Designing social and industrial structures from a holistic perspective

～Social and Industrial Architecture Design in the Digital Age～

Seiko Shirasaka, Professor
Graduate School of System Design and Management
Keio University
shirasaka@sdm.keio.ac.jp

“83% of radiologists missed the gorilla.”

By Trafton Drew, Harvard Medical School

People are subconsciously selecting information.

出典：”The Invisible Gorilla Strikes Again:Sustained Inattentional Blindness in Expert Observers”, Trafton Drew, Melissa L.-H. Võ, and Jeremy M. Wolfe, Harvard Medical School.

People only see what they want to see.

- People's cognition has an unconscious bias (cognitive bias).
- Certain groups are often subject to certain biases (Expert bias).
- Utilizing diversity to actively try to see what we don't see because of our biases.
- It's not easy to think beyond expert bias. We need the tools (= methodology) to integrate diversity.

<Previous>
School of Engineering, The university of Tokyo
Department of Aeronautics and **Astronautics**
The Graduate School of SDM, KEIO university
Doctor Degree（**Systems Engineering**）
Mitsubishi Electric Corporation
HTV: H-II Transfer Vehicle
QZSS:Quadi Zenith Satellite System
(MBSE at Airbus as Exchange Engineer)
ImPACT Program Manager, Cabinet office

<Present>
Professor, The Graduate School of SDM, KEIO university
Architecture、**“System x Design”** thinking
Methodology Development
IPA Digital Architecture Design Center
Chair of Advisory Board
ISO JTC1/SC7 WG42 “**System Architecture**”
Domestic Leader
Synspective inc. Founder, Board of Director
Committee member
Cabinet Office Space Policy
Cabinet Secretariat Digital Market Competition
METI Growth Strategy, New Governance Model

Who are we?

SDM System Design And Management

Graduate School of System Design and Management
Keio University

Systematizing, researching, and teaching interdisciplinary approaches that unites multiple disciplines

Graduate School for Diverse Working Students

Why we need holistic perspective?

Holistic Perspective = System Thinking

System Thinking

Systemic

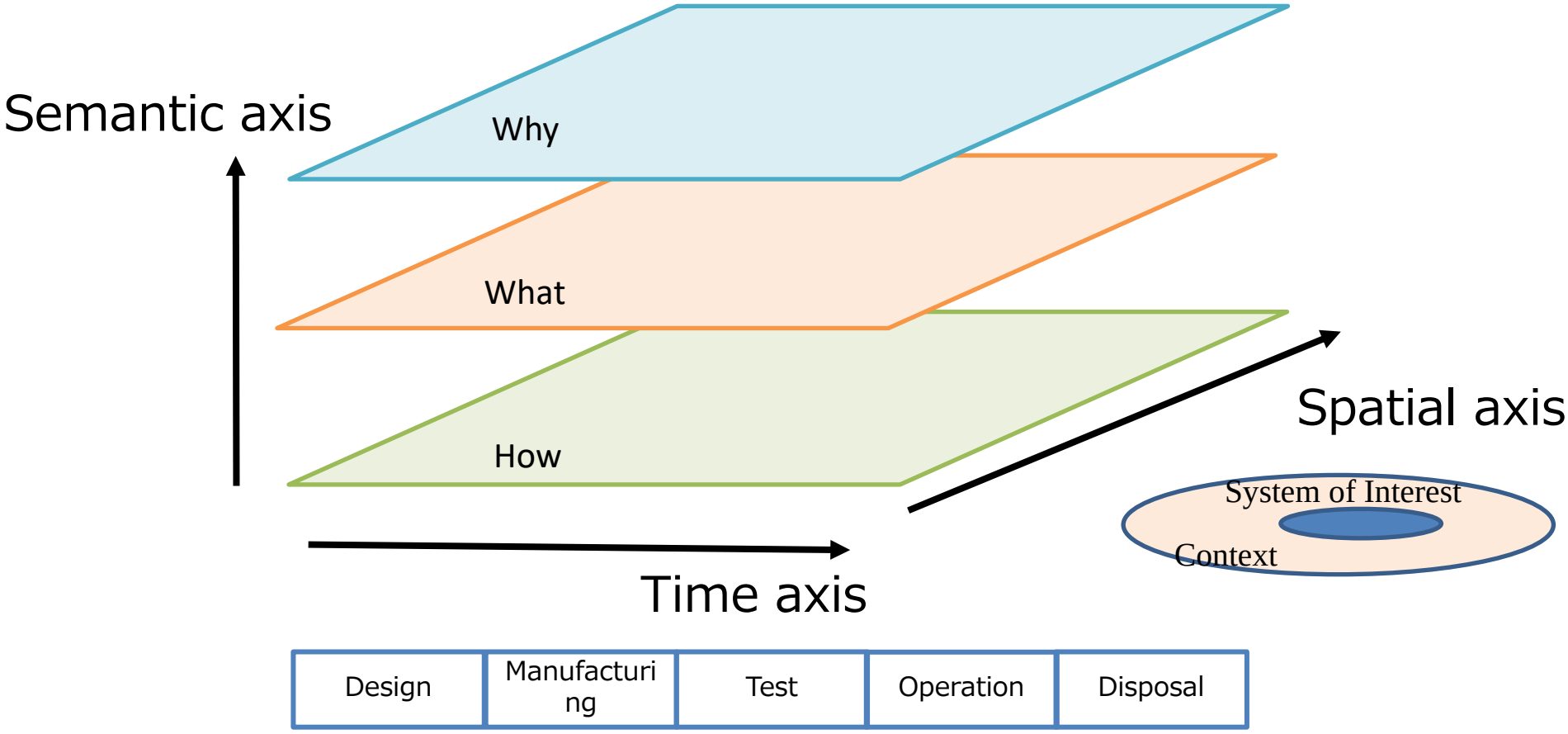
Systematic

a discipline for seeing wholes ...

a framework for seeing interrelationships rather than things ...

