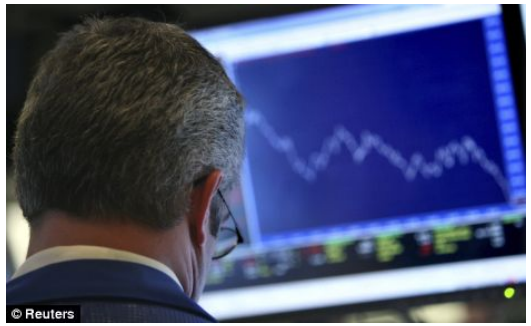
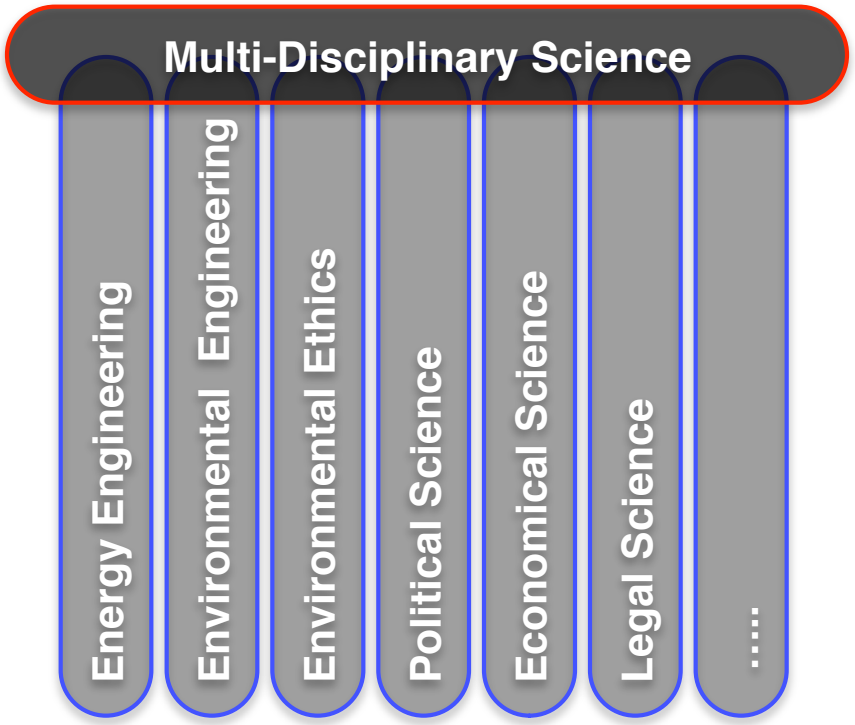
Background

- Arising many large-scale complex technological and social accidents and disasters
  - Train Disasters
  - Nuclear and radiation accidents
  - Aviation Failures
  - Financial Crisis
  - Natural Disasters
  - Environmental Pollution
  - Global Warming …



Background (cont)

- Large-scale complex technological and social accidents and disasters can not be solved by a single discipline



Educational Problems in Japan

- Most Japanese universities and graduate schools
  - provide education in a single academic discipline such as theories, principles, theorems.
  - do not provide education that offers a multi-disciplinary approach to solve the large-complex accidents and disasters.

- Many universities and graduate schools in the world
  - provide education in systems engineering as multi-disciplinary engineering
    - Systems Engineering defined by INCOSE is carried out in 75 universities and graduate schools in US. (Febrycky 2005)

System Design and Management Concept

"For Not only Technological System, but also Social System"

- System Design
  - is a creative activity to bring a concept to a real being by balancing all the technological and social factors such as customer requirements, use objectives, essential functions, costs for research and development and operations, adaptability to the environmental changes, and trade-offs among stakeholders.
- System Management
  - is to set up an suitable goal, and to be achieved by balancing various factors including quality, cost, and schedule under risks and environmental changes.
- System Design and Management
  - is a holistic approach by observing global trends of complex interactions among diverse languages, cultures and economies.

