RRI International Symposium 2020
Manufacturing policy in the world of post COVID-19
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Designing resilient manufacturing with versatile human interaction in the world of post-COVID-19

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- Designing the Future of Manufacturing in the world of post-COVID-19
- Resilient manufacturing based on model-based approach
- Active human role in resilient manufacturing
- Research example in Japan toward resilient manufacturing
- Actions to be taken

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Current issues towards the Future of Manufacturing

- Achieving high Quality-of-Life (QoL) is still an issue in the global world, especially in developing countries.
- High value creation with less resource consumption is a key for success.
- The advanced manufacturing is an infra-structural enabler.
  - Efficient usage of resources is a basis: natural resources, materials & products, technology, human, market and environment, etc.
  - Resources and demands are unevenly distributed in the world, and in-balanced.
  - “Optimized” global life cycle network of production and products is required.

Designing the Future of Manufacturing in the world of post-COVID-19

- In COVID-19 crisis, unforeseen and disruptive changes in various aspects of manufacturing
  - How to maintain the global life cycle network in the world of post-COVID-19
- Comprehensive Digitalization is a basis for the future of manufacturing
  - From “AS-IS” to “TO-BE” innovation based on digital infra-structure
- Dynamic decoupling and re-integration of “cyber world (knowledge)” and “physical world”
- Resolving the boundary of traditional industries and creating new ones
- Dynamic re-assignment of human resources to activities
  - Complete automation vs. autonomy with versatile human involvement