(Senge, P.M. 1990, 2006. The Fifth Discipline: The Art and Practice of the Learning Organization. New York, NY, USA: Doubleday Currency, 68-69)

"holistic perspective" is



Three reasons

caused by Recent features in the systems field

- Expansion of the scope as a system
- Rapid Changes in Context
- Increase of important system characteristics and accountability

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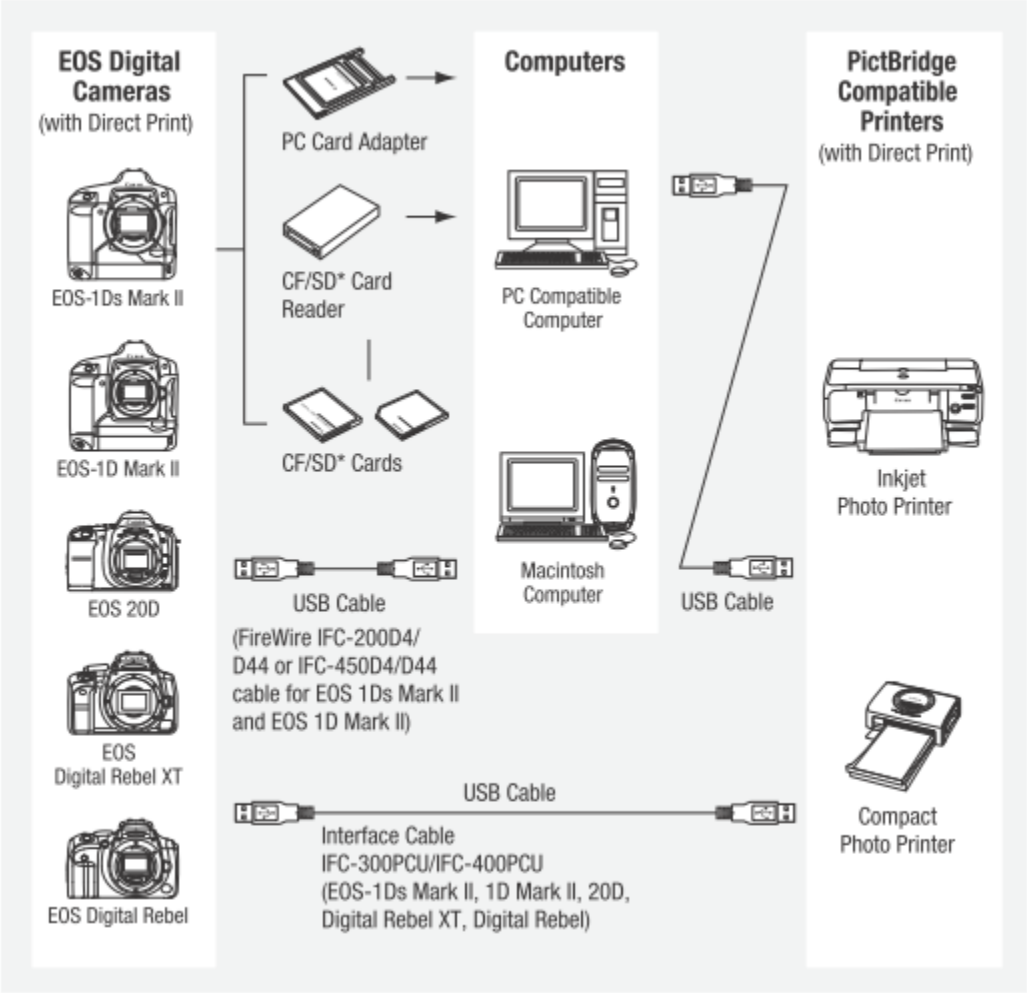
  - Connection : System of Systems
  - Digital : DX

System of Systems



出典：INCOSE Systems Engineering Handbook

System of Systems

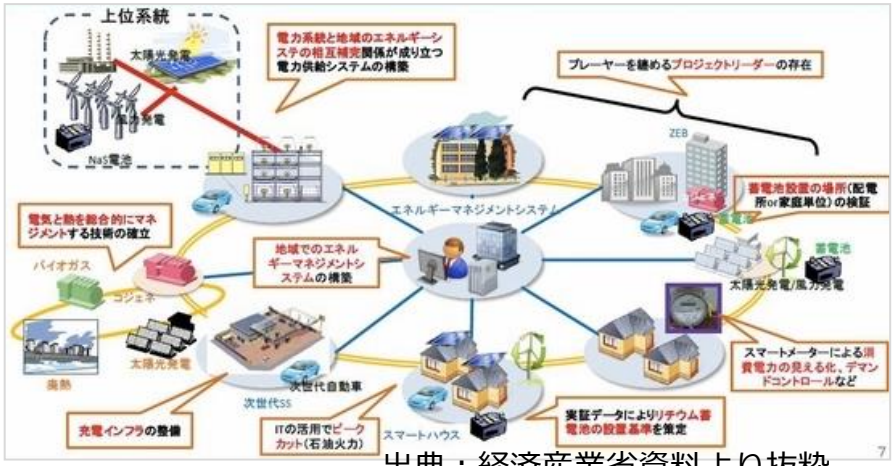
A system with the following five characteristics is called a System of Systems (SoS).

1. Operational Independence：the component systems must be able to usefully operate independently.
2. Managerial Independence：The component systems are separately acquired and integrated but maintain a continuing operational existence independent of the system-of-systems.
3. Evolutionary Development：A SoS evolves during operation by adding / deleting functions and objectives.
4. Emergent behavior：Achieve objectives that cannot be achieved by a single component system as a SoS.
5. geographically distributed：The component systems are geographically separated and exchange information between the component systems, rather than physical quantities of mass and energy.

出典：“Architecting Principles for Systems-of-Systems”, Mark W. Maier (1998)

System of Systems

Movement in the World：A system is starting to connect.