Goal

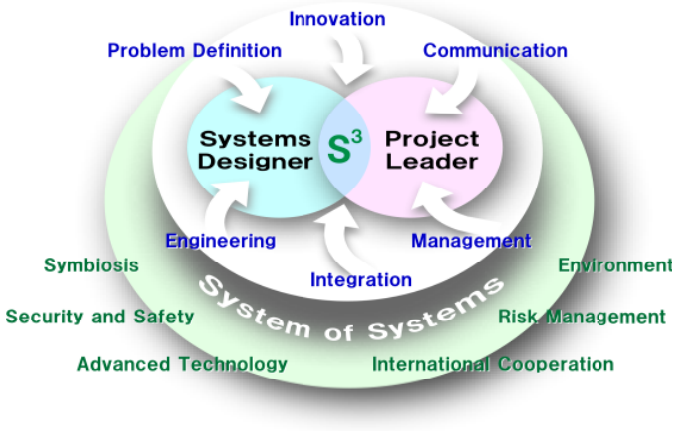
- To build a “System Design and Management (SDM)” program,

  an academic discipline that integrates humanities and science for creatively designing and effectively managing large-scale complex systems

- To establish and operate a graduate school of SDM program

  to foster talented person who can lead in the development and operation of large-scale complex systems

  - **Strong Leader** for Large-Scale Projects and Enterprises
  - **Creative System Designer** capable of planning, realizing and operating Innovative systems
  - **Reliable Project Manager** creating new markets, satisfying needs, and operating value chain



Keio SDM Establishment Details

Keio SDM was established to mark 150th anniversary

1858

Yukichi Fukuzawa established school for Dutch.

