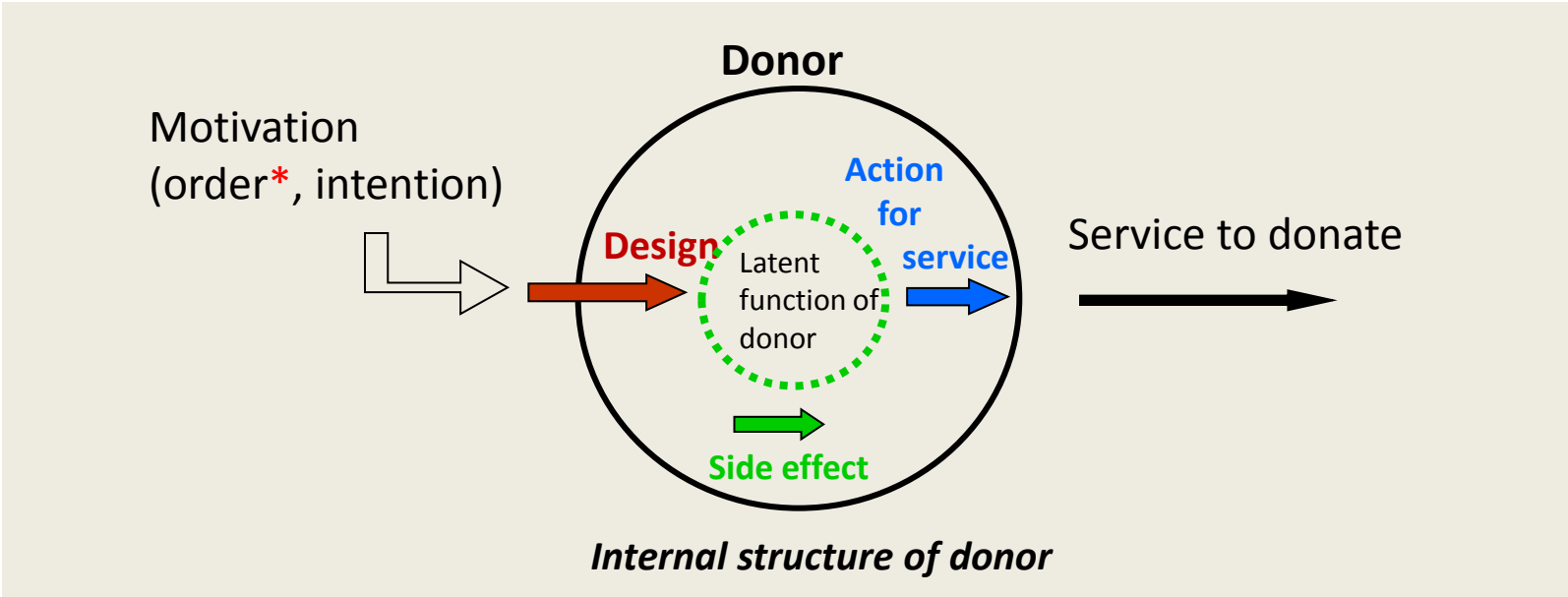
manufacturing	*design*	*manufacture*	*use*	*bricoleur*	*user*	*usefulness*

2.3 Donor and Receptor

Quantitative expression

Internal Structure of Donor



*Order is not only direct one from receptor but also assumption of social needs

Service designed／order, intention ＝ goodness of design : d

Donated service／service designed ＝ skill of donor : c

Transmission efficiency ＝ sc

Capacity of donor b ＝ c ＊ d ＊ sc

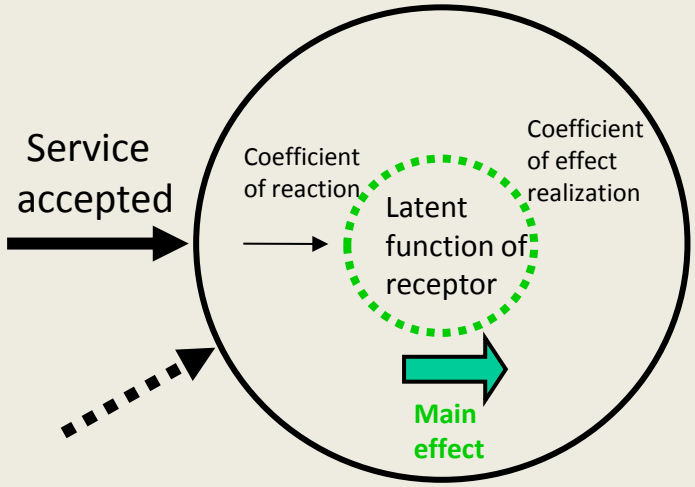
Basic Features of Donor

Donor acts being based on a motivation autonomous or heteronomous. The autonomous motivation is their own intention and the heteronomous motivation is an order give by someone else. Intention and order are generally represented by an effect expected to be appeared on receptor.

Following the intention or order, a service is designed which is to realize the relevant effect on the receptor. The designer of the service can be either orderer(receptor) or servicer(donor). When service is socialized, a professional called service designer will appear who creates ready-made service.

Donor donates the designed service to receptor, but only a part of the intended donation may arrive at the receptor. The rate of arrival depends on the goodness of design, the skill of donor and the conductance of the path of service between donor and receptor.

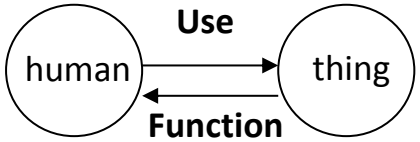
Internal Structure of Receptor



Internal structure of receptor

When a donor services a receptor, the receptor starts a receiving/reacting action. The action manifests receptor's latent function into visible one, which is the effect of service given by the donor to the receptor.

In the theory of function, the function manifests when human uses a thing , which means that the human is serviced by the thing.



Receptor is forced to react by a service from donor. The receptor extracts their latent function by their own reaction. Therefore, the effect of service is the result of manifest of their own latent function or potential capability. Unless receptor has such capacity to react, they cannot receive any service effectively.

Basic Features of Receptor (1)

When a receptor R receives service from a donor D, the receptor starts a receiving action resulting some effects to themselves. Effects are change of state such as physical change (state, place etc), body/physiological change (recovery from exhaustion etc), mental change (increase of knowledge etc) which are not easy to be represented by physical quantities. Receptor usually expects the possible effects raised by the reception of service, followed by an order.

It is stressed here that the state change of receptor is not given by donor but the receptor produces it by themselves, utilising the service the receptor accepted.

Service donated(arrival) → Receptor's reaction (D→R) → State change of receptor (R→R)

The receptor's reaction is not necessarily an intentional action. For example, when an anesthetized patient is operated and then recovers unconsciously, we think the recovery is the patient's reaction. The patient's own physiological action is essential for the recovery. Actions are physical, physiological and mental.

We assume that the latent capacity of action of receptor manifests by the stimulus from outside, and then the action raises the effects to themselves. This is the fundamental character of the living things, and here the effect of service is attributed to this fundamental character. This assumption is necessary to maintain the autonomy of receptor who is positioned as a passive entity in the service phenomenon.

Basic Features of Receptor (2)

Satisfaction by receptor corresponds to receptor's complacency about the expectation after the service. Expectation is expected effect. Therefore, we have the following process:

Expected effect→Design→Service(donation and reception)→Receptor's reaction→Effects to receptor

Here, the goodness of each process is defined as follows:

design／expectation	**：goodness of design**	**d**
donated service／design	**：skill of action）**	**c**
service that arrived／service donated	**：efficiency of transfer）**	**et=1/ls**
reaction by receptor／service that arrived	**：coefficient of reaction)**	**cr**
effect／reaction by receptor	**：coefficient of effect realization)**	**ce**

By using these parameters, the relationship between expected effect h and resulted effect e is represented as follows:

$$e = h * d * c * et * cr * ce = (d * c * et) * (cr * ce) * h$$
$$= b\text{（capability of donor）} * a\text{（sensitivity of receptor）} * h$$

Functions and Effects

Some definitions and relations

Quantities
L : Latent function
F : Manifest function
f : Rate of manifestation
k: Factor
e: Effect

Suffix
d : **donor**
r : **receptor as receiver**
r' : **receptor as self-actor**
0 : **initial value**
1 : **value at t**

$$L_{d0} = L_{d1}(t) + F_{d1}(t)$$

Sum of latent and manifest function is constant.

$$f_d = -k_d \cdot d(L_{d1})/dt$$

$$f_r = k_r \cdot d(F_{r1})/dt$$

Rate of manifestation (**flow of function=service**) is differential of latent function.

$$F_{r1}(t) = G * F_{d1}(t)$$

$$F_{r1} \neq L_{r1},$$

$$f_r = (k_r/k_d)G \cdot f_d$$

Received function by receptor is proportional to function donated by donor.

$$f_r' = CA * f_r$$

$$L_{ro} = L_{r1}(t) + F_{r1}'(t)$$

$$f_r' = k_r' \cdot d(F_{r1}')/dt$$

$$f_r' = -k_r' \cdot d(L_{r1})/dt$$

$$e = CE * f_r'$$

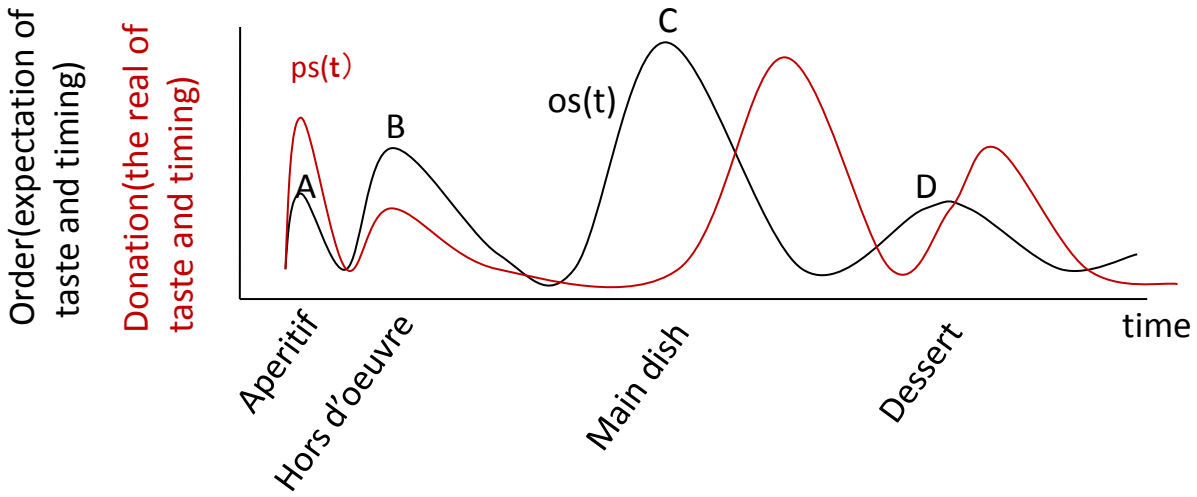
G = goodness of design, skill, efficiency of transmission
CA = coefficient of functional accumulation
CE = coefficient of effect realization

Flow of function is service.

An Example of Primitive Service

R : a guest　“ I would enjoy a delicious meal . I go to a restaurant and according to my value(taste), I select A, B, C and D from dish list, and order them.” The expectation for what and when dishes are served is represented by a time series.

D: a cook　”I prepare a service to the guest, that is to design and cook dishes ordered as satisfactorily to the guest as possible. “ Dishes are served in a time schedule.



If definition of appropriateness **ap** is given as follows, service effect is calculated .