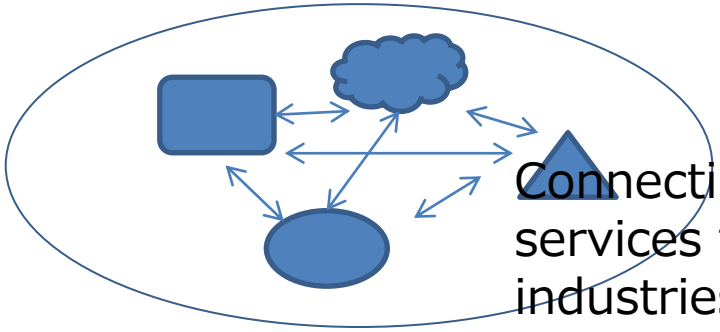


出典：経済産業省資料より抜粋

出典：テキサスインスツルメント資料より抜粋

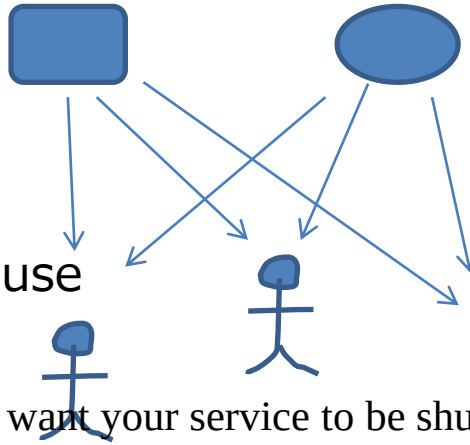
出典：「インダストリー4.0 実現戦略報告書」より抜粋

Difficult to guarantee quality



Connecting products and services from different industries to provide users with.

Expanding the connection of system

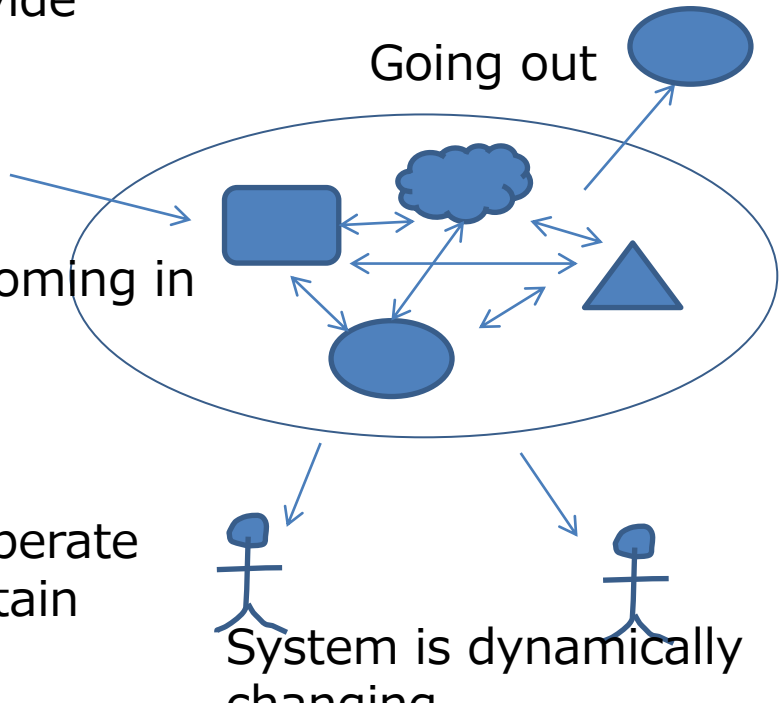


Easy to use

Easy to operate and maintain

You don't want your service to be shut down because of a system failure.