1868 School renamed Keio. **Meiji Reformation**

1874 Yochisha elementary school is established.

1906 Graduate programs established. **Russian War**

1917 School of Medicine founded . **World War I**

1934 Hiyoshi Campus opens. **World War II**

1944 Faculty of Engineering founded.

1957 Faculty of Business & Commerce is established.

1962 Business school is established.

Shonan Fujisawa Campus opened

Faculty of Policy Management &

Faculty of Environmental Information founded

Keio Academy founded in New York. **1990**

Graduate School of Media & Governance is founded. **1994**

Faculty of Nursing & Medical Care is founded. **2001**

Law School is established. **2004**

Graduate School of Health Management is founded. **2005**

2008

150th anniversary

Graduate School of Pharmaceutical Sciences,

Faculty of Pharmacy,

Graduate School of System Design and Management

Keio University

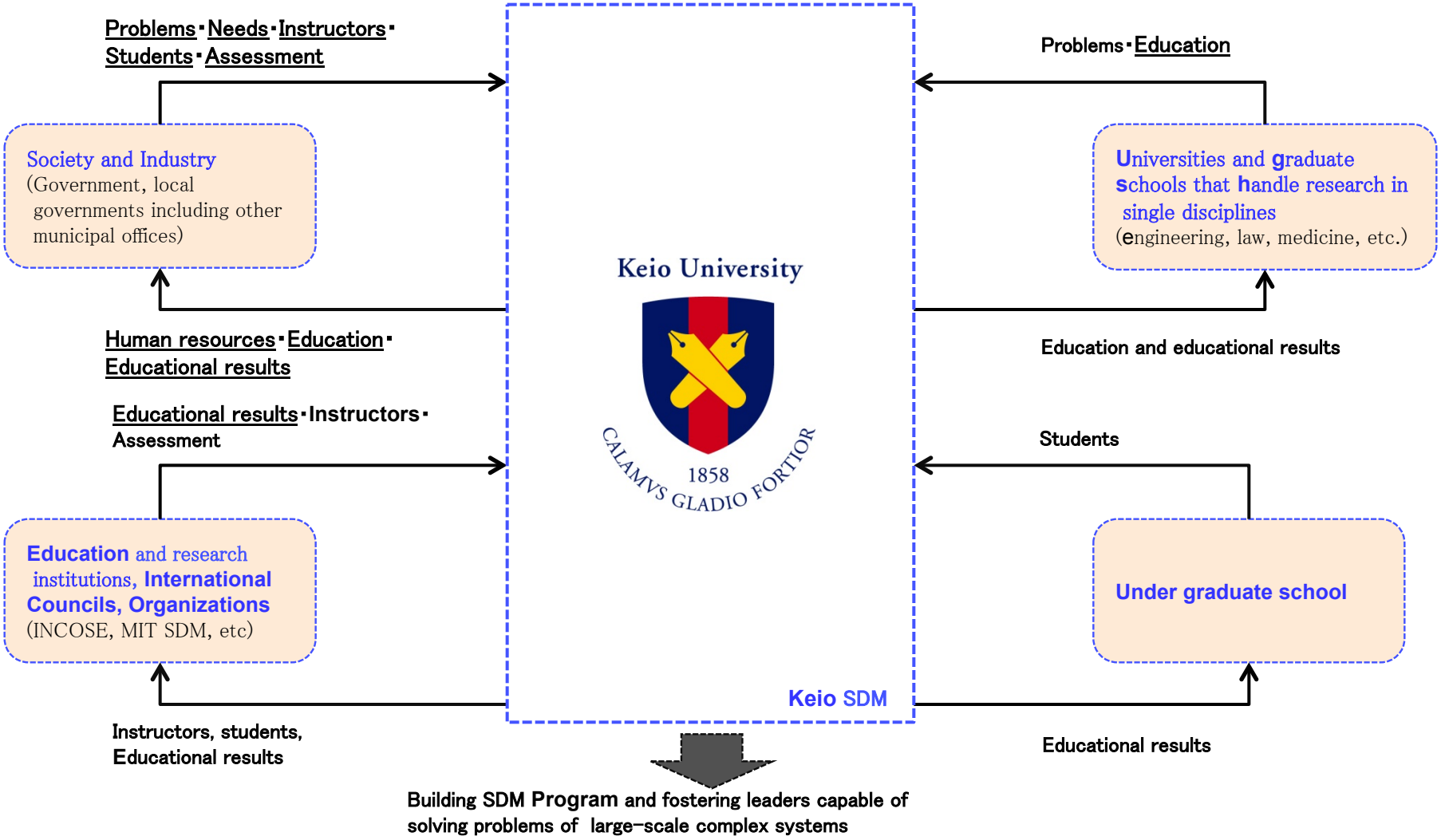
1858

CALAMVS GLADIO FORTIOR

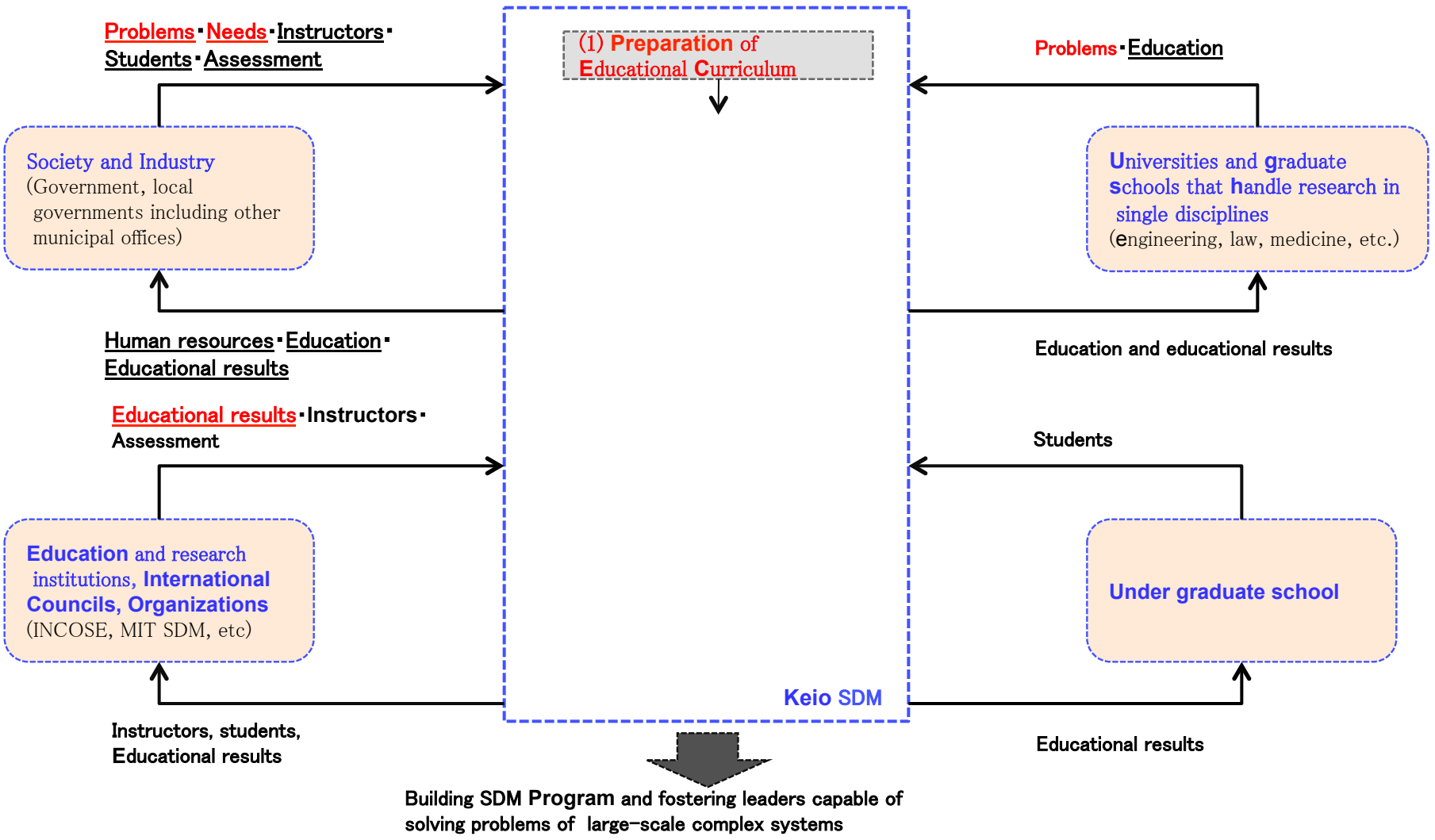
SDM

System Design and Management

Scenario for Achieving Goal and Relationships with Stakeholders



Scenario for Achieving Goal and Relationships with Stakeholders



Interviews and Survey

- To find the actual problems and determine the demands placed on a graduate school education,
  - Interviews were conducted among 100 or more industries and governments in Japan and overseas involved in large-scale complex technological and social systems
  - Survey various data regarding problems in large-scale complex systems and expectations of universities and graduate schools