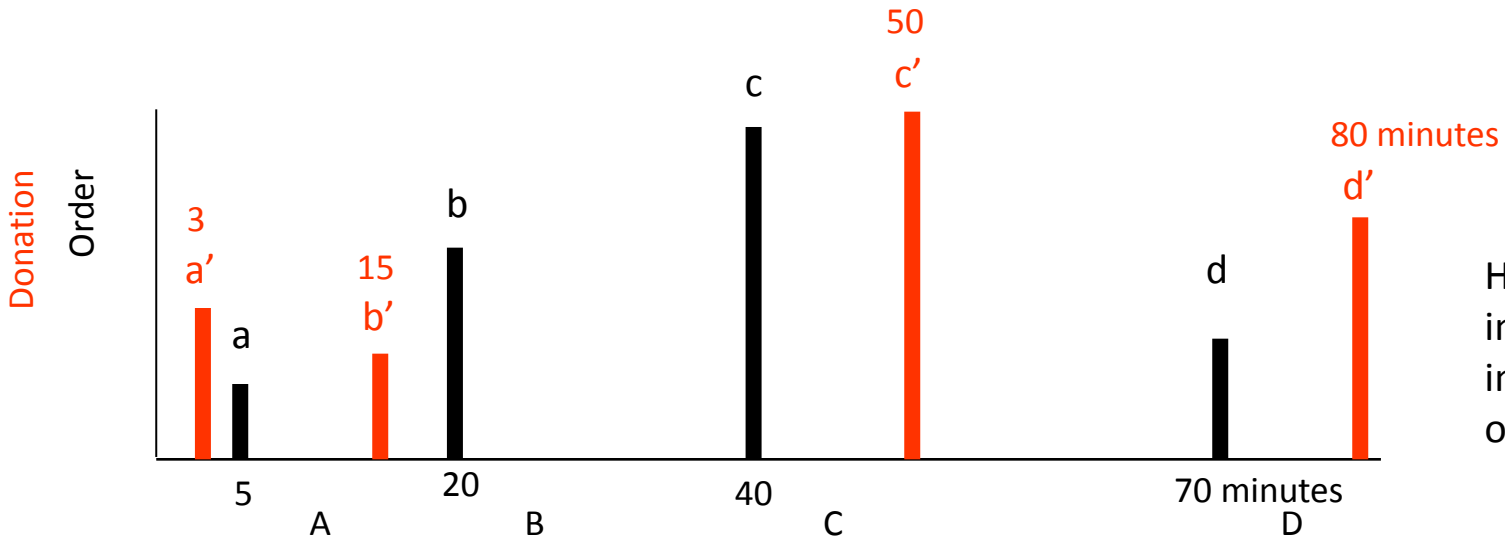
$$\mathbf{ap}(\text{appropriateness}) = \frac{\int((ps(t)\cdot os(t))dt}{\int ps(t)dt \cdot \int os(t)dt}$$

$$\mathbf{e} = \mathbf{ap} * \mathbf{h}$$

A Numerical Example

R (order) Delicious meal , selection A, B, C, D from dish list, expecting serving time after the order t_1,t_2, t_3, t_4 minutes

D (donation) Cook A, B, C, D at her/his best and serve them at times following her/his philosophy.

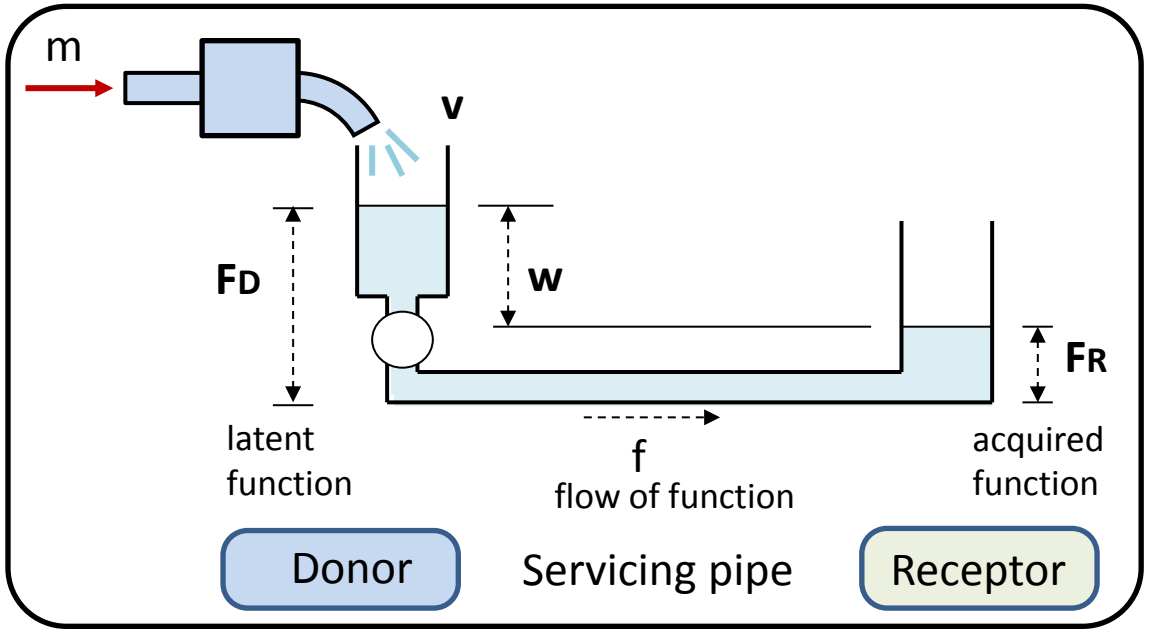


An example : Satisfaction(appropriateness) = $\frac{1}{4}\Sigma(\mathbf{xx'}/\mathbf{x}^2)(\mathbf{1}-(|\mathbf{t}-\mathbf{t'}|/\mathbf{t}))$ = 0.69

2.4 A mathematical Model of Service in Society

Considering the effect of individual services to society

Servicing Process as Functional Flow



m: motivation
v : supplying speed of latent function
F_D: Latent function of donor
w : functional gap
f : speed of functional flow
F_R: Acquired function by receptor (latent and gradually changes into effect)

$$f = dF_D/dt$$
$$w = F_D - F_R$$
$$f = k \cdot w$$

A simple fluid-dynamics model of service

A donor's motivation*(subjective) is transformed into a function (objective) at the first stage of service design. Function is input to themselves(donor) increasing the potential of latent function. When the potential exceeds the receptor's potential of latent function, a service starts. (Hypothesis : Rate of flow is proportional to gap of function between donor and receptor.)

*Motivation is subjective but function is objective（R.Merton）

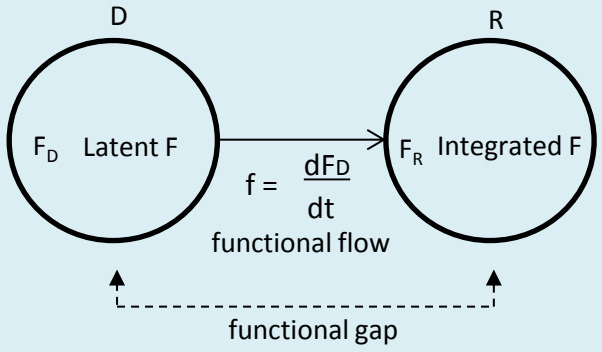
Functional Gap and Functional Flow

When one finds more amount of function or higher functional potential within one than others, then one decides that one can become a donor of service to others or receptors. This decision creates a donor's motivation of a service to receptors.

Functional gap: $w = F_D - F_R$

Functional flow: $f\ (= dF_D/dt) = k \cdot w$ k is a constant

Functional potential must be derived from the amount of function which is defined quantitatively. Here, the definition is that the amount of function is donor's capacity to exert the function. Latent function here is defined by this capacity*.

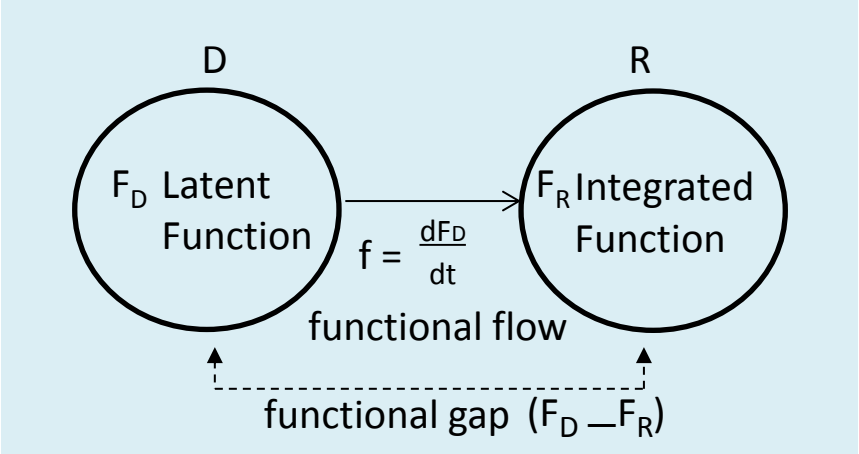


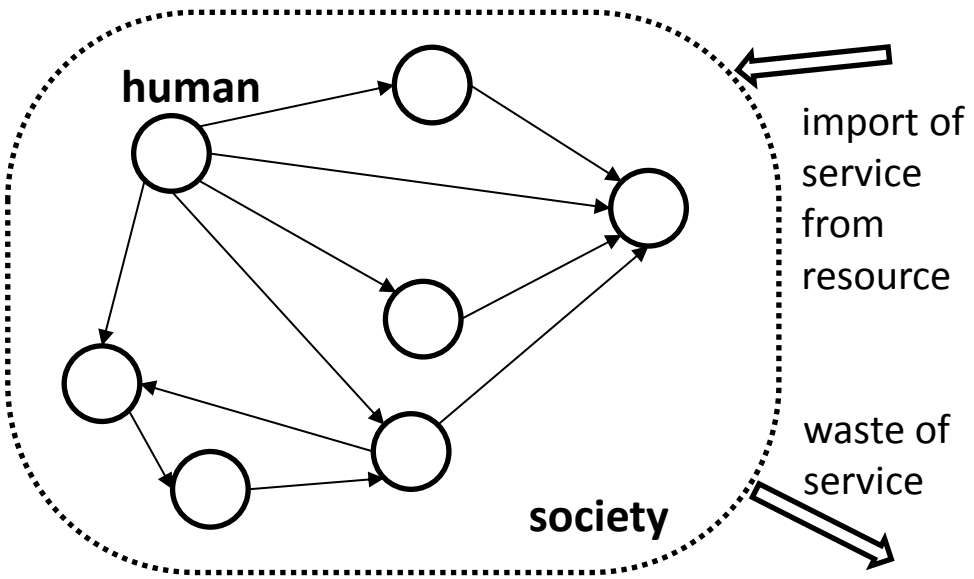
When $F_D > F_R$, function flows from donor to receptor in this figure. Instead, when $F_D < F_R$, the flow occurs inversely from receptor to donor. In this case, they exchange their missions.

*The definition of latent function by Merton is different from this one. Merton defined it as a function which is not recognised by people but effective socially. But here, it is latent and manifested by intention of donor to serve, or intention of receptor who uses the product in which the function is embedded as latency.

Service in Society

Motivation of a donor increases its latent function and when it exceeds the latent function (same kind) of a receptor, functional flow (service) starts. Rate of flow is proportional to the functional gap and admittance of the path. A society is composed of people with different latent function of a kind. Also, each member has its capacity of receiving the function (admittance). As the result, system of functional flow in the society is decided.





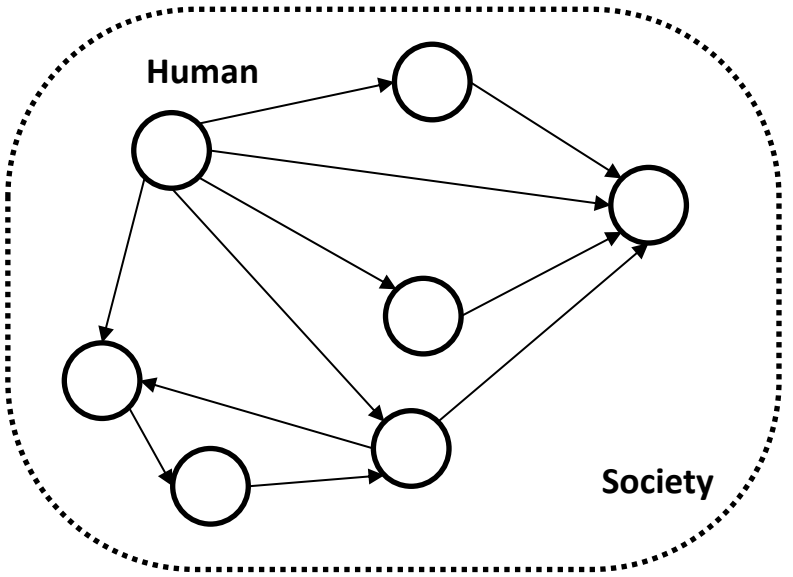
The total of functional flow in a society can be an index of wealth instead of GNP.

Services make a Society(appendix)

Motivation of a person(donor) creates function which moves to another person(receptor). Function generates values in a person, so function is the carrier of values among people.

Society has a network of paths where functions flow carrying values. Structure of the network is nearly stable but evolves gradually. 。

Functional flow is different from information flow. The physical information flows independently of people's character, but the flow of service is highly dependent of characters of donor and receptor. The source of functional flow exists in donor and receptor has autonomy for receiving the flow.



Service system is the structure of functional flow from donor to receptor. Therefore, service can only exist in a world where donors and receptors exist. Features of service difficult to discuss scientifically, such as transient, simultaneousness, non-determinism due to subjectivity etc. are dissolved by a model that service is a functional flow on the structure of donor and receptor where conservation holds. Although the primitive service is exactly the relation between a donor and a receptor, it is a fundamental element of macroscopic parameters which decide the situation of society, such as economy, comfort of living, or happiness, and therefore it can be an indicator of optimality of social policies and regulations.