A wide variety of stakeholders



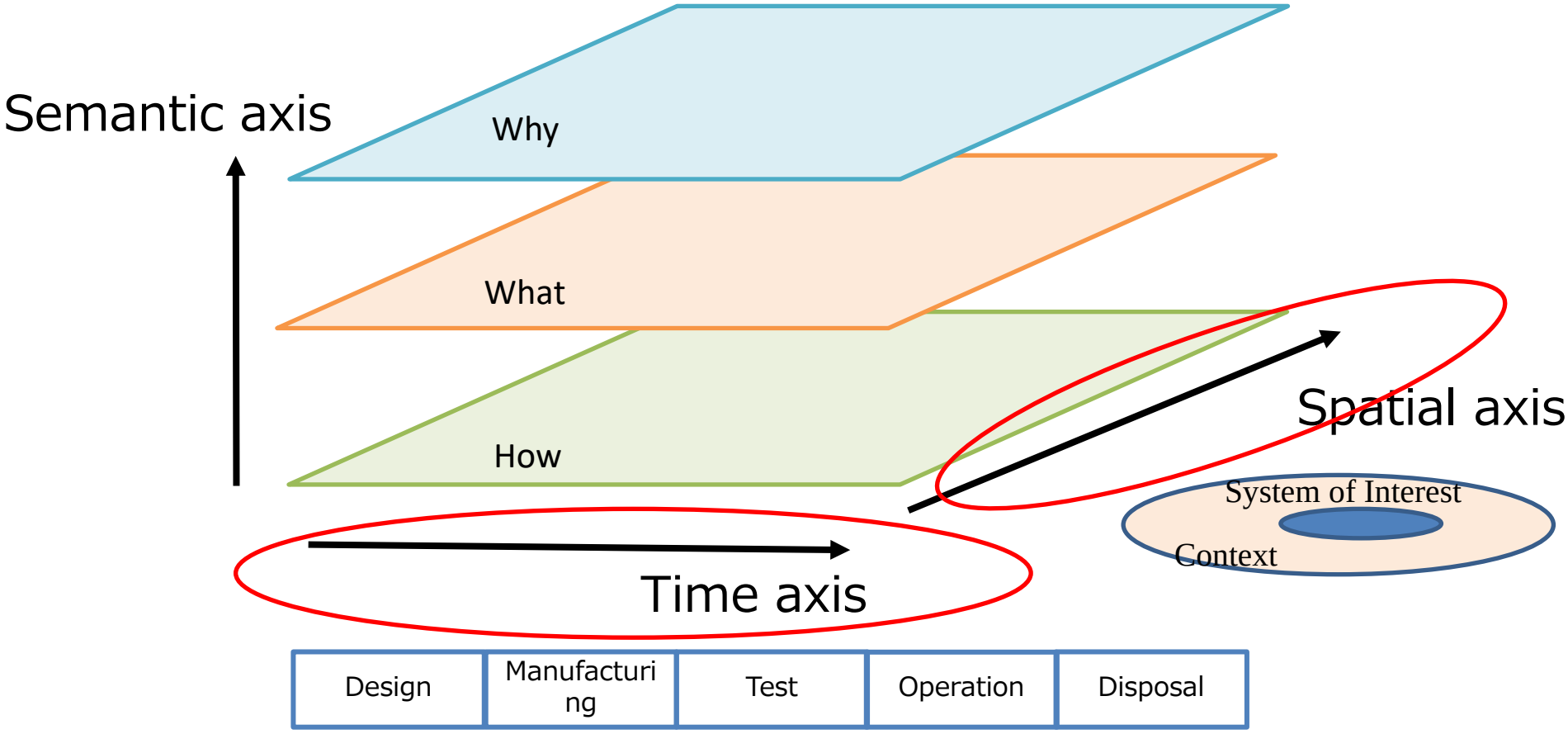
Going out

Coming in

System is dynamically changing

Unscheduled system changes during operation

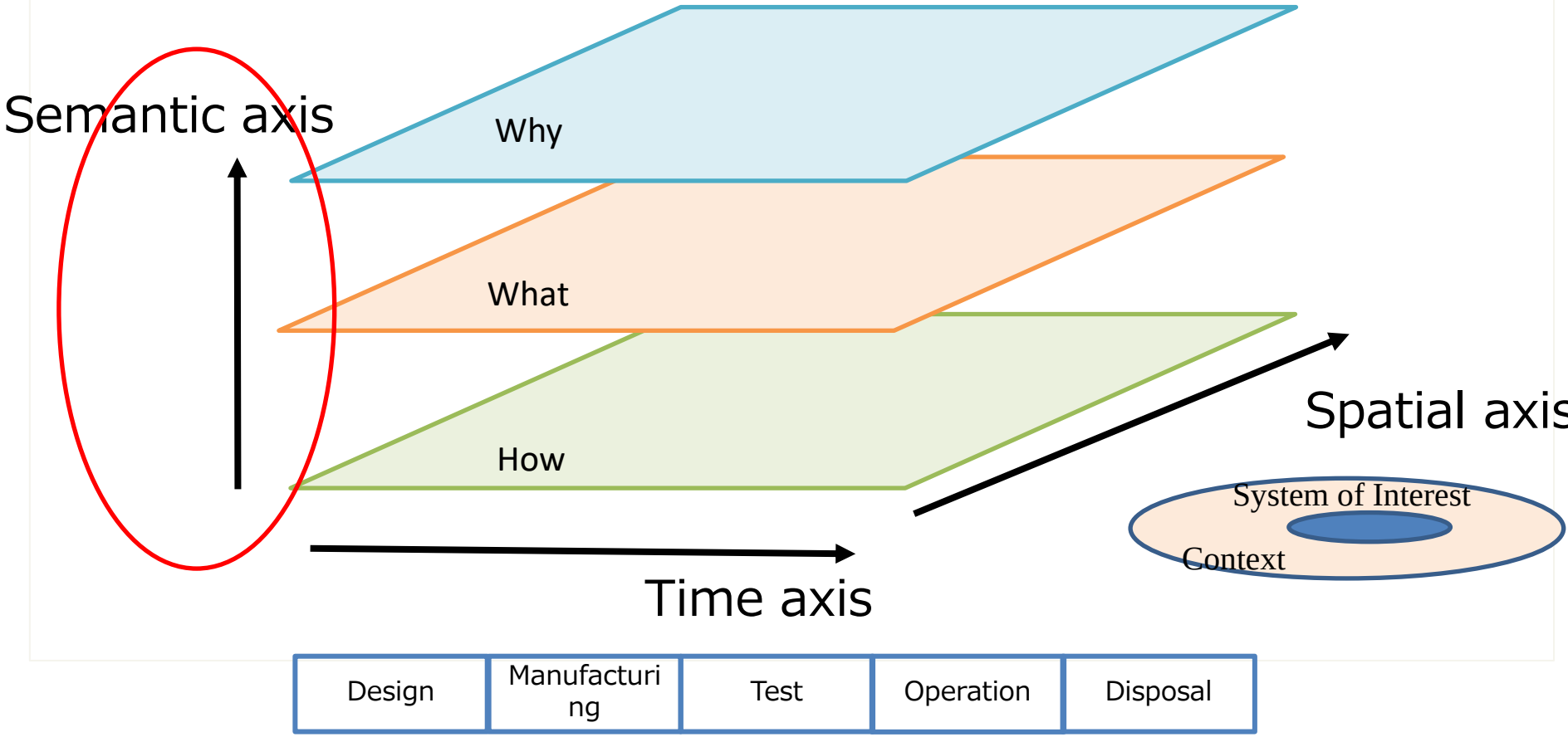
"holistic perspective" is



DX

It's not simply about replacing the means with digital means.

It's about transforming to a better way of achieving our objectives.



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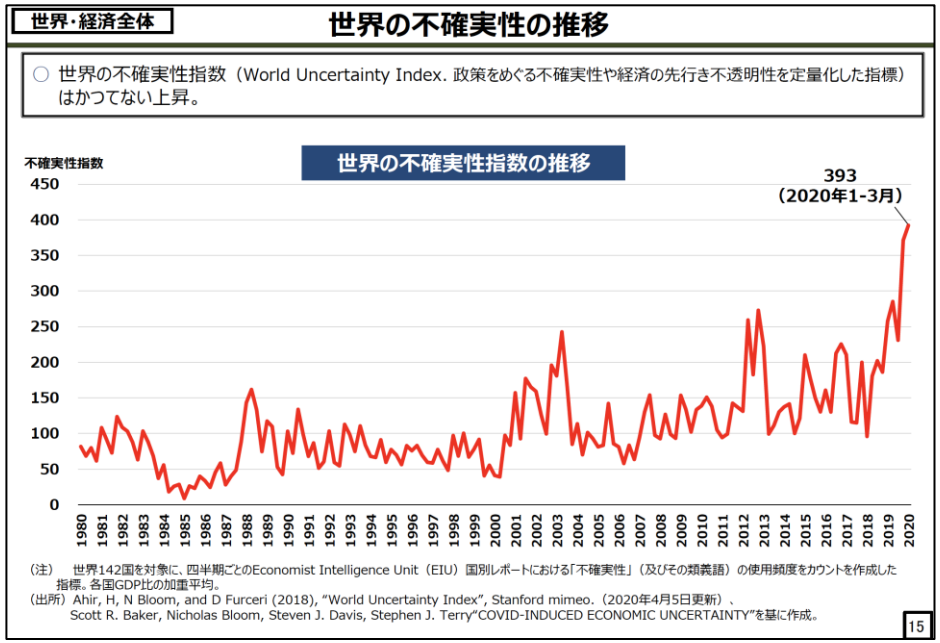
Rapid Changes in Context