    - “Results of a questionnaire on human resources sought by corporations” by Japan Business Federation in 2004

Expectations of Universities and Graduate Schools from Industry

- "Results of a questionnaire on human resources sought by corporations"
  - 520 Japanese companies and 3 response by each company
  - The 5 most frequent responses in this table

	Response	No. Comp
1	The firm acquisition of specialist knowledge by students	340
2	Training in the assembly of knowledge and information and derivation of one's own thoughts	287
3	The acquisition of fundamental knowledge of other areas relating to one's own specialist field	231
4	To provide education with an awareness connected to the real world in addition to theory	162
5	To give students the experience of assembling teams and tackling specific challenges	119

- Expectations of universities and graduate schools
  - to foster talented person who can make the most of advanced technical expertise, create and manage future generation systems capable of coping with the rapidly changing conditions of present-day society.

Designing Educational Curriculum

- Structure of the SDM education was designed on the basis of

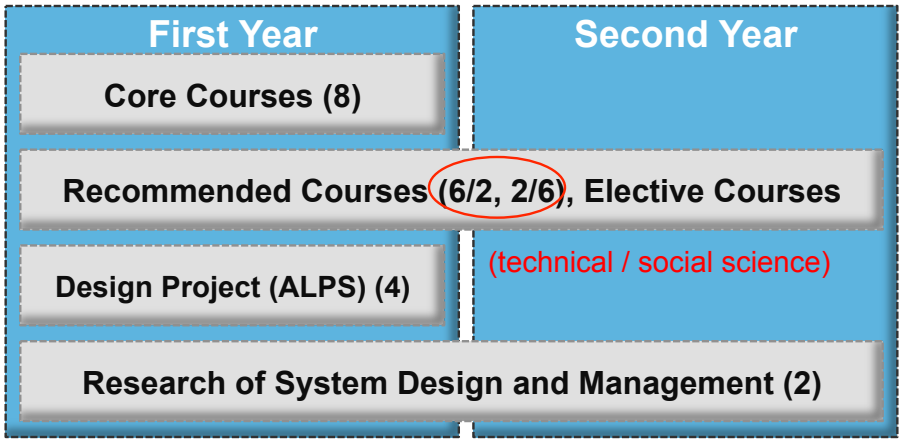
1. Design procedures in large-scale complex systems used in Systems Engineering defined by INCOSE

2. System design methodology of technological and social systems used by the Japanese industry for automobiles, robots, plants, network, or information system

3. A know-how and procedures required for social system design and management

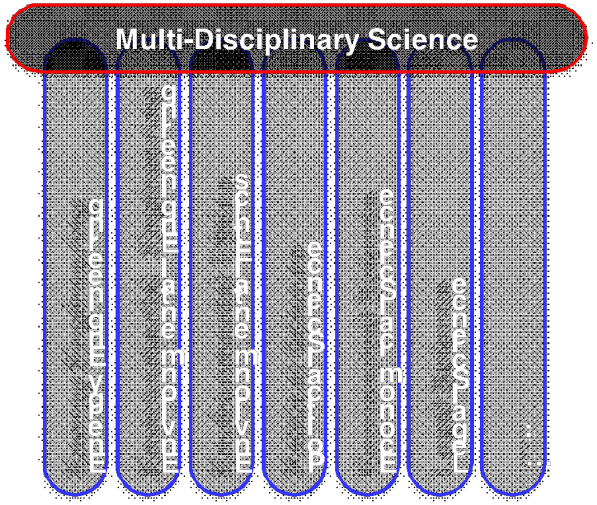
Master's Program Curriculum and Degree Scheme