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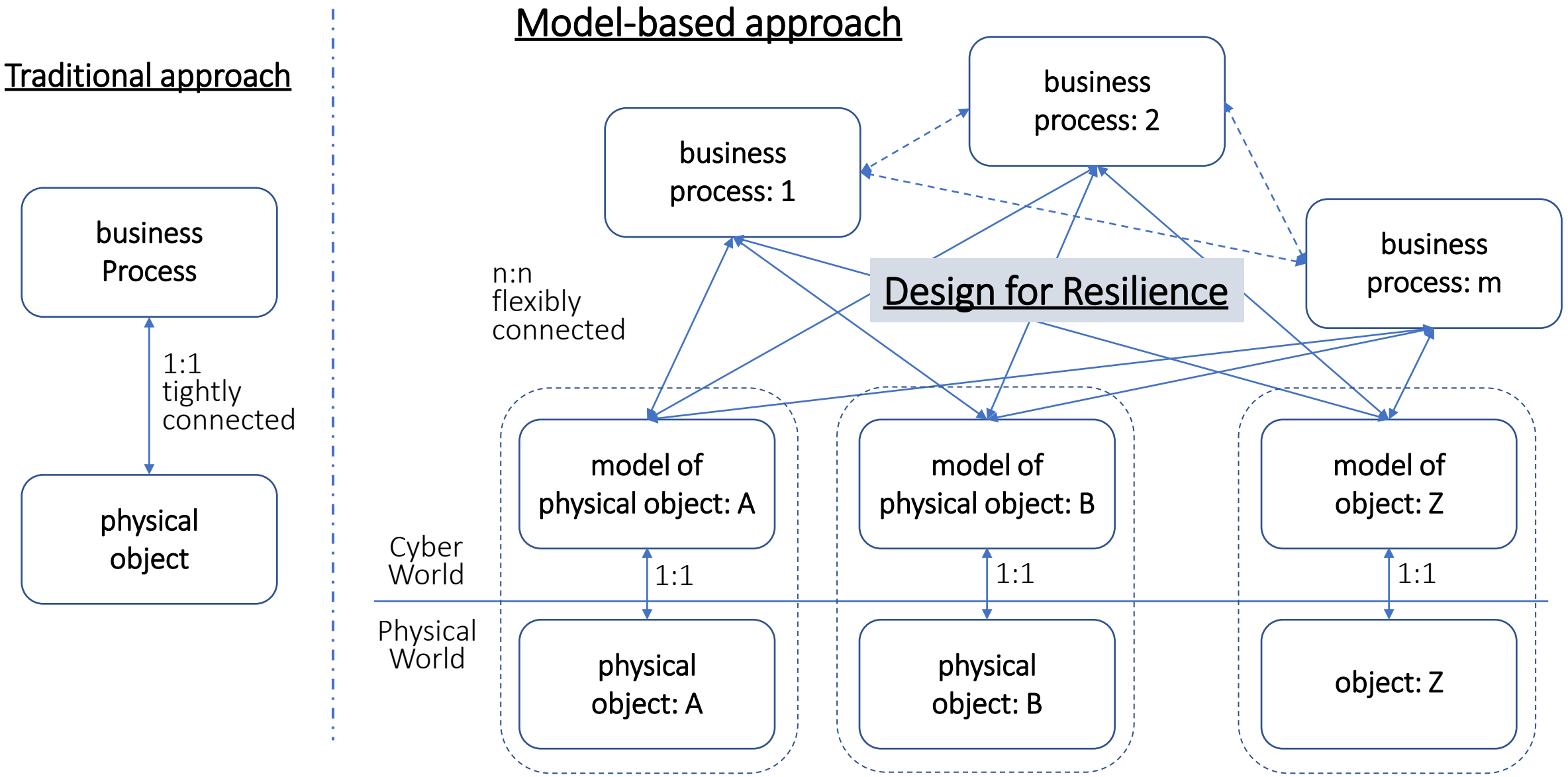
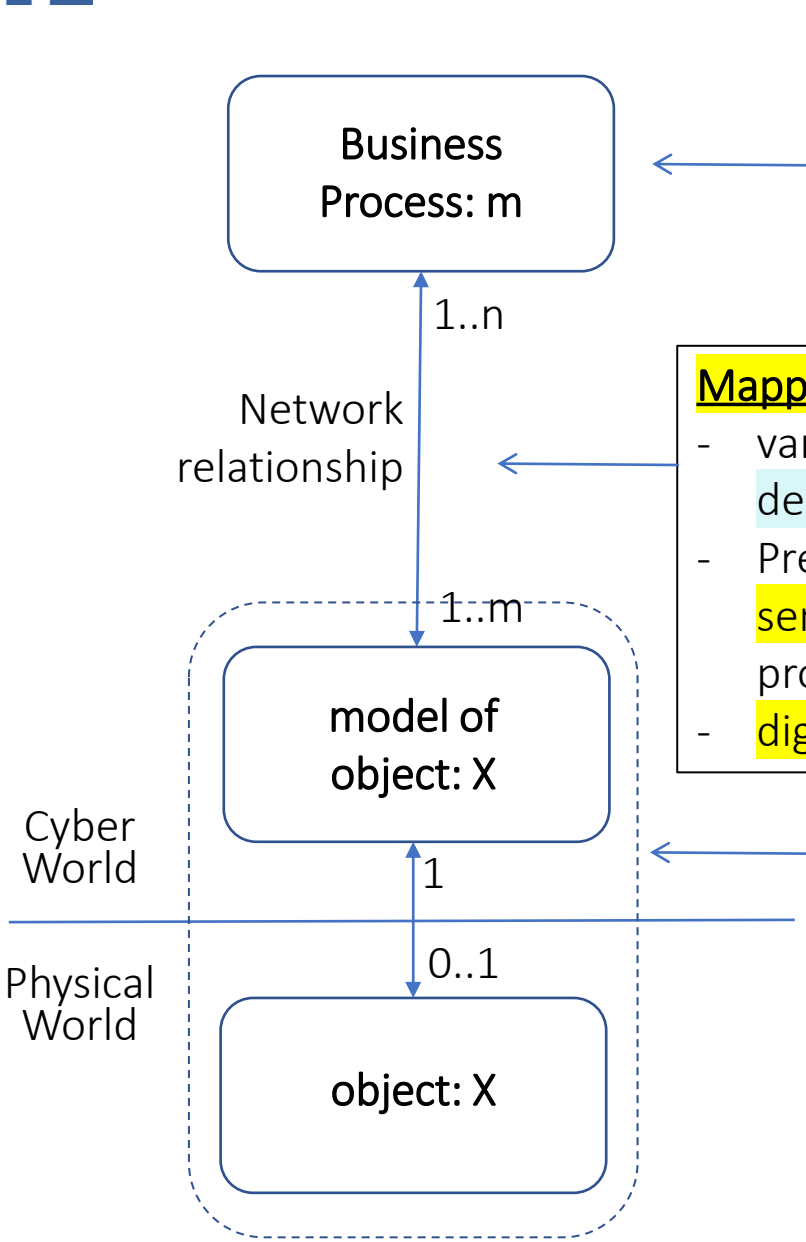
Resilient manufacturing based on model-based approach

- Resilience in manufacturing
  - adaptability, flexibility, agility, efficiency, high-value-creation, human involvement , sustainability, etc.
- How to introduce resilience in manufacturing
  - Business process (activity) innovation : from AS-IS to TO-BE
  - Enabling environment: technology, natural & social environment
  - Mapping: business process vs. enabling environment
- Enabler: importance of “Digitalization”
- Model-based approach
  - CPS in narrow sense: modelling of physical world
  - CPS in wide sense: modelling of physical world + designing of business processes