An era of greater unexpected environmental change

- Increased Uncertainty ：World Uncertainty Index
- Strengthening Connections ex. Society 5.0
  (Systems of Systems)



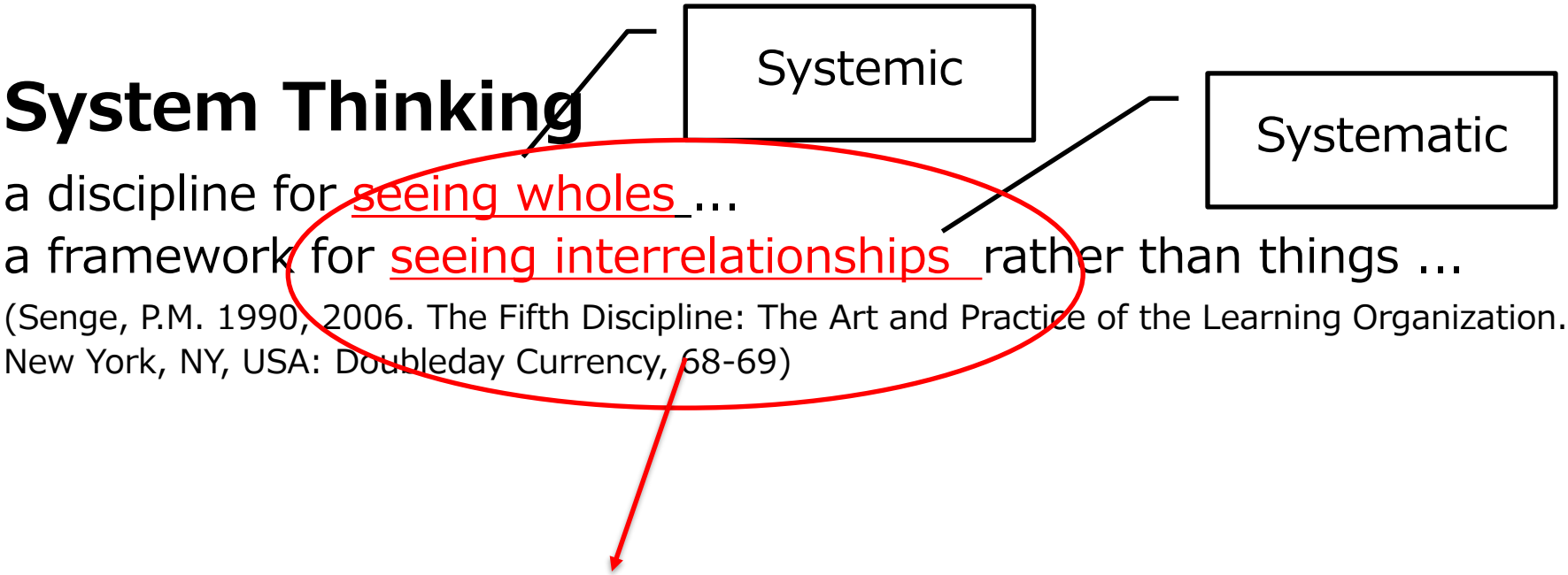
出典：経産省 第3回成長戦略部会

VUCA World

Volatility, **U**ncertainty
Complexity, **A**mbiguity

- Conventional wisdom and assumptions don’t work
- You don't know what you think you know.

Holistic Perspective = System Thinking



System Thinking

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Define and update

- Interrelationships between a system and its context
- Interrelationships between system elements

through spatial axis, time axis and semantic axis.

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-ilities

- "-ilities" is a Related Discipline of Systems Engineering.
- It was previously called "Specialty Engineering.
- Systems Engineering needs to Integrate “–ilities”.
- SEBOK Part6
  - Reliability, Availability, and Maintainability
  - Human Systems Integration
  - Safety Engineering
  - Security Engineering
  - System Assurance
  - Electromagnetic Interference/Electromagnetic Compatibility
  - Resilience Engineering
  - Manufacturability and Producibility
  - Affordability
  - Environmental Engineering