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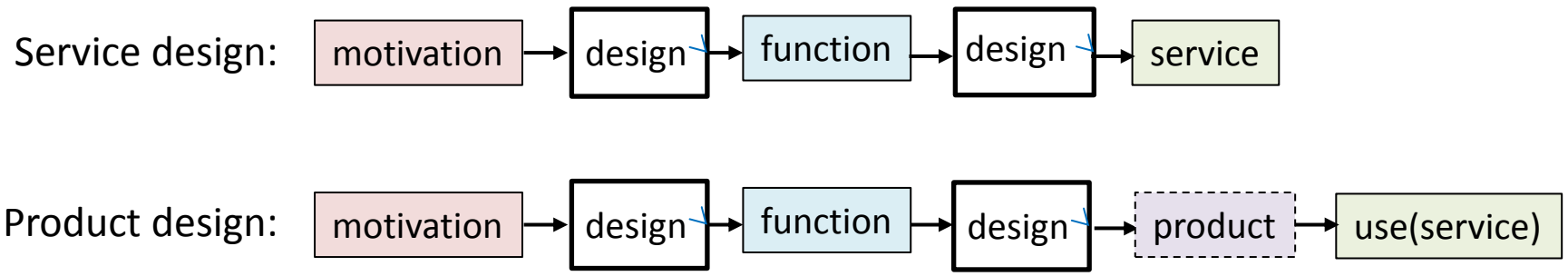
Measurable variables designating amount of respective service

Quantitative amount of service is detected by effects on receptor.

Design of Service and Product

Design of service is composed of two stages. The first is transformation of the motivation to function and the second is construction of flow mechanism of the function from donor to receptor(service). Design of a product is to embed the function into an object (vehicle), but instead, design of service creates the function to be sent directly to receptor (simultaneousness). Because receptor is the user of service, a product can be identified as a path through which service is transported.



3. Amplification of Service

3.1 Massage type and message type
3.2 Amplification
3.3 Quantification of service
3.4 Proliferation and amplification of primitive service
3.5 Amplification by tools
3.6 Amplification by conditions
3.7 Amplification by social systems

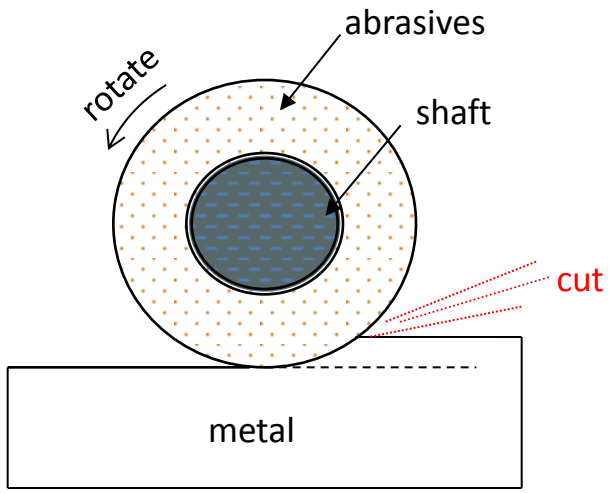
“Physics” of Service

Service is the manifestation of latent functions contained in human or thing. The mechanism of manifestation of human latent function seems too complicated to be discussed quantitatively without further development of physiology or psychology relevant to this subject .

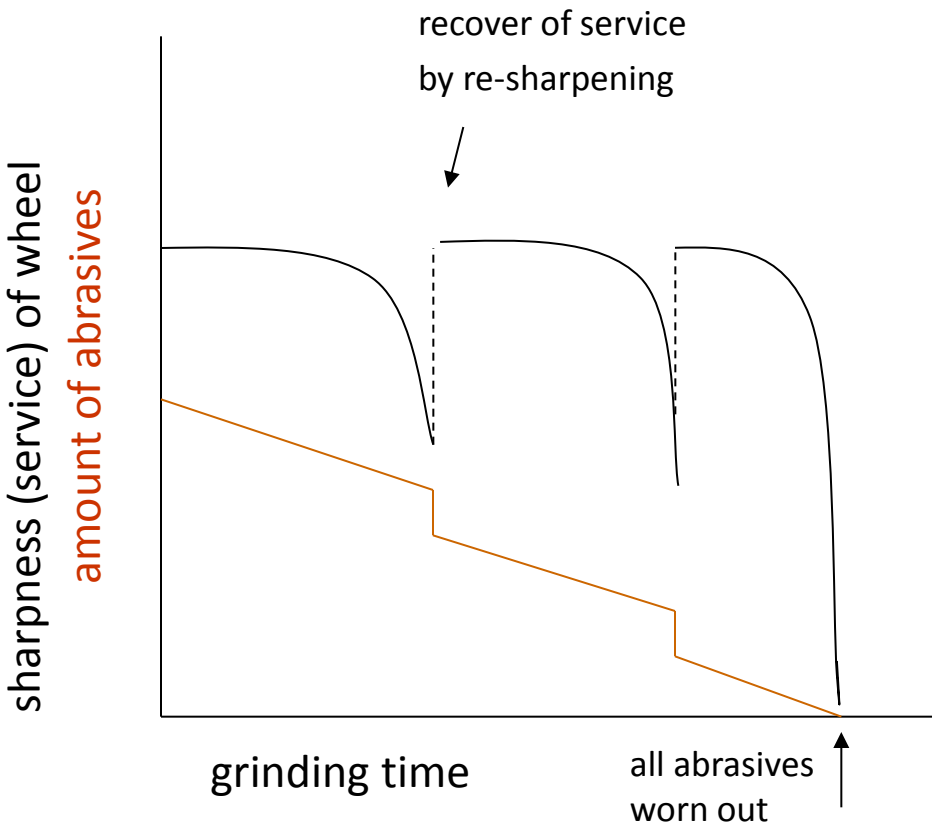
On the contrary, it seems possible to quantify the latent function of things, because the manifestation of latent function of things is always accompanied with phenomena of change in material and energy. Therefore, the latent function of things will be discussed in terms of mass and free energy of things concerned. It is $m+\Delta G$.

Quantification of Latent Function of a Thing

The simplest example: A grinding wheel exerts service "to Cut"



A grinding wheel contains function to cut metals. The "service" of cutting terminates (functionality exhausts) when all abrasives wear out.



Amount of functionality contained in a grinding wheel is proportional to amount of metal cut .
(Proportional to amount of abrasives and life of grains (grinding ratio))

$\int w(service)dt$ ***= functionality of wheel = amount of metal cut***

Amplification of Service

Service can be amplified through medium. Basic unit of service is defined as the amount of service donated by a human to another, that is, primitive service. Rate of amplification is shown by the ratio of particular amount of service to the basic unit of service.

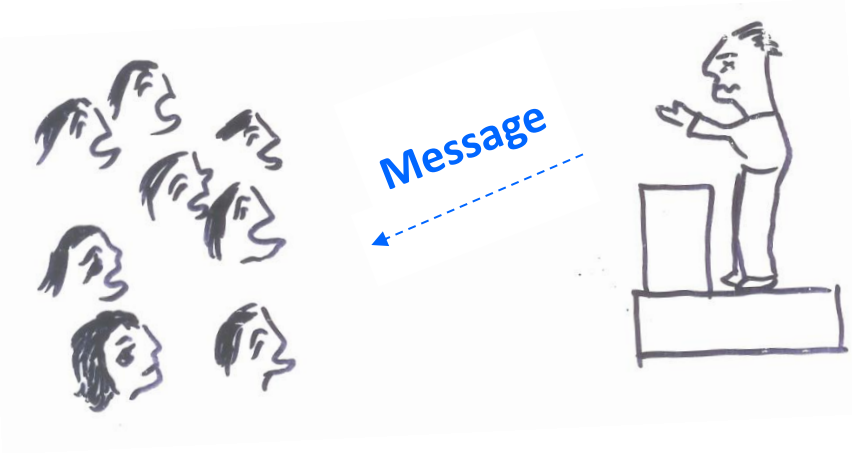
There are two modes in amplification. **The first is intensification by the aid of medium** under the condition of primitiveness. When a human donate service to another, not directly but through some medium such as tool, the service usually becomes faster or strengthened. This is defined as the amplification by intensification. The donor can donate much faster service, that is amplified primitive service, by a car than humping,

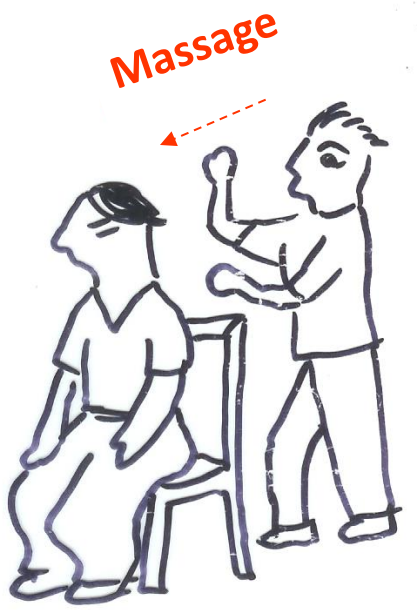
The second mode is proliferation. When a donor donates services simultaneously to many receptors by making a network with media, without deterioration of each service, the total amount of service will be increased. A story teller can donate a service to a huge number of receptors through television. This is defined as the amplification by proliferation.

There are tools for amplification (medium) such as equipment and machines, circumstances such as theater and buildings and social systems such as laws, rules and customs offered by governments and other organizations.

Primitive services

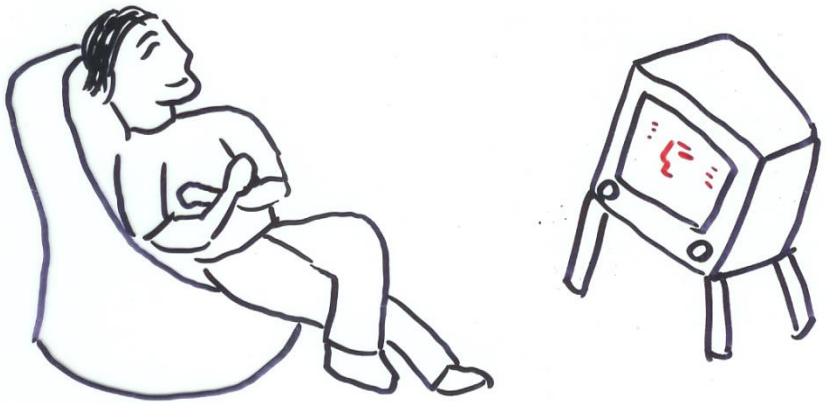
Two types of service : Message-type and Massage-type