Resilient manufacturing based on model-based approach



Resilient manufacturing based on model-based approach



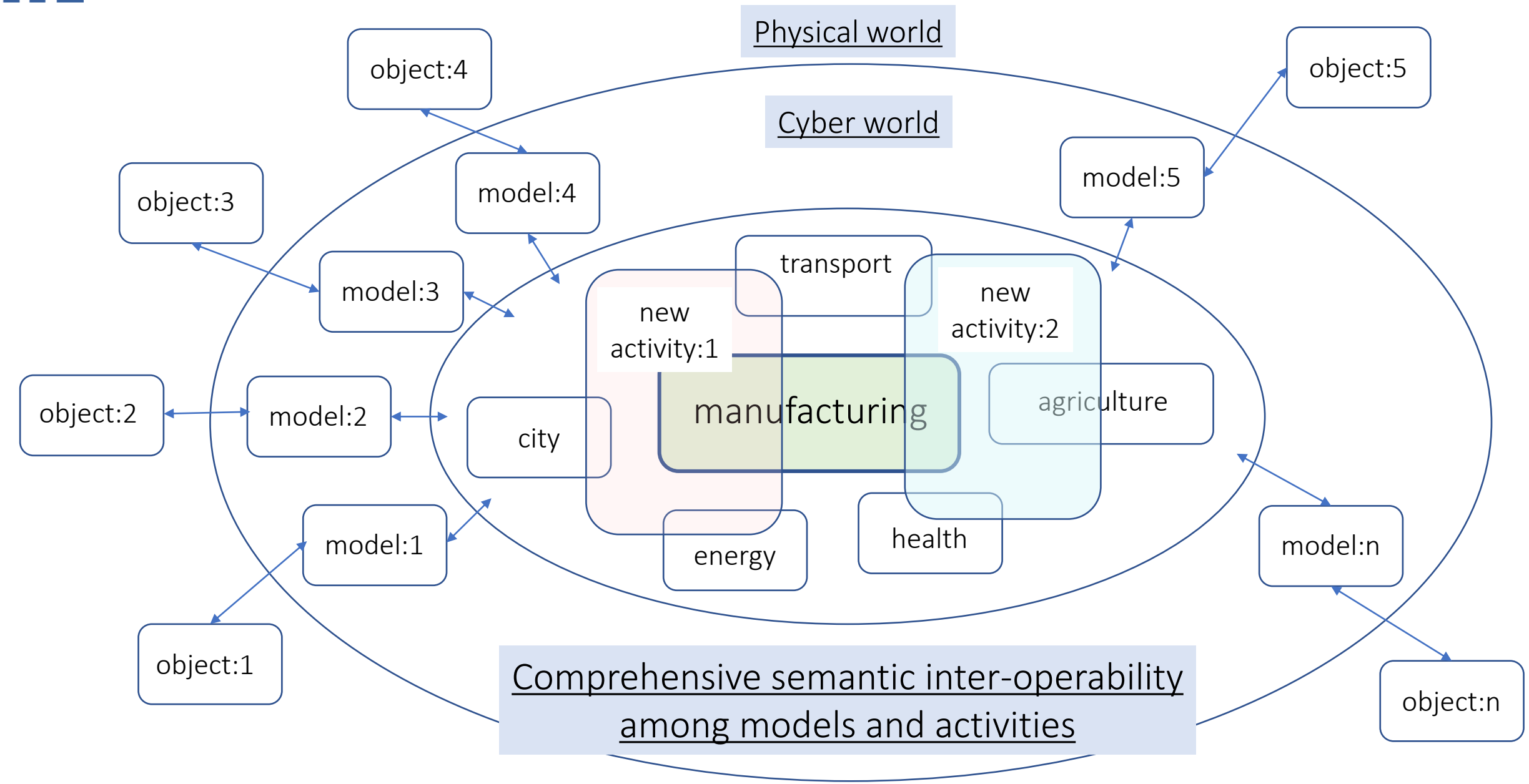
Design of processes
- engineering, production, management, service, society, etc.
- dynamism and autonomy
- process for whole life cycle
- modularity and standardization

Mapping among processes and models
- various mapping according to the design objective
- Prerequisite: comprehensive semantic inter-operability among processes and models
- digitalization as a basis

Design for Resilience
- risk reduction under unforeseen and disruptive changes
- from cost-competitiveness to risk-competitiveness
- traditional approach: design for productivity: cost reduction

Modelling of objects
- physical objects, including natural environment
- non-physical objects: human, information, knowledge, etc.
- dynamism and autonomy
- appropriate accuracy, precision and granularity
- comprehensive approach
- modelling of whole life cycle

New value creation activities including “manufacturing” as a basis



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Active human role in resilient manufacturing

- Characterization of human capability is mandatory in the model-based approach.
  - Human as a resource
  - Reduction of traditional human work
  - Possibility of new roles
- Adapting to human diversity become possible by the model-based approach.
  - Design and dynamic re-configuration of work sharing and division according to change of environment
  - Leading role, supporting role or …
- Decision and design must be done by people and society.
  - Technology is almost ready, and how to motivate the change of people's "mind-set" is a key.