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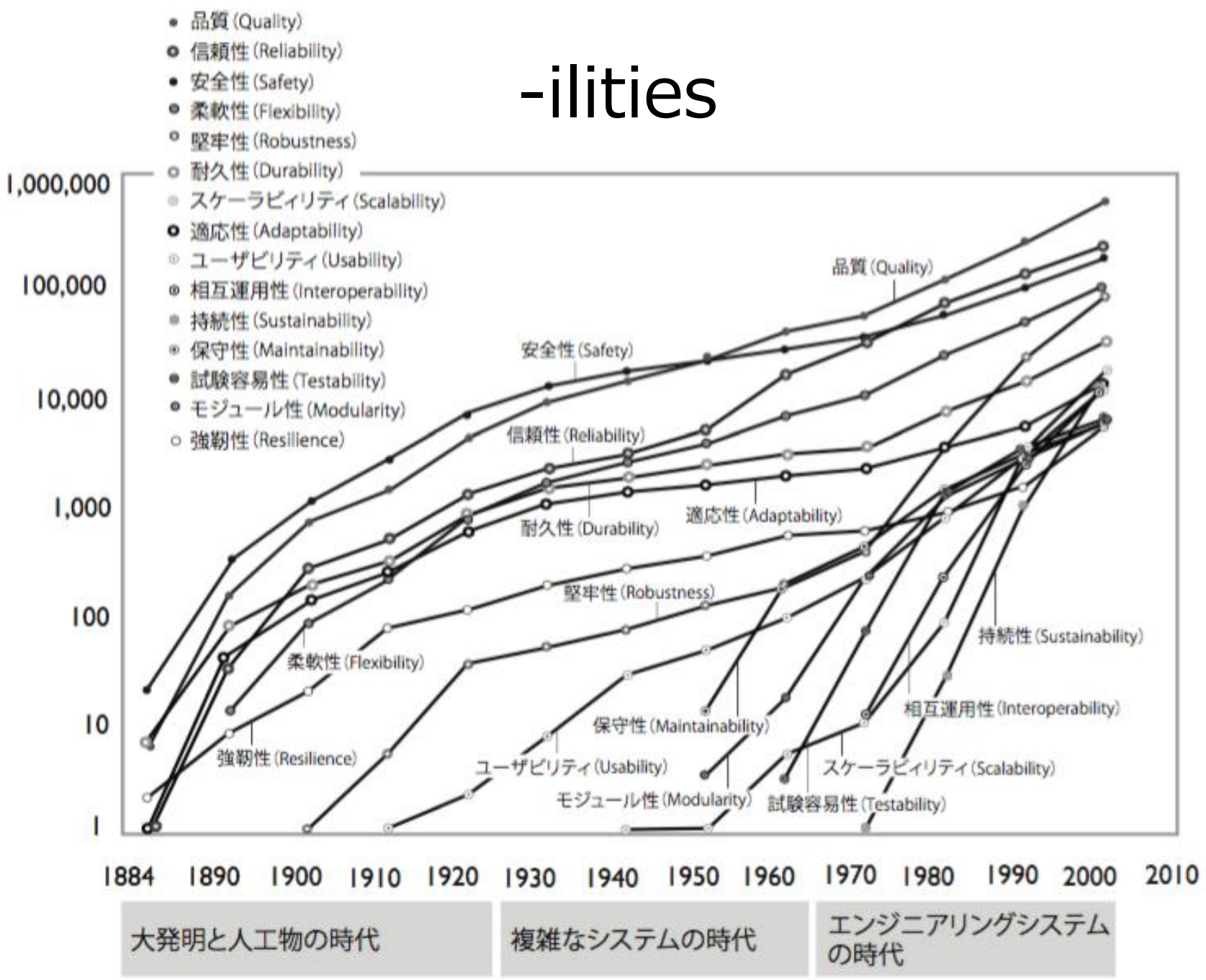
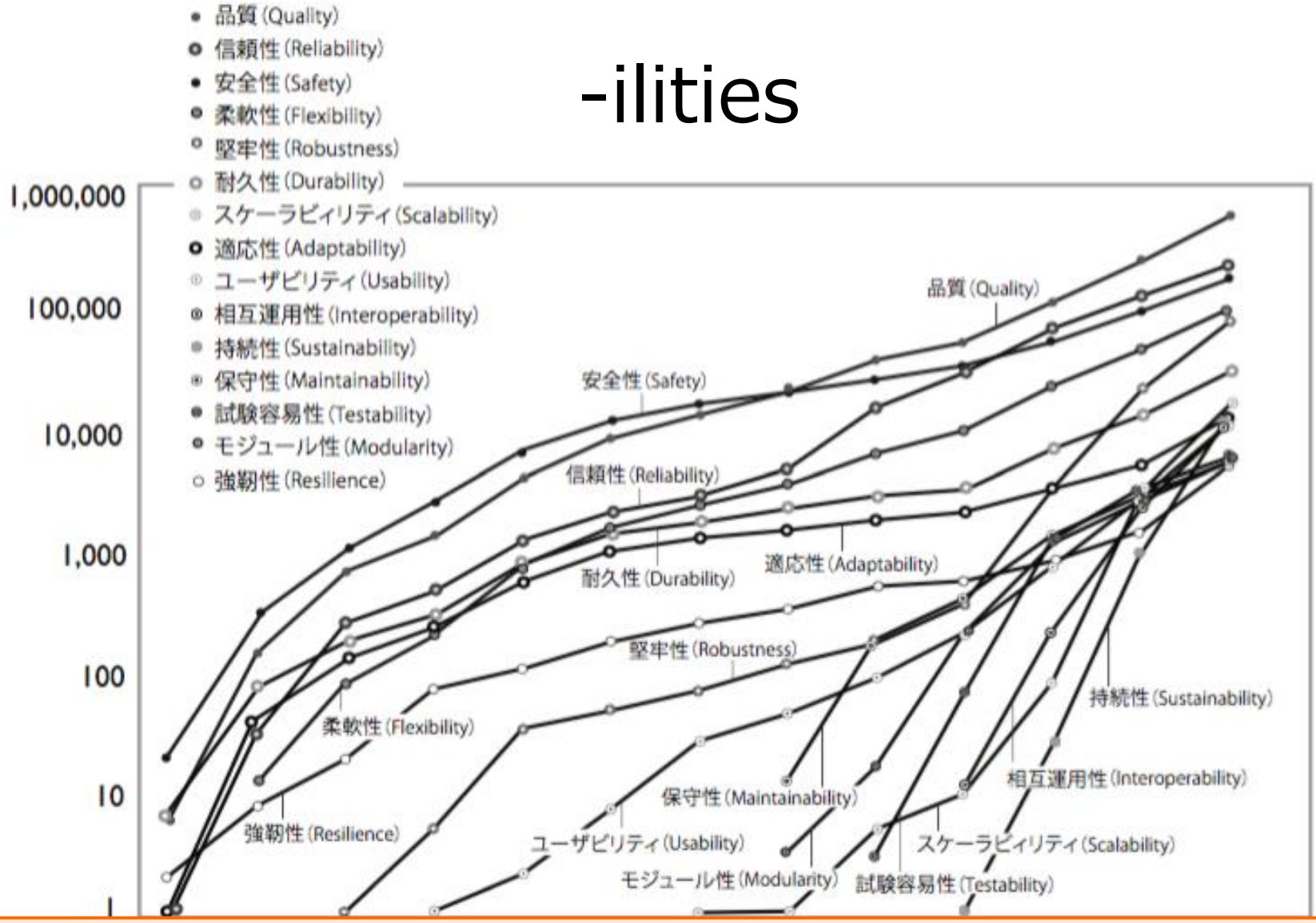
"-ilities" is a property that has to be viewed as a system system characteristic

-ilities



出典：エンジニアリングシステムズ

-ilities



Proving system characteristics has to be a top-down process.
Functional Safety（26262, RAMS)