Amplification of Services

Message-type



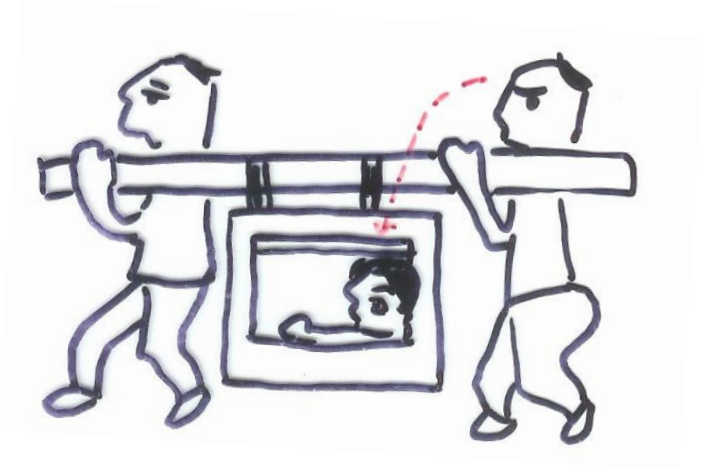
Broadcasting

Massage-type

Mechanical massager

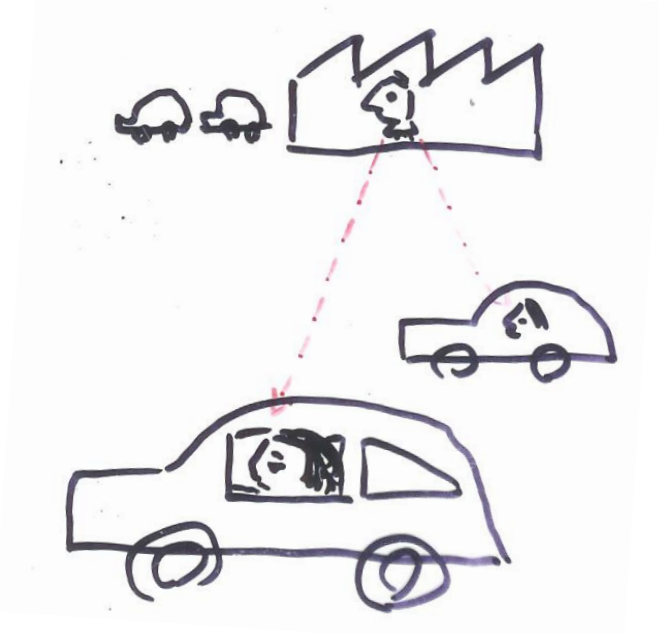
Car is also Service

Primitive process of massage-type service



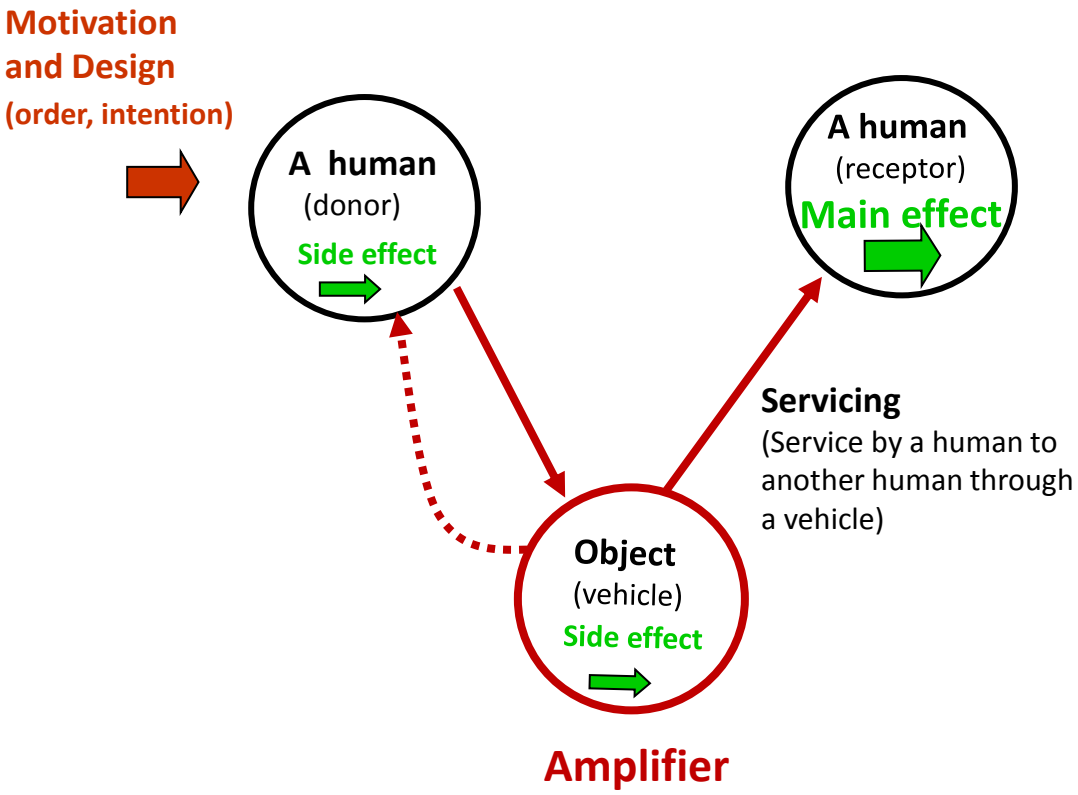
Two people offer massage-type service to a passenger in a palanquin.

Amplified massage-type service



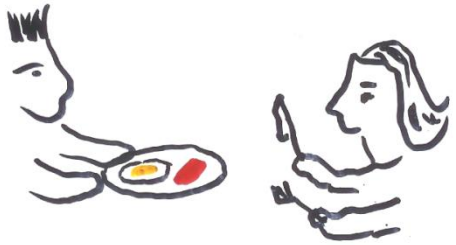
Car manufacturers offer massage-type service to car drivers.

Amplification of Primitive Service

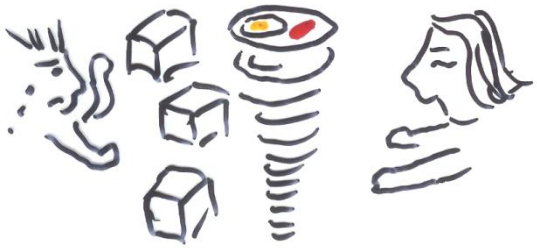


Proliferation and Amplification of Service

1. Fundamentally, service is made by one to someone else (primitive service).
2. Service is countable and unit of service is an independent completion of service. ex. one-hour lecture, cooking ham and egg for someone.
3. We shall measure the amount of service *s* by number of unit of service made by one to someone else.
4. When the service is done within time *u*, the service rate *r* is *s/u* . *
5. Service can be embedded into a specially designed machine. Embedded service is potential. When someone uses the machine, it becomes actual. If the service appears taking time *t*, the service rate is multiplied by *u/t*.
6. Service is available when the machine is used repeatedly, but the number of use is limited that is life of the machine, *n*.
7. A machine, therefore, proliferates the service by the life of machine.
8. When applied *m* machines, the proliferation of service is *n* x *m*. The total service is multiplied by *n* x *m*. It is a stock of service. We call the increase of service rate as amplification. It is *m* x *u/t*.
9. Wealth of a nation is given by total rate of service, instead of GDP.



1 unit



30,000units by three machines

* When it took you half an hour to cook ham and eggs for your wife, you made service 1 unit to her, and service rate is 2 (=1/0.5).

** When you serve your wife using three automatic ham and eggs machines until each machine exhausts its life (*n* = 10,000), then you make service 30,000 units to her. If the machine makes a ham and egg in 6 min., then the service rate is 30 (=3/0.1).

A Chain of Primitive Services

1. Donate a service "vegetables dish"

A donor cultivates field, seeds vegetables, raises, harvests, transports, delivers and cooks them.

A receptor eats the vegetables dish.

2. This service is composed of three primitive services.

1) Produce foods* (socialized service)	**2) Sales service (socialized service)**	**3) Cooking service (primitive service)**
Donor: farmer Vehicle 1: fields Vehicle 2: vegetables Receptor: wholesaler of vegetables	Donor: retailer of vegetables Receptor: purchaser of vegetables	Donor: cook Vehicle: dishes Receptor: eater

3. Vehicle is a medium of service. Tool is a typical vehicle.

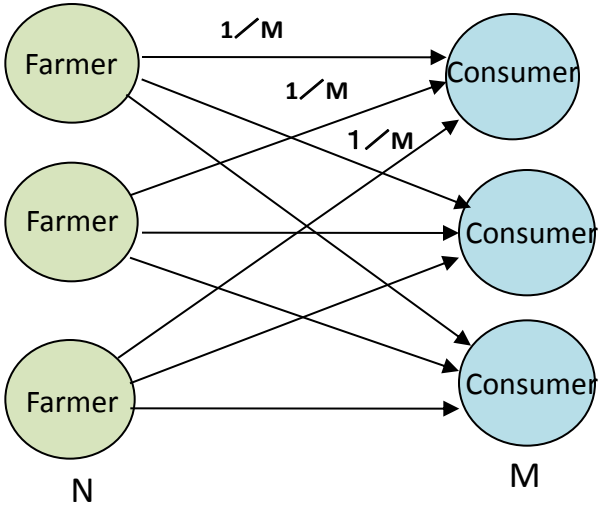
*Production is a kind of service

Amplification of Service by Social Systems

Unsatisfactory service for consumer due to insufficient delivery of agricultural products which are of enough amount.

1.Primitive service

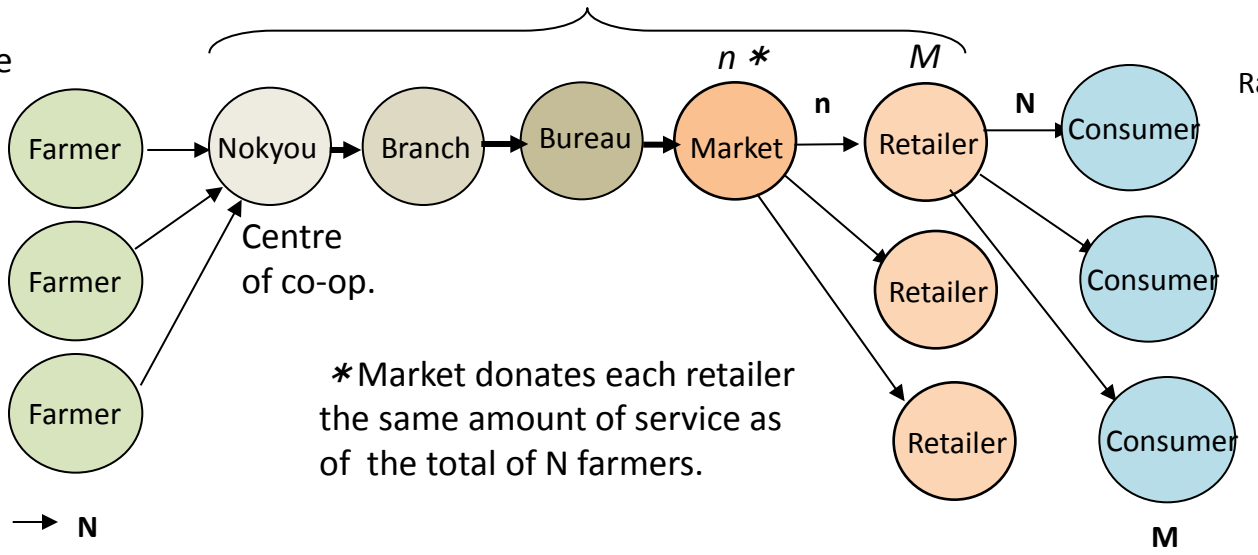
All services of N farmers are divided M consumers.
Service effect per consumer ＝**N／M**
(decreases with M)



2.Social systems

Amplifier is installed to send farmer's service to consumer.
Service effect per consumer
＝**N・n・M／M＝N・n**
(no decrease with M)

Vehicles for Amplification



Growth of latent function
N→N・n・M
Rate of amplification
: n・M

Price
Quality
Steady supply
Traceability
Service productivity

Categorization of Service Amplifier

Categories of vehicle (amplifier)	**Vehicles**	**Familiar Examples**
Tools	Instrument, machineries, database, software	TV, automatic massager, motorcar, word processor, cell phone All machines are service amplifiers.
Circum-stances	Structure, space, layout, network	Theatre, music hall, hotel, playground, Information network, highway systems
Social systems	Regulation, rule, organization, institution (politics, administration, finance, distribution, communication, medical, education services)	Government, ward office, police, banks, shops, communication systems, traffic systems, schools, hospitals, corporations
Complex vehicles	Compositions	

4. “General Engineering”

A Trial to develop an engineering curriculum based on function or service

Examples of primitive service (no business)

Effects : physiological, mental, material

D : donor R : receptor

Meaning (contents)	Prepare by D (design)	Action by D (donation)	Action by R (reception)	Examples of D	Examples of R	Effects on R (functionality)
medical service	diagnosis	cure	accept	mother	child	health
care	judge	care	rely	youth	aged	activity
support	request	help	cooperation	mighty man	weak man	power
move	designate	conveyance	obey	driver	rider	distance
meal	cook	serve	eat	husband	wife	nutrition
esthetic	decision	cosmetic	cosmetic	self	self	looks
lodging	prepare	offer	sleep	host	guest	recover
education	assess	teaching	understand	parent	child	knowledge
information	fabricate	offer	receive	receiver	friend	information
consultation	analysis	propose	solve	elder	sufferer	release
music	plan	play	listen	player	listener	pleasure
story tell	production	speak	listen	teller	listener	sight
amusement	direction	perform	appreciate	performer	family	relax
keeping	valuation	keep	leave	keeper	leaver	period
transport	packing	distribute	entrust	carrier	receiver	distance
maintenance	diagnosis	repair	renewal	repairer	clumsy	recovery
manufacturing	*design*	*manufacture*	*use*	*bricoleur*	*user*	*usefulness*

Measurable variables designating amount of respective service

Quantitative amount of service is detected by effects on receptor.