Human-to-Human and Human-to-Machine Interactions

- Modelling of diversified roles of “human”, “machine” and “environment”
- Change of basic thinking: from “cost-competitive” to “risk- competitive”
  - complete automation of “low-value-additive” and “simple”, but “un-organized” works ”
    → Disruptive changes of the employment structure !
  - gradual replacement of human roles in highly sophisticated physical and logical works
- New technologies available for Human-to-Human and Human-to-Machine Interactions
  - Physical distance does not matter !
  - Innovative technologies of VR/AR
- Deep re-thinking of human roles strongly required
  - human-machine co-existence/separation
  - New works need to be created: disappearing the boundary of manufacturing and services
  - Diversity of human and machine must be recognized. Therefore the solutions are diversified.
    No general solution !

“TO-BE” Mapping of Roles to Human/Machine

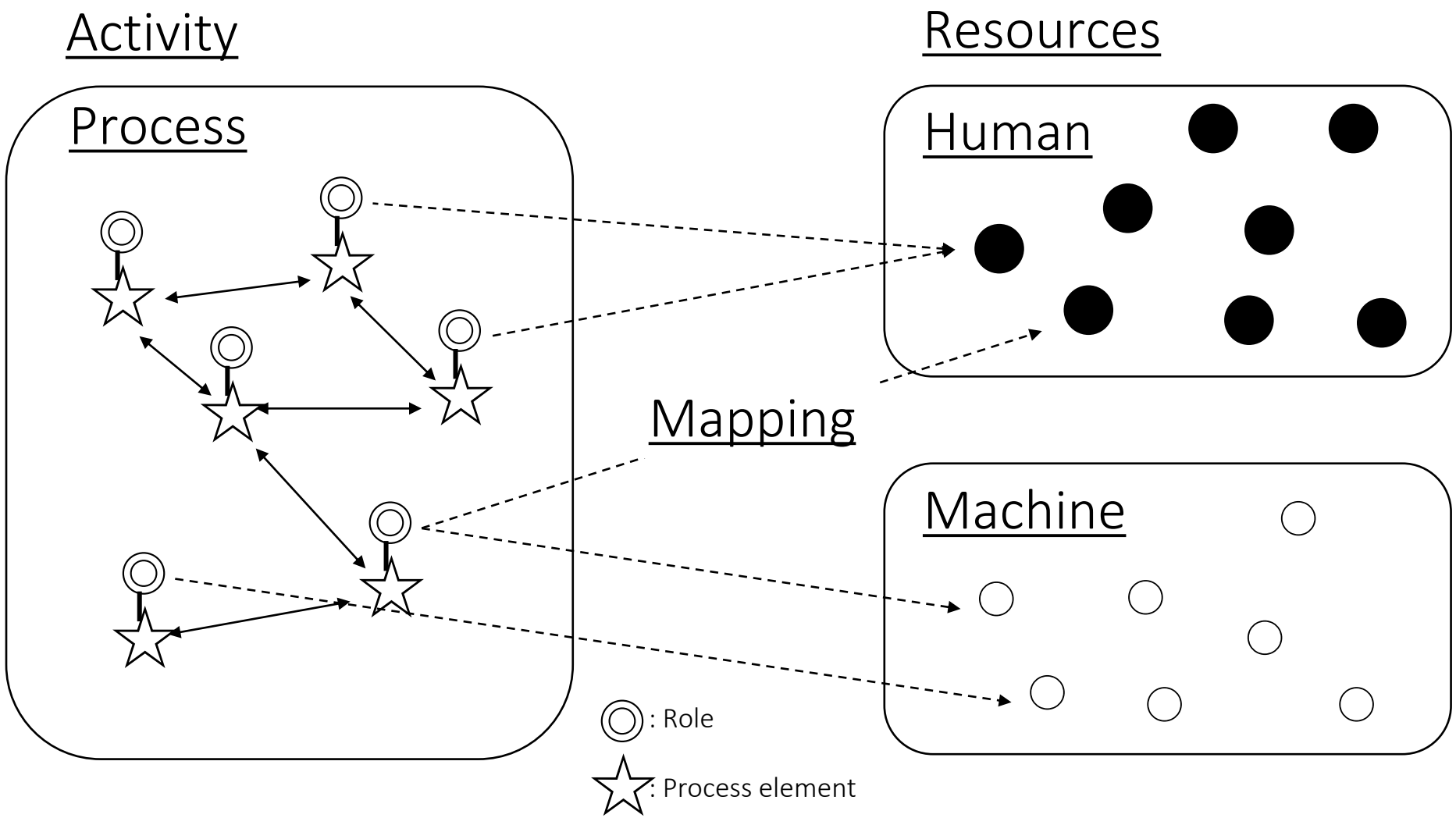
KPI:

Quality of Life

Sustainability

Risk- Competitiveness

etc.