System Architecture

Systems Approach

Systemic

Systematic

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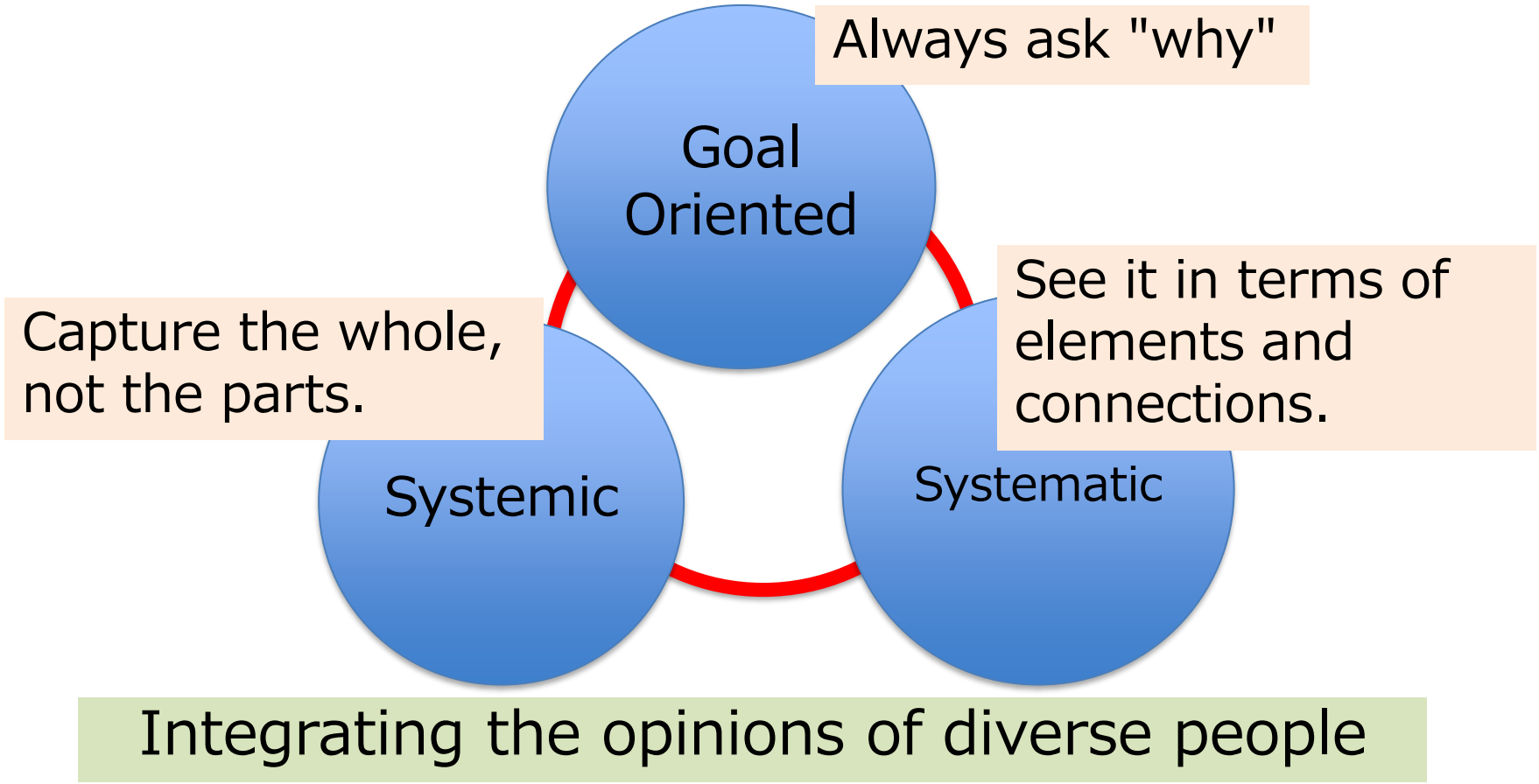
Goal Oriented

Systems Approach

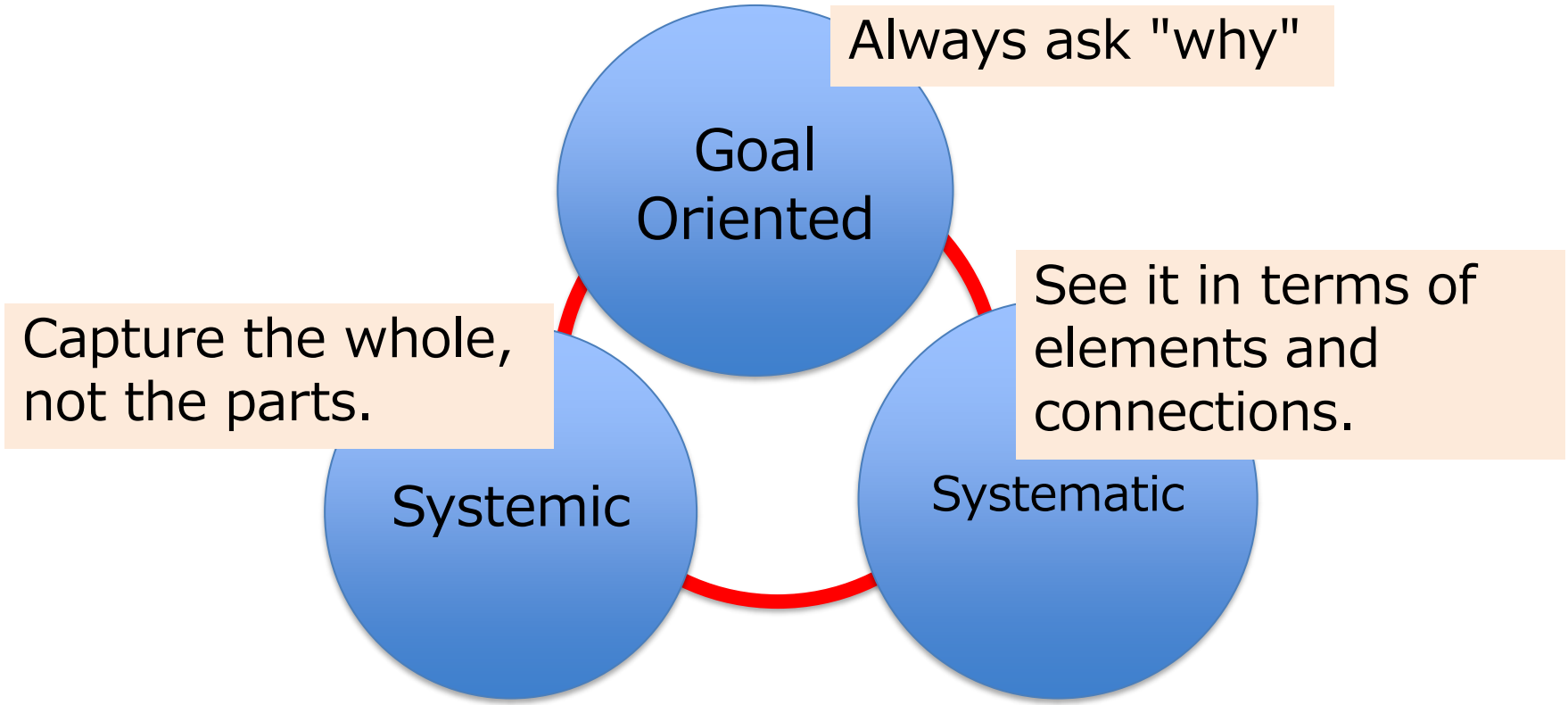
The systems approach is a way of tackling real world problems and making use of the concepts, principle and patterns of systems thinking to enable systems to be engineered and used.