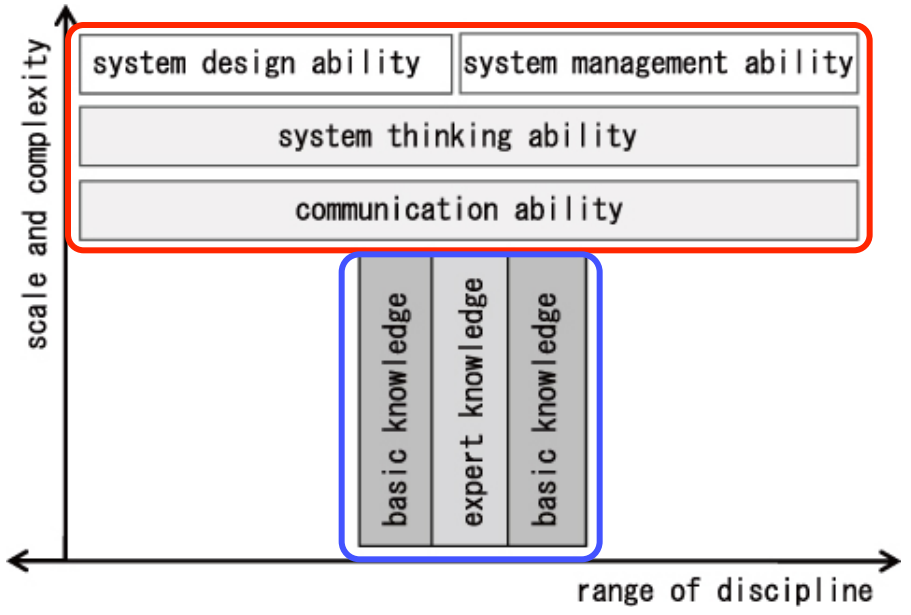
- Master Degrees
  - System Design and Management
  - Systems Engineering
- Requirement for Master Program
  - Minimum of 30 Credits
  - Minimum 14 classes of 90 minutes each required for 1 credit
  - Design Project (ALPS)
  - Master thesis (Research of SDM)
  - Part of courses can be covered by distance learning
- Admission Quota
  - 77 students each year (Ph.D. : 11 students each year)



Ability and knowledge that should be acquired by students

- System Design Ability
- System Management Ability
- System Thinking Ability
- Communication Ability
- Expert Knowledge
- Basic Knowledge





Correspondence of Educational Curriculum and Ability/Knowledge

- ◎
  - Strong related
- ○
  - Related
- △
  - Lecture subjects that related to abilities and knowledge that a student must attend due to specialization