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Research example in Japan toward resilient manufacturing

- Many research and development activities are emerging.
- Establishing comprehensive modelling environment and semantic inter-operability requires long-term endeavor.
- Long-term planning and agile implementation should go in parallel.
- Feasibility study is effective for changing people's "mind-set".

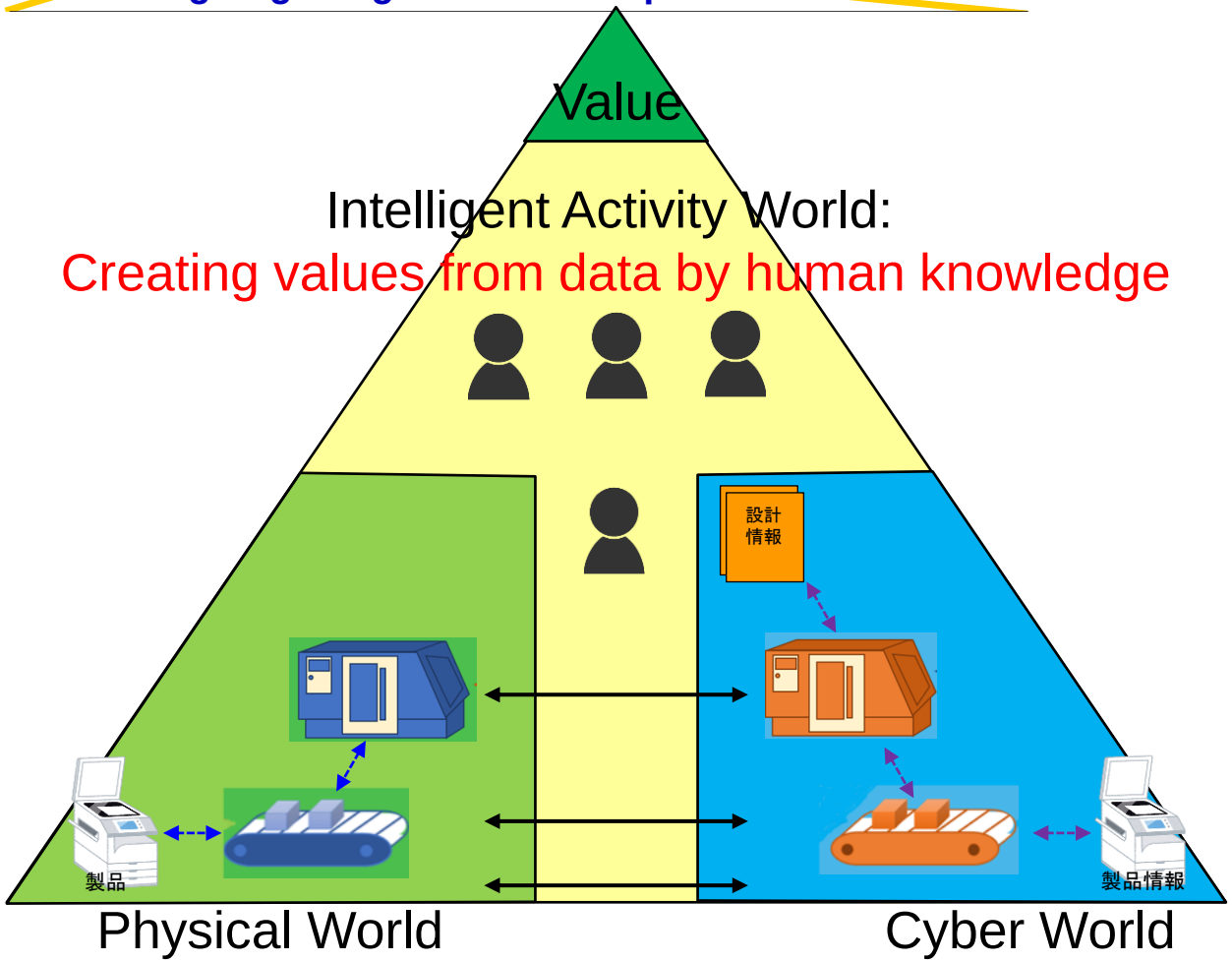
The Image of Digital Triplet

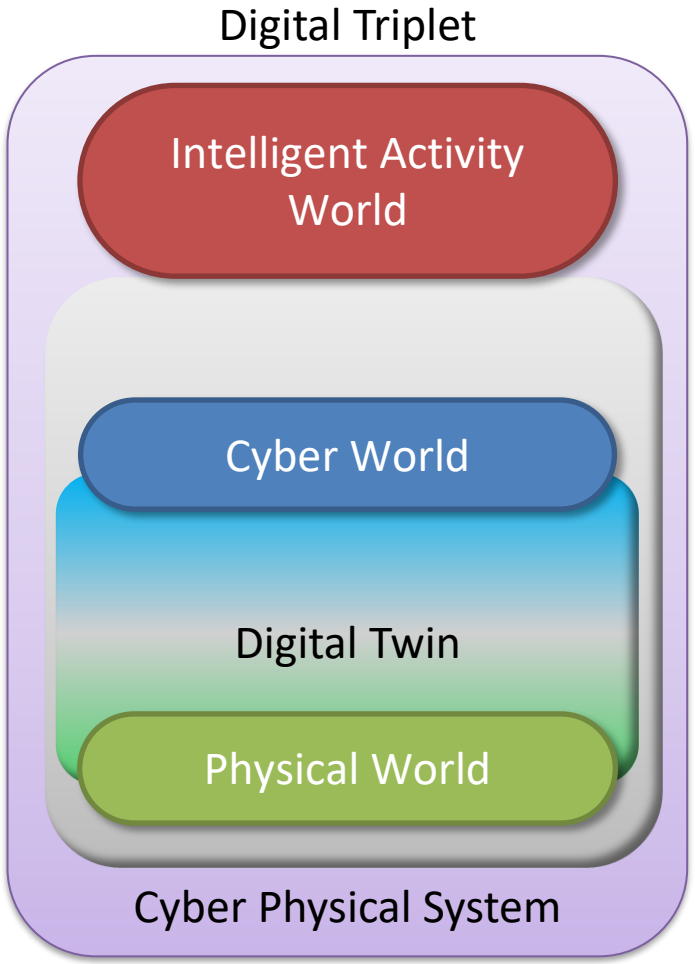
(Prof. Yasushi Umeda: The University of Tokyo)