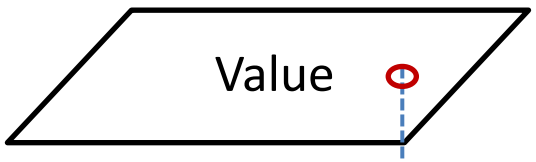
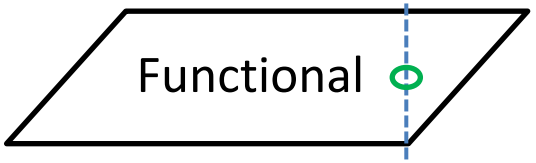
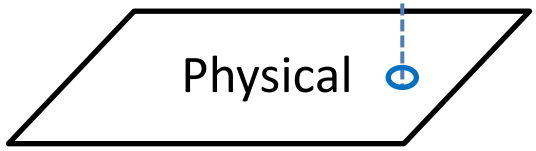
Elementary engineering and functional engineering

Meaning (contents)	Action by D (donation)	Effects on R (functionality)
medical service	cure	health
care	care	activity
support	help	power
move	conveyance	distance
meal	serve	nutrition
esthetic	cosmetic	looks
lodging	offer	recover
education	teaching	knowledge
information	offeror	information
consultation	propose	release
music	play	pleasure
story tell	speak	sight
amusement	perform	relax
keeping	keep	period
transport	distribute	distance
maintenance	repair	recovery
manufacturing	*manufacture*	*usefulness*

Actions by donor seem to be dealt with physical parameters, that is, within elementary engineering disciplines such as mechanical, electrical and chemical. On the contrary, effects appeared on receptor which is functional cannot be but need to be dealt with functional disciplines.

We need to develop engineering disciplines which deal with functions.

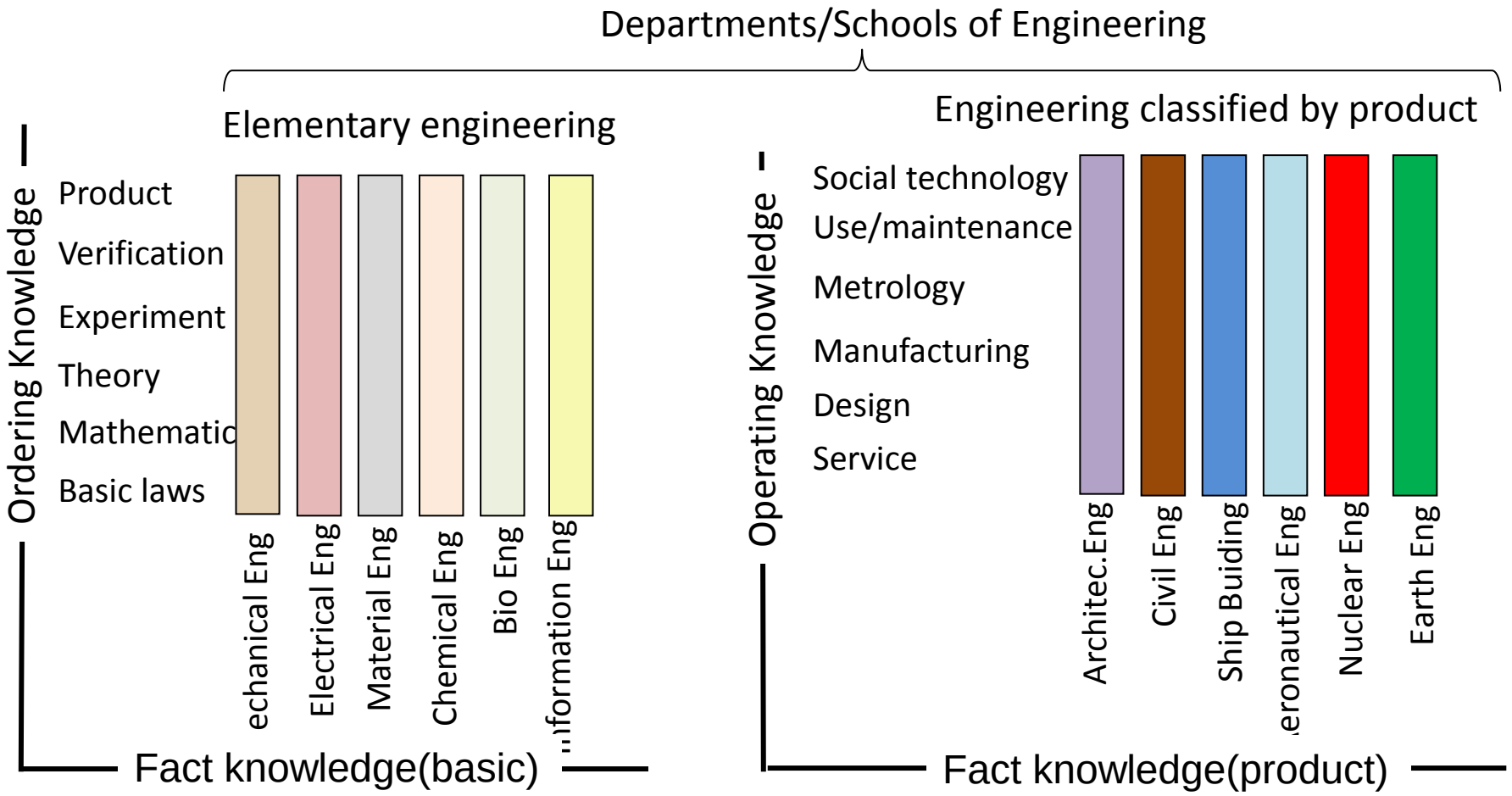
Layers of Knowledge by Abstraction

Levels of Abstraction	Knowledge	Disciplines	Example: Shale Oil
	Knowledge of use for value	**Social Sciences** for theory of value	Shale oil industry Shale oil reserves Shale oil in best mix etc.
	Knowledge of use for function	**Engineering Sciences** for theory of function*	Mining technology Refinement Combustion technology etc.
	Knowledge of exist for data	**Natural Sciences** for theory of data	Shale oil geology Historical process of growth Properties etc.

*Service is flow of function

Structure of Engineering Knowledge

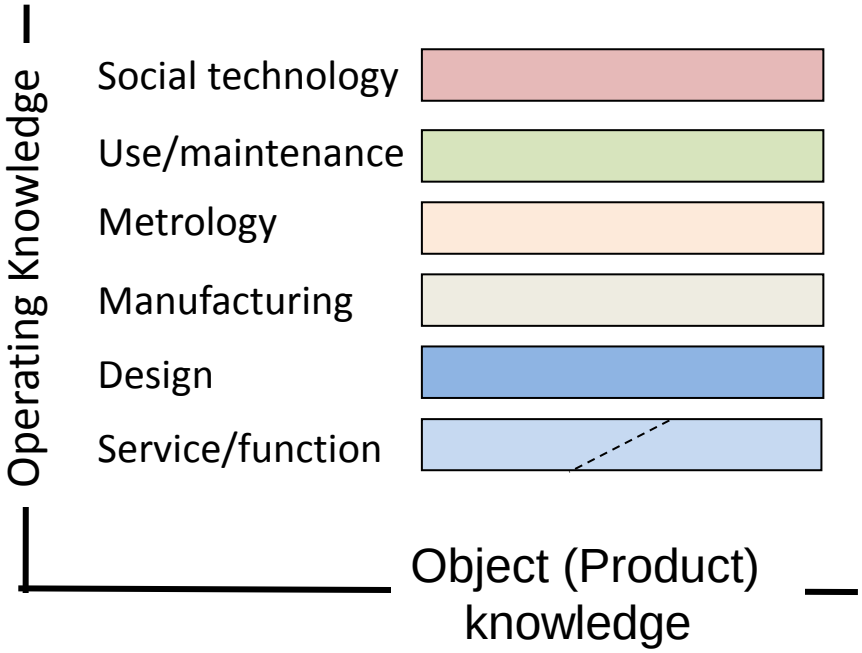
Traditional curriculum of engineering

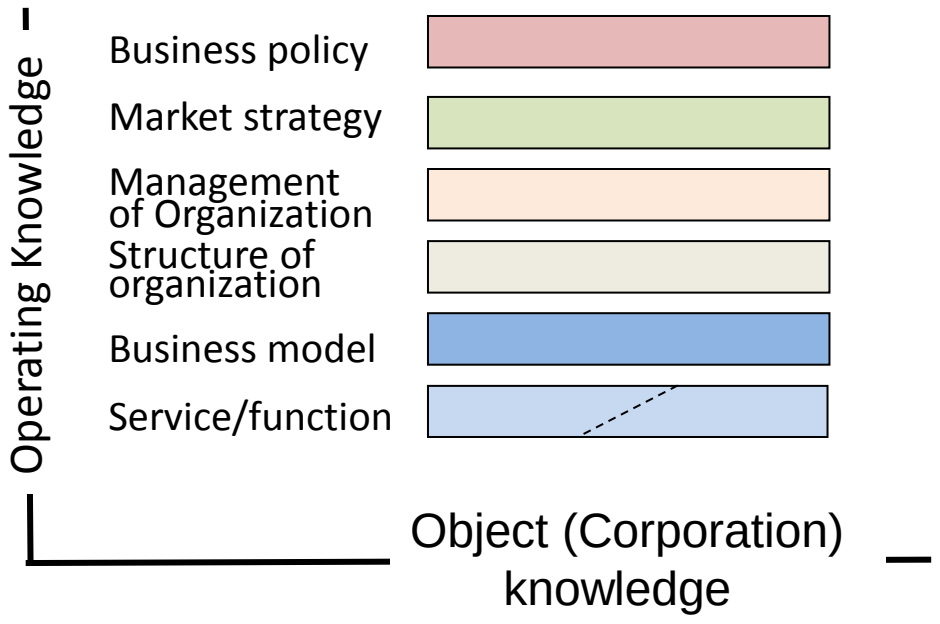


Ordering knowledge is for syntax in disciplines and operating knowledge is for semantics in disciplines.

Curriculum Classified by Operational Knowledge

Synthetic-type engineering/management curriculum





Object of synthesis: Product
→Science of **Engineering Design**

Object of synthesis: Corporation
→Science of **Business Management**

Operational knowledge must be described as an abstract theory independent of object kind.

1. Functionality
1.1 Theory of function(physical, biological, psychical function)
1.2 Element(atom) of function
1.3 Function and attributes
1.4 Element and system
1.5 Functional theory of value
1.6 Role of engineering in sustainability(functional approach)
1.7 Social wish

2. Service
2.1 General service theory
2.2 Theory of primitive service
2.3 Amplification of service
2.4 Hierarchy of service(Nation, government, public, enterprise, individual, biological)
2.5 Informational theory of service
2.6 Economics of service
2.7 Storage of service (IPR, database)

3. Design-Synthesis
3.1 General design theory
3.2 Deign strategy
3.3 System theory(systematization, optimization, mining, search etc)
3.4 Computational theory
3.5 Domain specific theories of design (mechanical, electric, architectural)
3.6 Theory of disciplinary merging

4. Manufacturing
4.1 General manufacturing theory
4.2 Manufacturing processes (function, information, data, material)
4.3 Manufacturing technologies (devices and machines)
4.4 Integrated processes
4.5 Integrated manufacturing systems）
4.6 Standard

5. Performance(characterization, evaluation)
5.1 General metrology
5.2 Integrated observation
5.3 Physical measurement
5.4 Measurement of function and risk
5.5 Safety, reliability, life, resilience
5.6 Burden to environment, recyclability, waste
5.7 Economy of measurement

6. Maintenance
6.1 General maintenance theory
6.2 Life cycle theory and technology
6.3 Maintenance technology
6.4 Maintenance system
6.5 Physics of maintenance
6.6 Maintenance of earth
6.7 Life cycle industries: integration of maintenance, recycle, waste

7. Social technology
7.1 General theory of use
7.2 Innovation ecosystem
7.3 Entrepreneurship, realization, dissemination, acceptance
7.4 Regulation, organization, funding
7.5 Side effects(unexpected function(physical, social, biological, psychical)
7.6 Social effect of innovation

8. Introduction of disciplinary engineering(analysis-type curriculum)
8.1 Mechanical engineering (mechanics, heat, fluid etc.)
8.2 Electrical engineering(circuit, field theory)
8.3 Material technology(metals, plastics; nanostructure)
8.4 Information theory
8.5 Bioengineering
8.6 Software engineering

Synthetic-type engineering curriculum (version 7 Jan 2013)