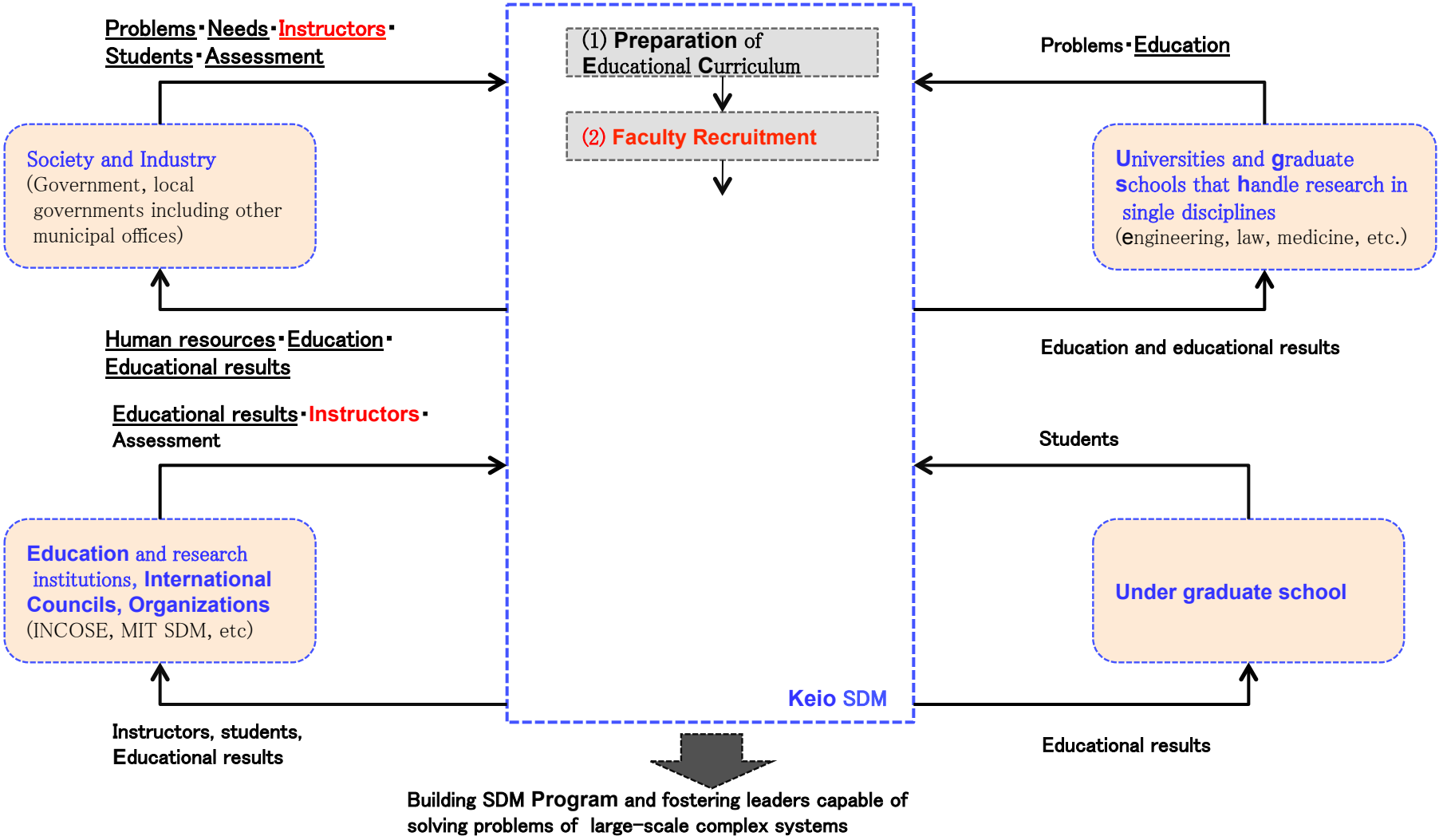
	Required Subject								
	Core Subject						Recommended Subjects (Technology/Social Skills)	Elective Subjects (Technology/Social Skills)	Subjects from other Departments and Universities
Ability and Knowledge	Introduction to Systems Engineering	System Architecting and Design	System Integration	Project Management	Design project ALPS	System Design and Management Research			
System Design Ability	◎	◎	◎	○	◎	◎	○		
System Management Ability	○	○	○	◎	◎	◎	○		
System Thinking Ability	◎	◎	◎	○	◎	◎	○	○	
Communication Ability				◎	◎	○	◎	○	
Expert Knowledge					○	◎	△	△	◎
Basic Knowledge					○	○	△	△	◎

Recommended subjects and elective subjects

Recommended Subjects	Technical	System Environment
		Human Factors
		Risk Management of Engineering System
		Dependable Systems
		System Life
		Digital Manufacturing System
		Model Based System Engineering and Architecting
	Social Science	Introduction to International Affairs
		Communications
		Human Relations
		System Management
		Ethics for System Design Engineers
Elective Subjects	Technical	Mathematical Modeling and Statistics
		Mathematical Technique of Prediction and Optimization
		Mathematical Technique of Dynamical Analysis and Control
		Database Management System under Network Environment
		Software Safety Engineering and Reliability
		Software Engineering
	Social Science	Fundamentals of Accounting, Marketing and Economics
		Introduction to Legal Issues for Engineers
		System Simulation Technique
		Global Standardization Strategy
		Methodology of Creative Decision Makings
		Business Intelligence
		Design Philosophy for Policy and Regulation
		Political Economy of International Systems
		Methodology and Management of Socio-Critical System
		Special Lectures

- Other subjects can be taken at other 12 graduate schools in Keio Univ.
  - Graduate School of
    - Letters
    - Economics
    - Law
    - Human Relations
    - Business and Commerce
    - Medicine
    - Science and Technology
    - Business Administration
    - Media and Governance
    - Health Management
    - Media Design
    - Pharmaceutical Sciences