Integrated support of engineering activities throughout a product life cycle

Design ⇔ Mfg ⇔ Use ⇔ Maint. ⇔ Reman. ⇔ Circulation

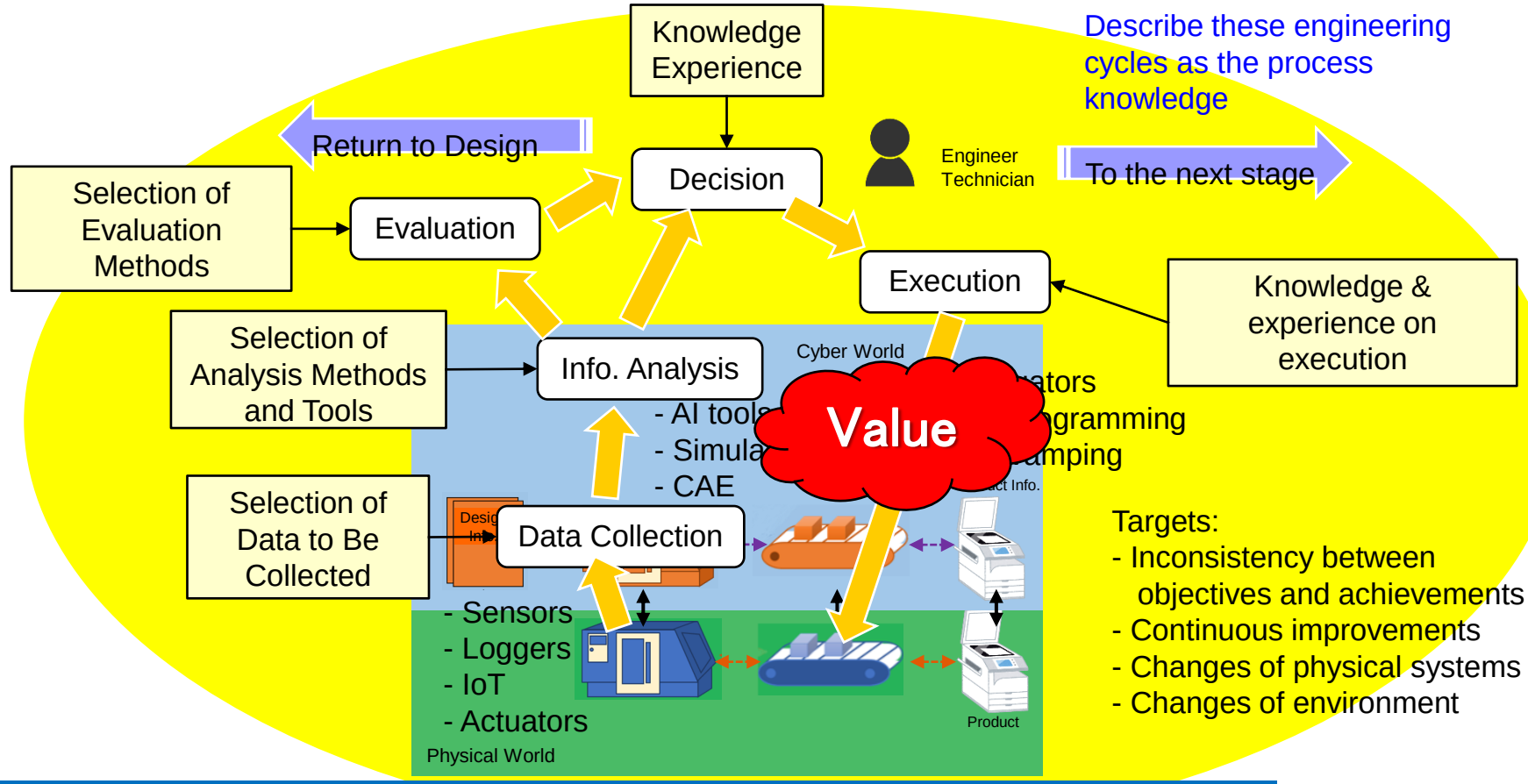
Taking mfg. stage as an example