(INCOSE Systems Engineering Body of Knowledge)

Systems Approach



Systems Approach in Practice



Integrating the opinions of diverse people

Multi-viewpoints | Structuration | Visualization

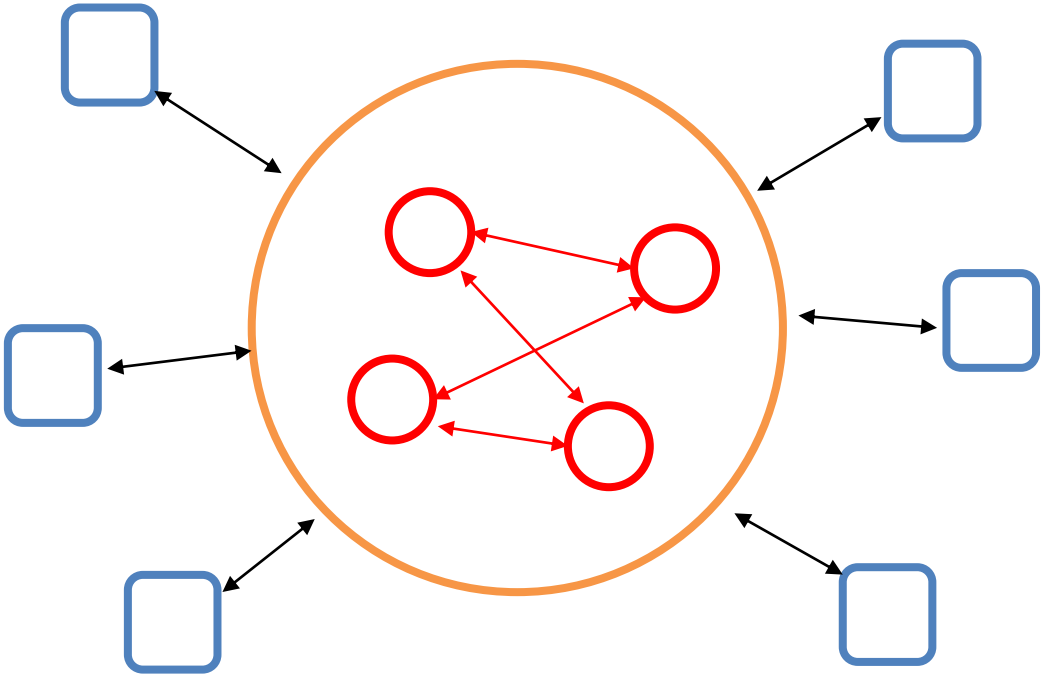
Definition of Architecture

- fundamental concepts or properties of a system in its environment embodied in its elements, relationships, and in the principles of its design and evolution

（source：ISO/IEC/IEEE 42010-2010)

- Fundamental concept of system which shows how system purpose is realized. The properties are emerged by the concept.
- The fundamental concept of system is defined by relationship between a system of interest and the context of system and between components of the system.

Definition of Architecture



- The relationship between the system and the context and between the elements of the system in order to achieve its objectives.

Characteristic	Architecting	A & E	Engineering
Situation/goals	Ill-structured Satisfaction	Constrained Compliance	Understood Optimization
Methods	Heuristics Synthesis **Art** and science	↔ ↔ Art **and** Science	Equations Analysis **Science** and Art
Interfaces	Focus on "mis-fits"	Critical	Completeness
System integrity maintained through	"Single mind"	Clear objectives	Disciplined methodology and process
Management issues	Working for Client Conceptualization and certification	Working with Client Whole waterfall	Working for Builder Meeting project requirements

Because of the heavy reliance on people, human resource development is more important than setting rules and procedures. Requests for human resources training are increasing rapidly.

System Architect

- Lack of people who can handle both high level of abstraction and concrete architecture
  - Big picture creation and actual implementation experience
  - Diverse experience
- We need both theory and practice.
  - There are people in their field of expertise who can design an architecture that is close to implementation.
  - You may be able to do it practically, but you don't know how to apply it to other field because you don't know the knowledge, concepts and approaches to Systems of Systems and architectural design.
  - On the other hand, if you don't have practical experience, you can't imagine the difficulties in execution.
- Multidisciplinary integration is needed.
  - Integration of fields other than your own
  - Communication & Visualization Skills

Digital Architecture Design Center (DADC)

Designing a new social and industrial "architecture" for the realization of Society 5.0

Summary

- There are three reasons why we need holistic perspective (=System Thinking).
  - Expansion of the scope as a system
  - Rapid Changes in Context
  - Increase of important system characteristics and accountability
- An approach “System Architecture” is a appropriate way to design new society and industry form holistic perspective.
- It is not easy to foster system architects.


Design the future!
www.sdm.keio.ac.jp
日吉駅前 協生館