5. Evolutionary development of service

4.1 Basic loop for sustainable evolution
4.2 Evolution of product
4.3 No evolution of service

Evolution of Service in Society
toward sustainable society

Our fundamental viewpoints of service in society

⇩

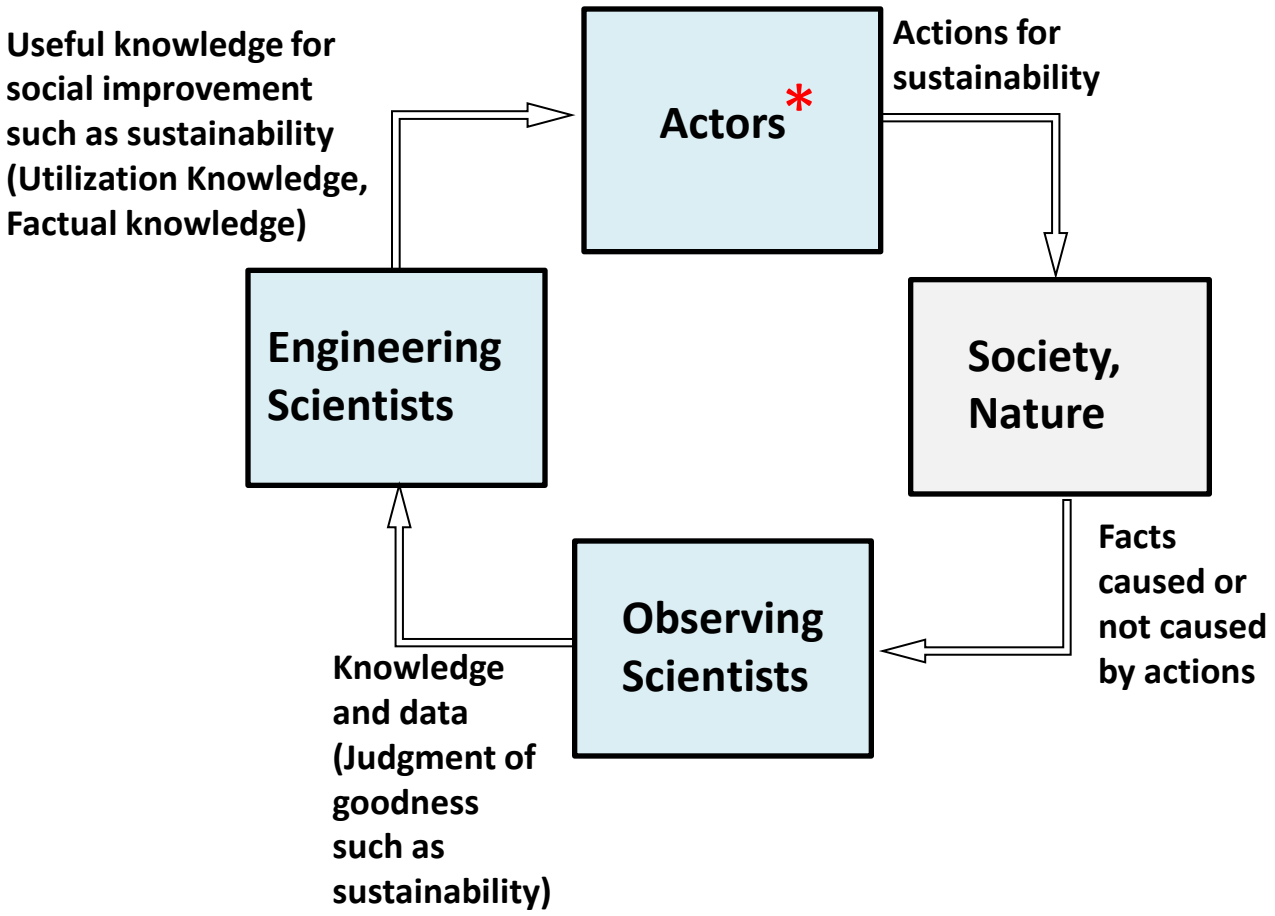
Service evolves incrementally in society according to the actions intended and performed by actors and accepted by people.

⇩

evolves	Evolution of language(Ferdinand de Saussure)	**Basic Ideas**
incrementally in society	Piecemeal social technology (Karl R. Popper)	
intended and performed	Abduction (Charles Sanders Peirce)	
accepted	Satisfaction of social wish（CRDS)	

Basic Loop in Evolving Society with Scientists

Sustainable Society by "Scientific" Evolution

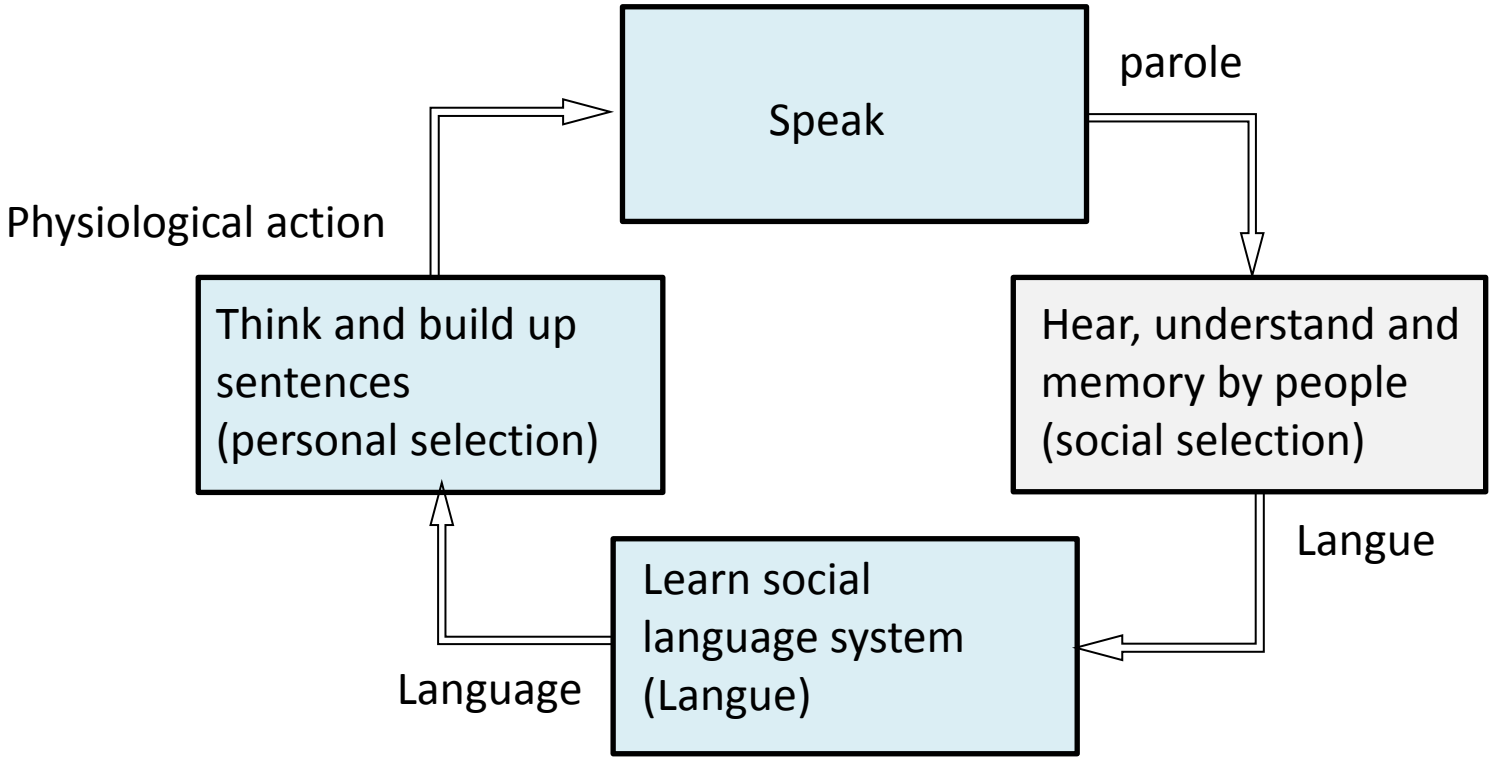


* Actors in Society are:
statesmen,
policymakers,
business humans,
administrators,
engineers,
educators,
writers,
artists,
journalists,
etc.
who move society.

C. S. Peirce: Abduction, F. Saussure: Evolutionary Loop, K. Popper: Piecemeal Technology

Evolution of Language System

Ferdinand de Saussure (1857 – 1913)