Acquiring Process Knowledge of Engineering Activities on Digital Triple

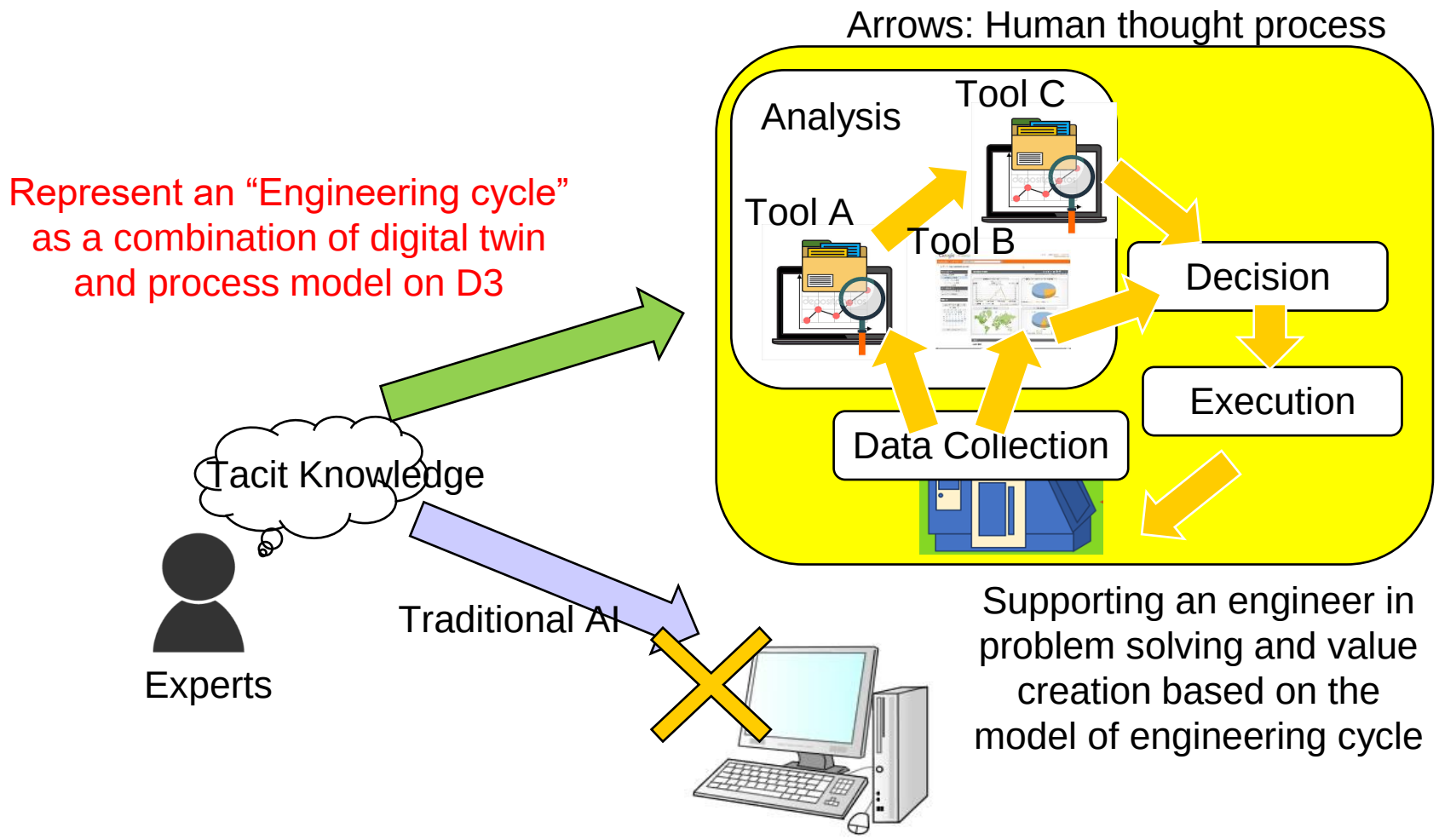
- **From now: Engineers should execute engineering activities mainly with the cyber world**