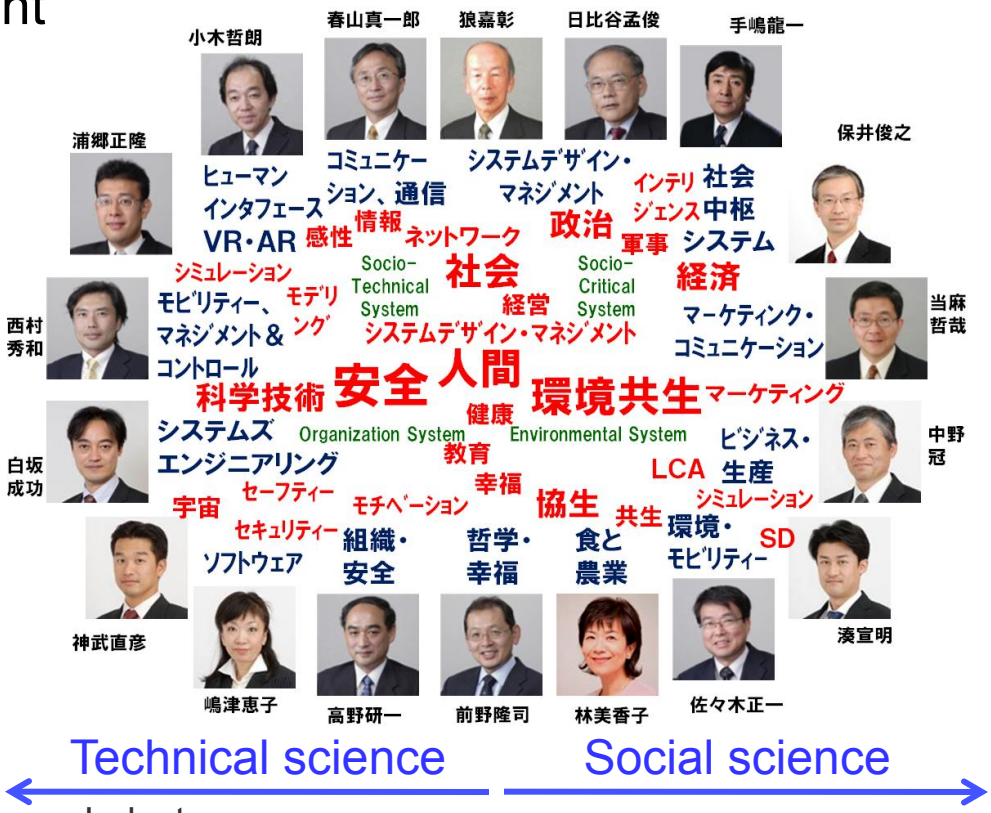
Scenario for Achieving Goal and Relationships with Stakeholders



Faculty Recruitment

- Most faculties (90%) are from industries and government
  - 3M
  - AT&T
  - Canon
  - Financial Service Agency
  - JAXA (Japanese Space Agency)
  - JGC (Japan Gasoline Company)
  - Ministry of Foreign Affairs
  - Mitsubishi Electric
  - Mitsubishi Research Institute
  - NEC
  - NHK(Japan Broadcasting Corporation)
  - Sony
  - Toyota
  - Xerox
  - Central Research Institute of Electric Power Industry
  - …