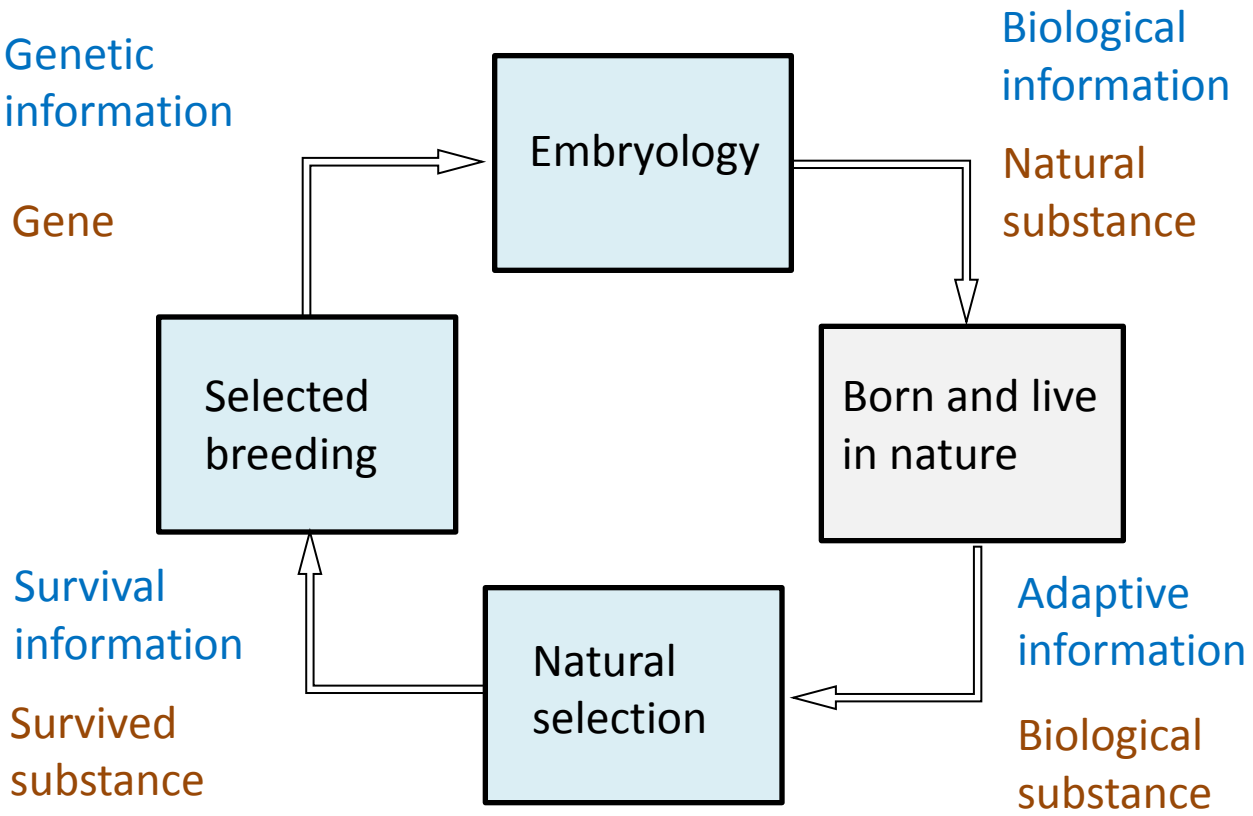


A human who learns and speaks

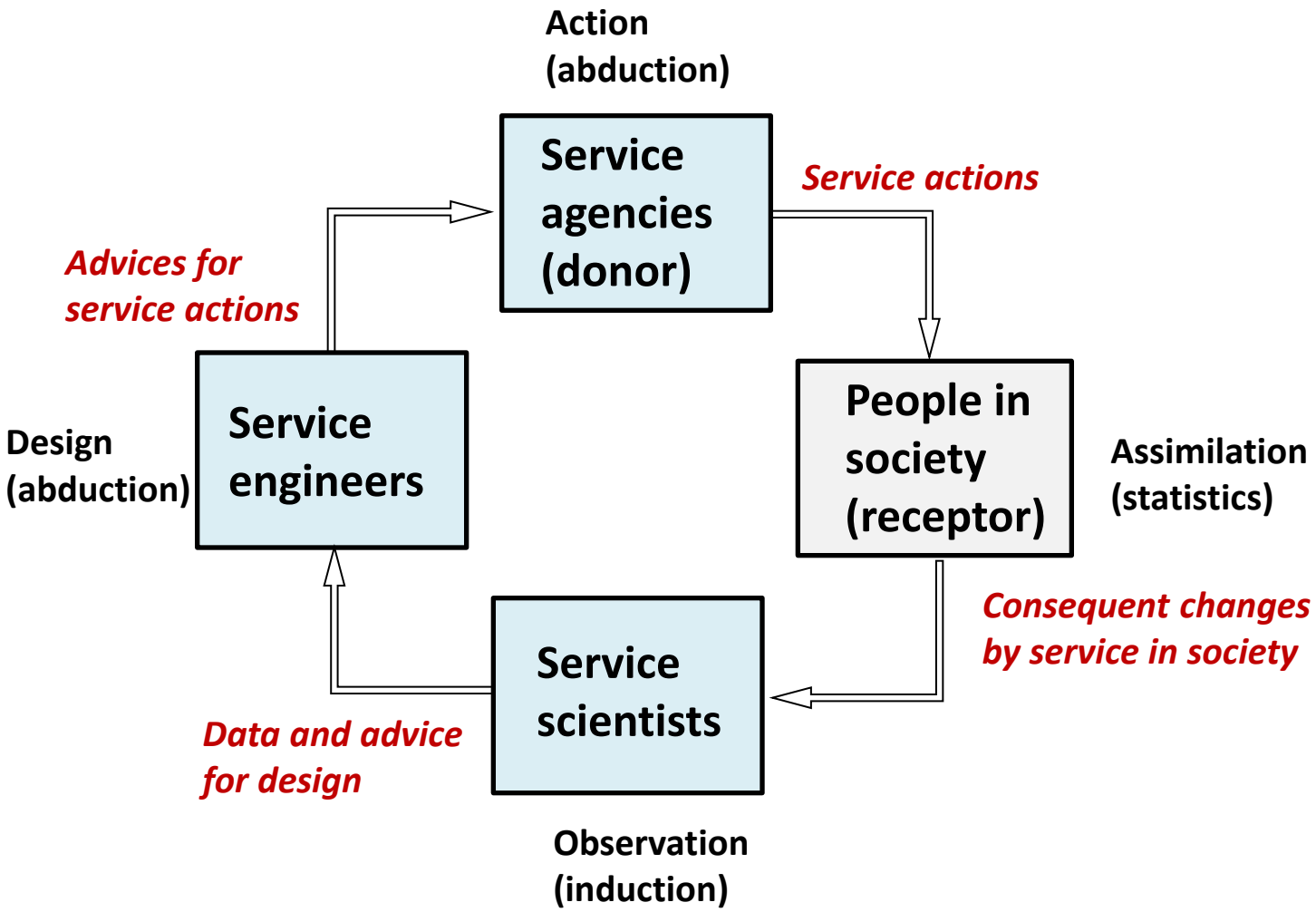
Society which develops language system

Sustainable Evolution of Living Things

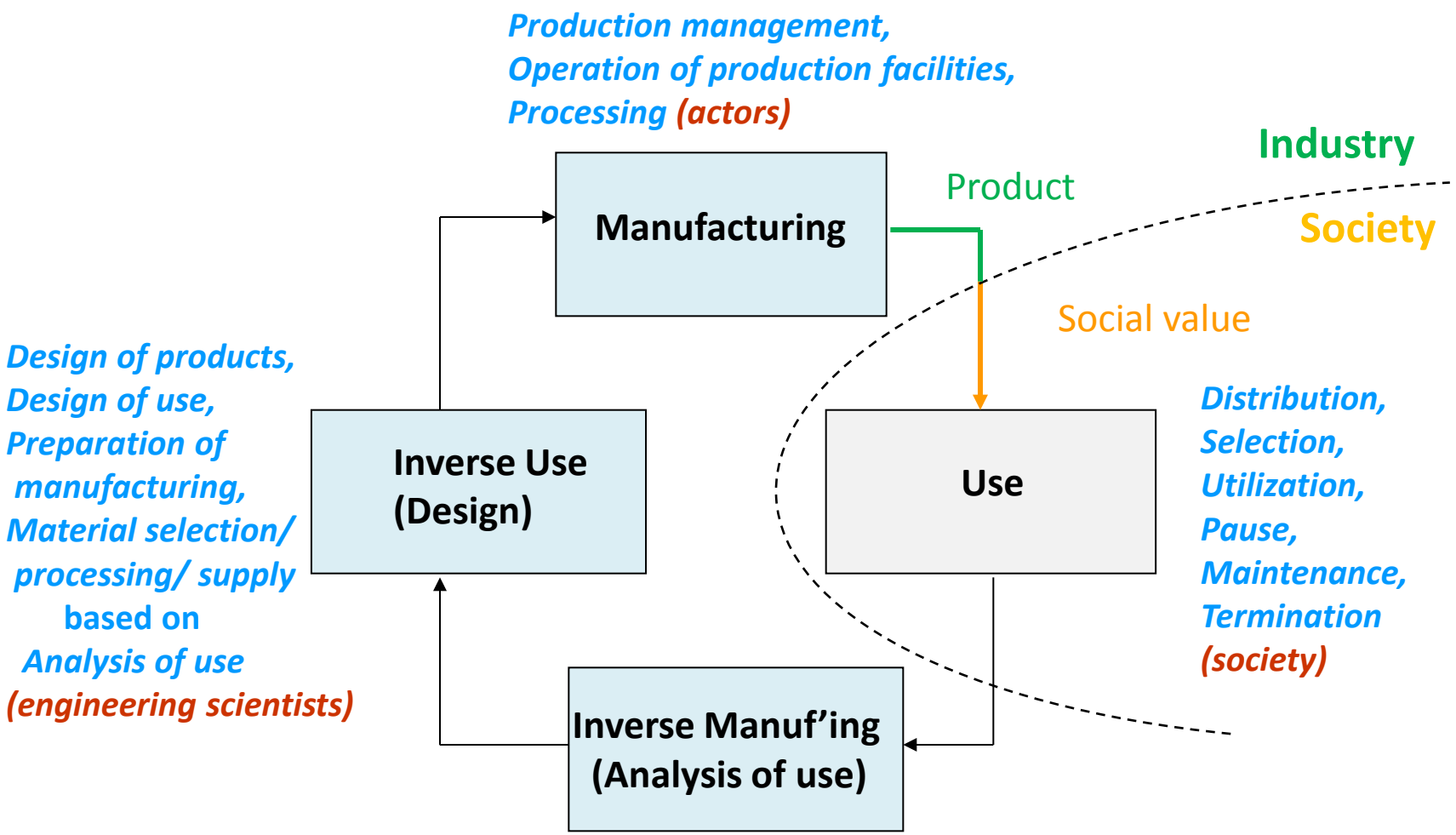
Concurrent Occurrence of Information Cycle and Substance Cycle



Sustainable Evolution of Service in Society



Evolutionary Loop of Manufacturing Industry



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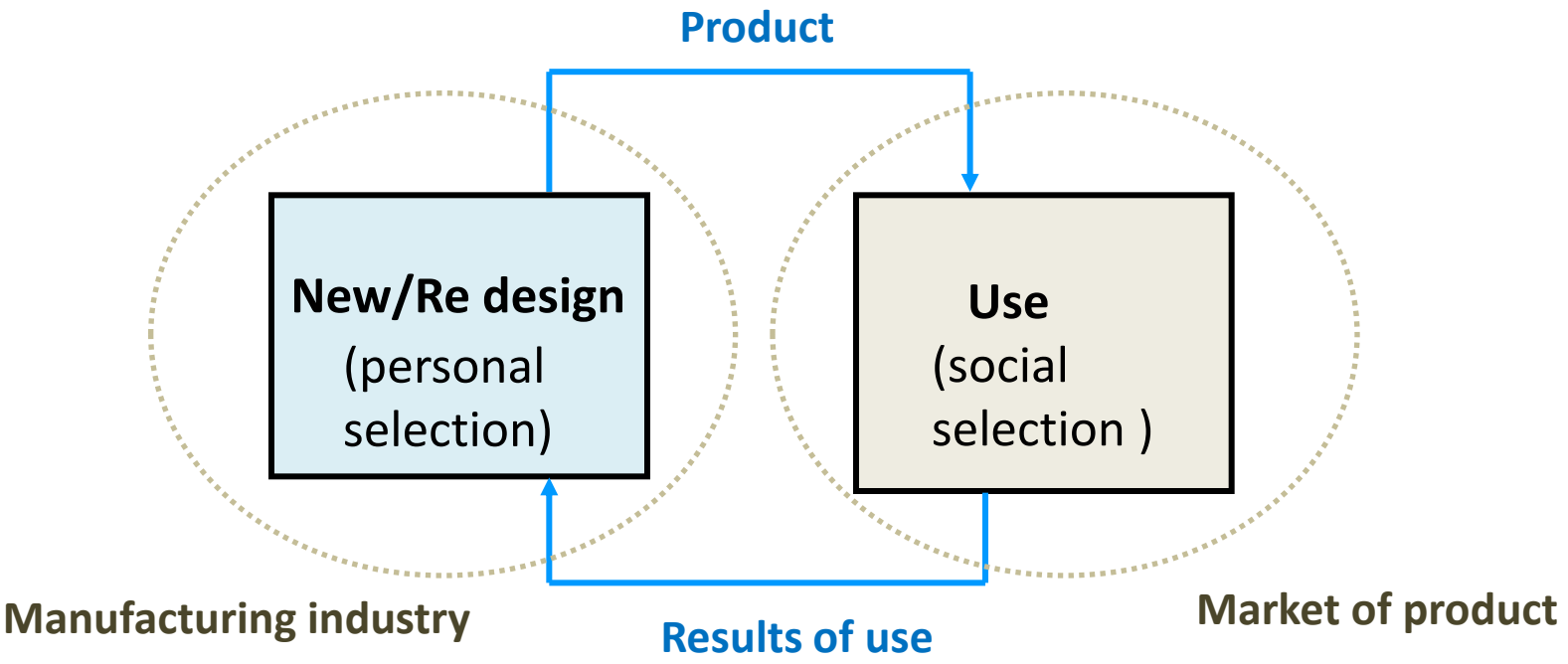
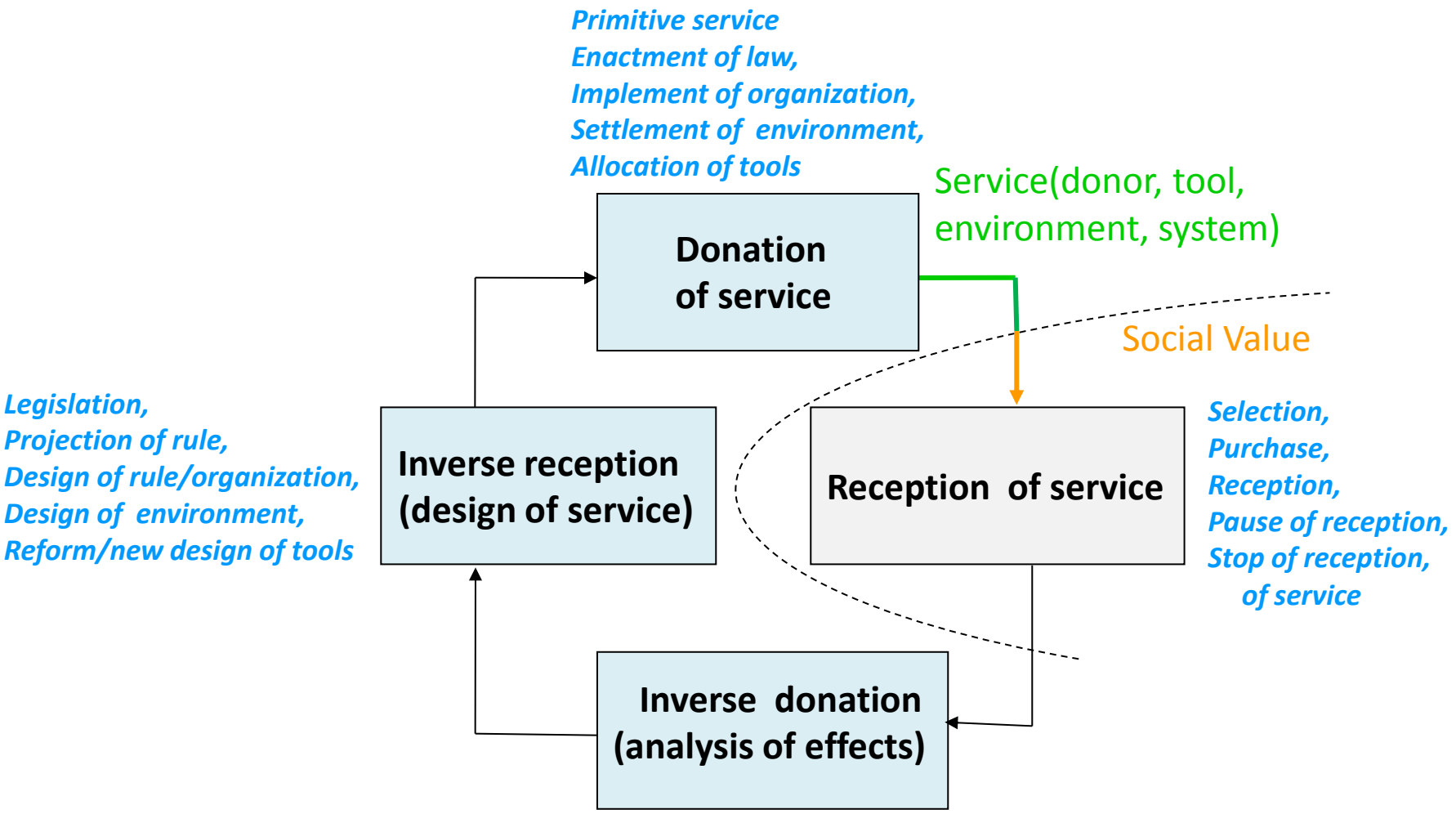
Evolution of Products by Selection in Market