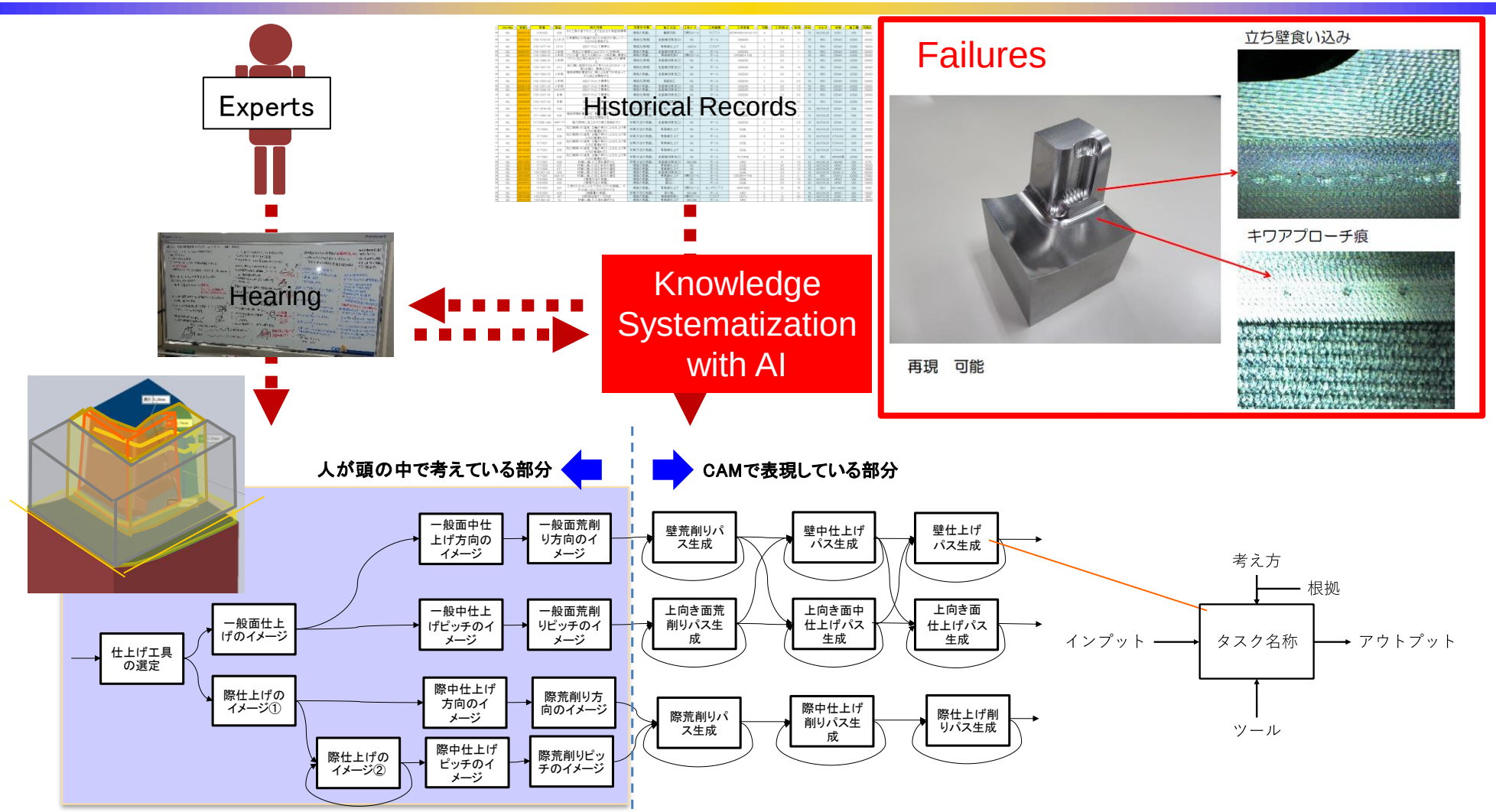
- Formalizing, collecting, and archiving the process knowledge
- Supporting human activities by reusing and deploying the knowledge
- Employing the knowledge to education

Concept of Engineering Support by D3

- We represent know-how and tacit knowledge in engineers



Extraction of Engineering Cycle of Mold Processing for Injection Molding



Engineering Cycle Model
（for Mold Processing）

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- Technology for new manufacturing is already there or being ready ! (Still need more investment !)
- Technology can be a common infrastructure to be shared by all.
- How to design systems and to implement technology in our life depend on vision and intention of individuals, society and countries.
- Therefore the new manufacturing paradigm must be selected and explicitly designed by individuals, society and countries.
- Even though the actual design could be different in society and countries, we can share the common technology basis, and collaborate towards the future society.

- Key message is: Future is not given, but it can be designed.