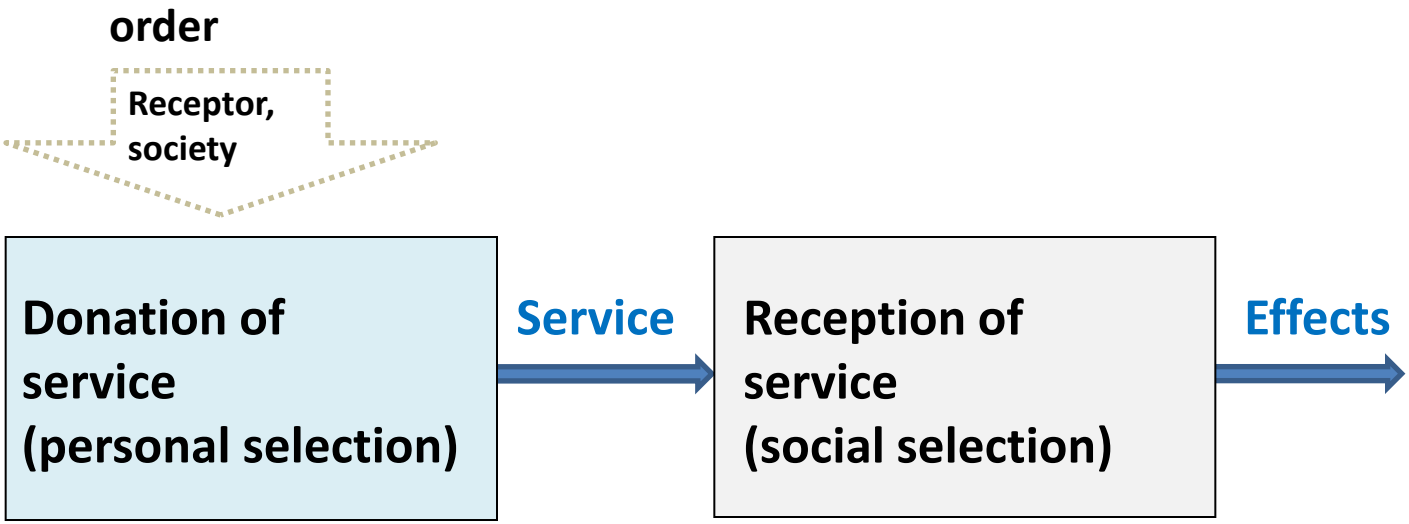


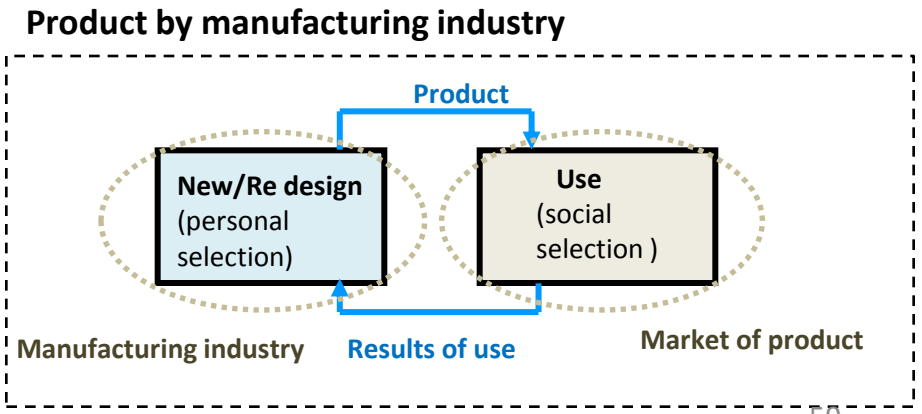
Evolutionary Loop of Service Industry



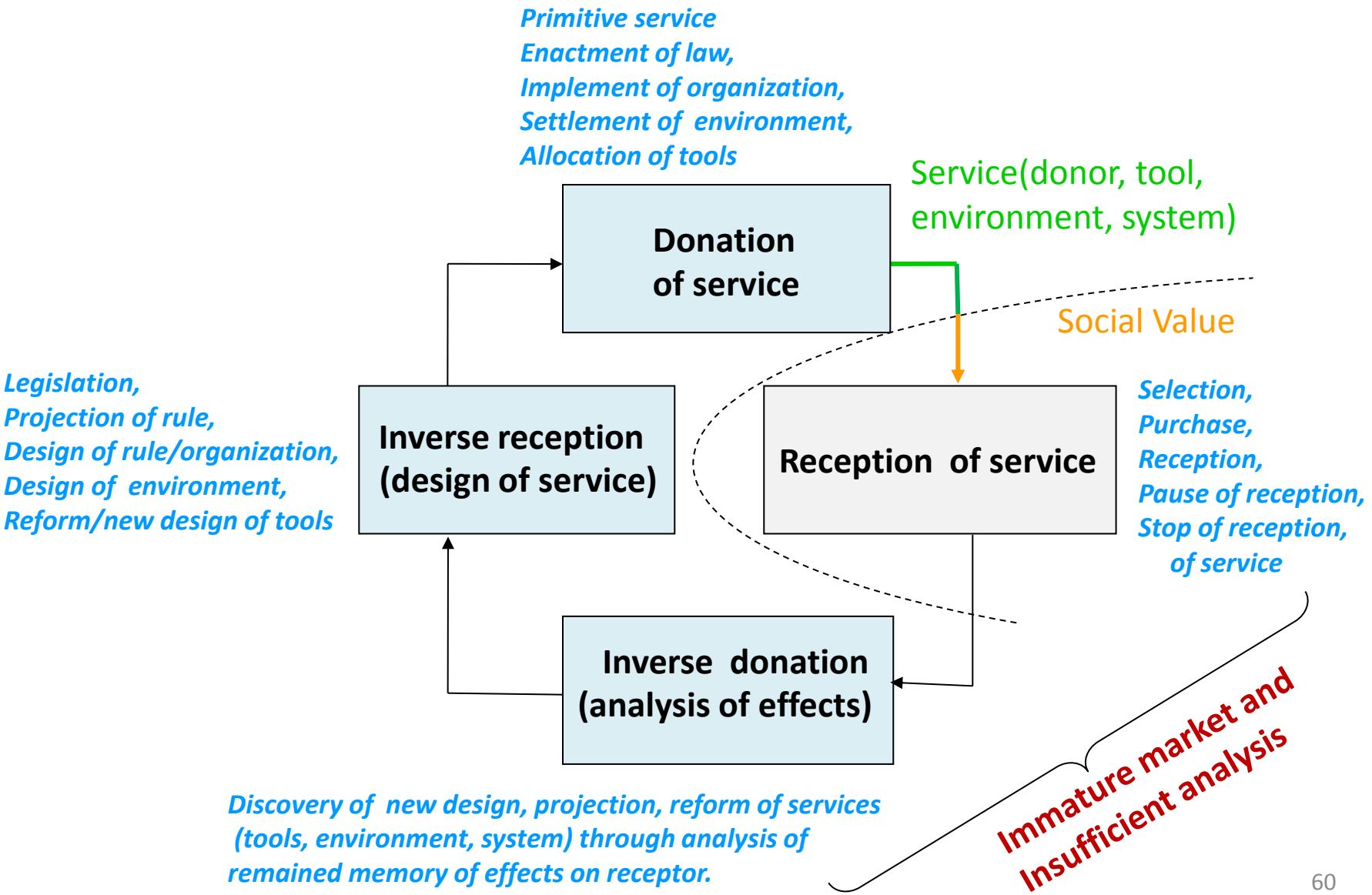
Discovery of new design, projection, reform of services (tools, environment, system) through analysis of remained memory of effects on receptor.

Incomplete Loop in Service





Improvement of Evolution of Service Industry

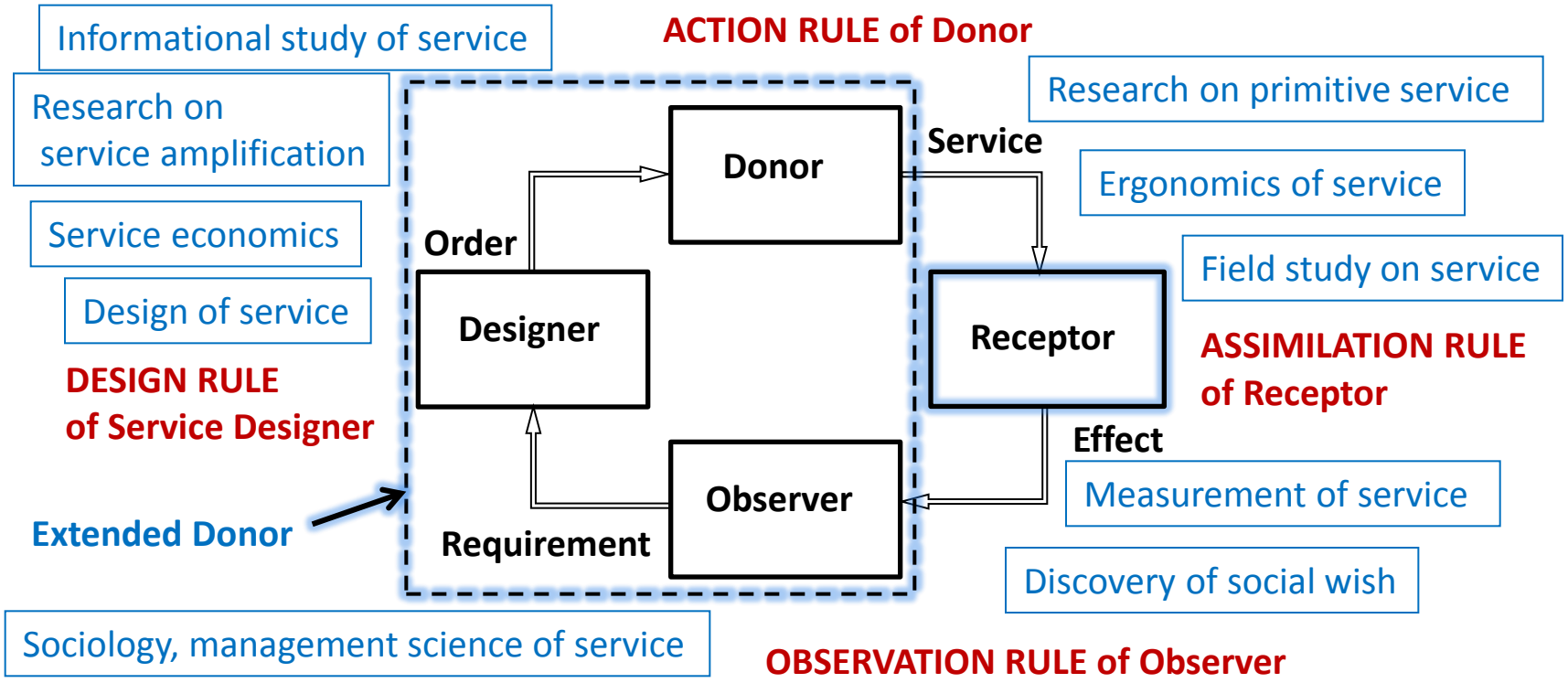


6. Conclusion

Necessary Scientific Research on Service

(multiple approaches to complete the cycle)

Multiple approaches to service, according to the basic loop



Research on service		Disciplines			
		Physical	Life	Mental	Social
Research on service	Action rule of donor Assimilation rule of receptor Observation rule of observer Design rule of service designer	all			
Research on service systems (amplifi-cation)	Research on primitive service	○	○	○	
	Economics of service				○
	Information-theoretical research				○
	Ergonomics of service		○	○	
	Field study of service				○
	Design research on service	○	○	○	○
	Measurement of service effects	○	○	○	○
	Discovery of social wish of service				○