Keio SDM Faculties



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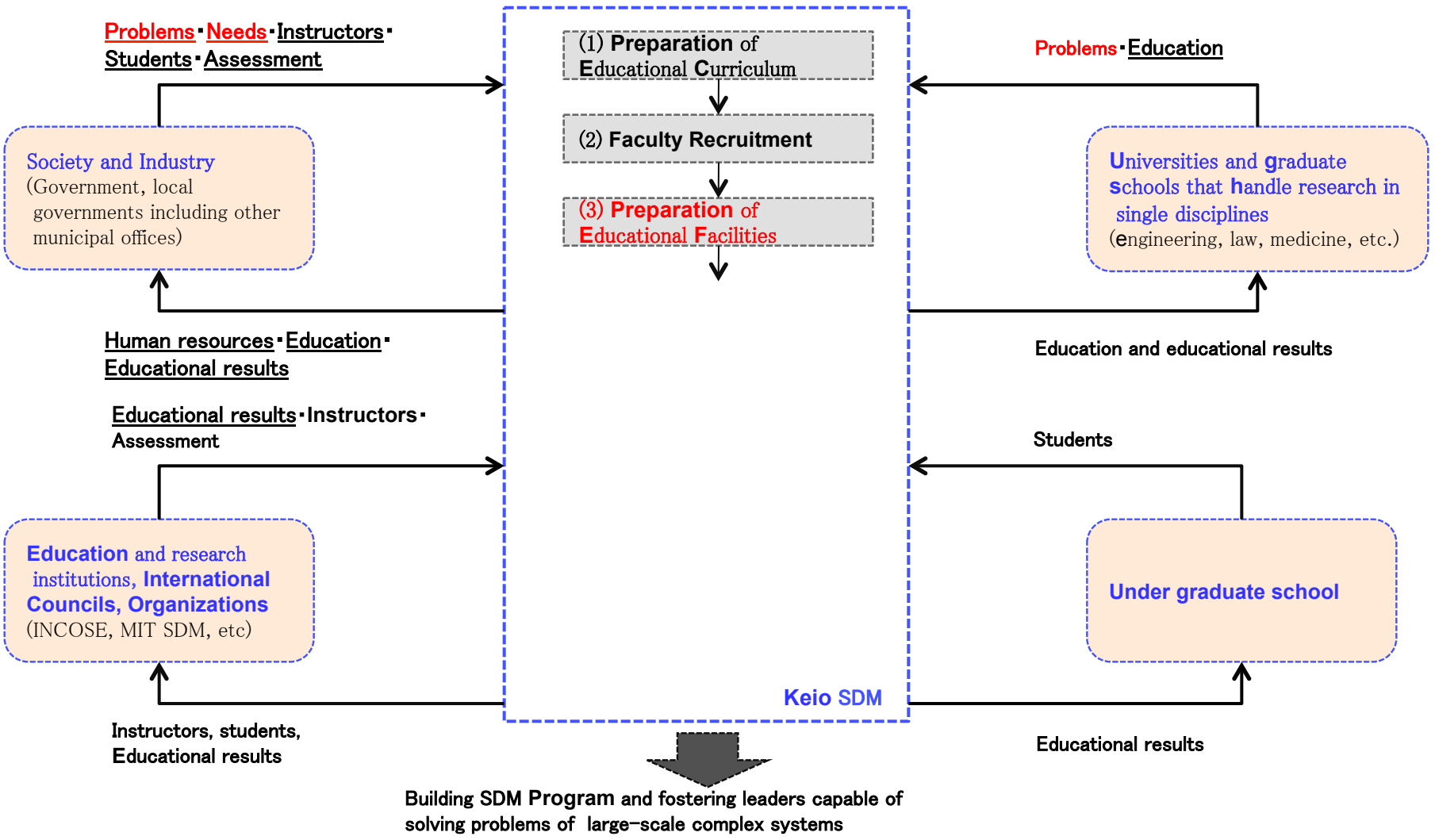
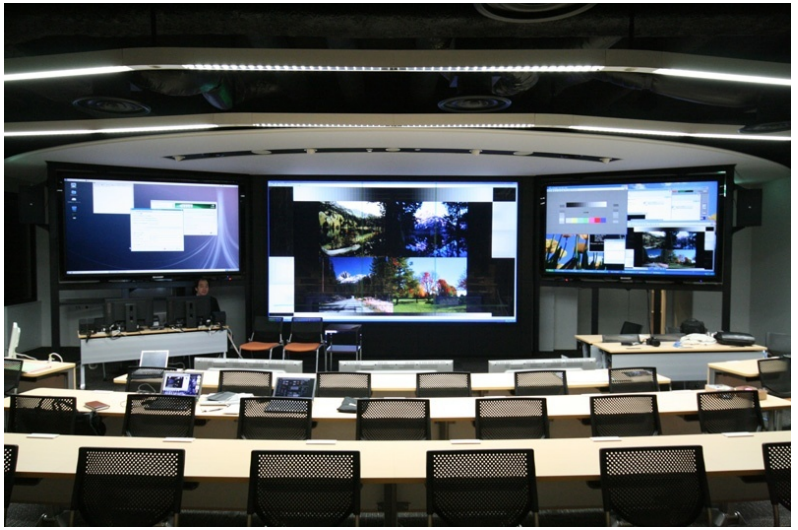


Educational Facilities

- Distance learning
- Facilities for Modeling and Simulation
  - Concurrent Design Facility
  - Virtual Environment (CAVE)
- Various software
- …



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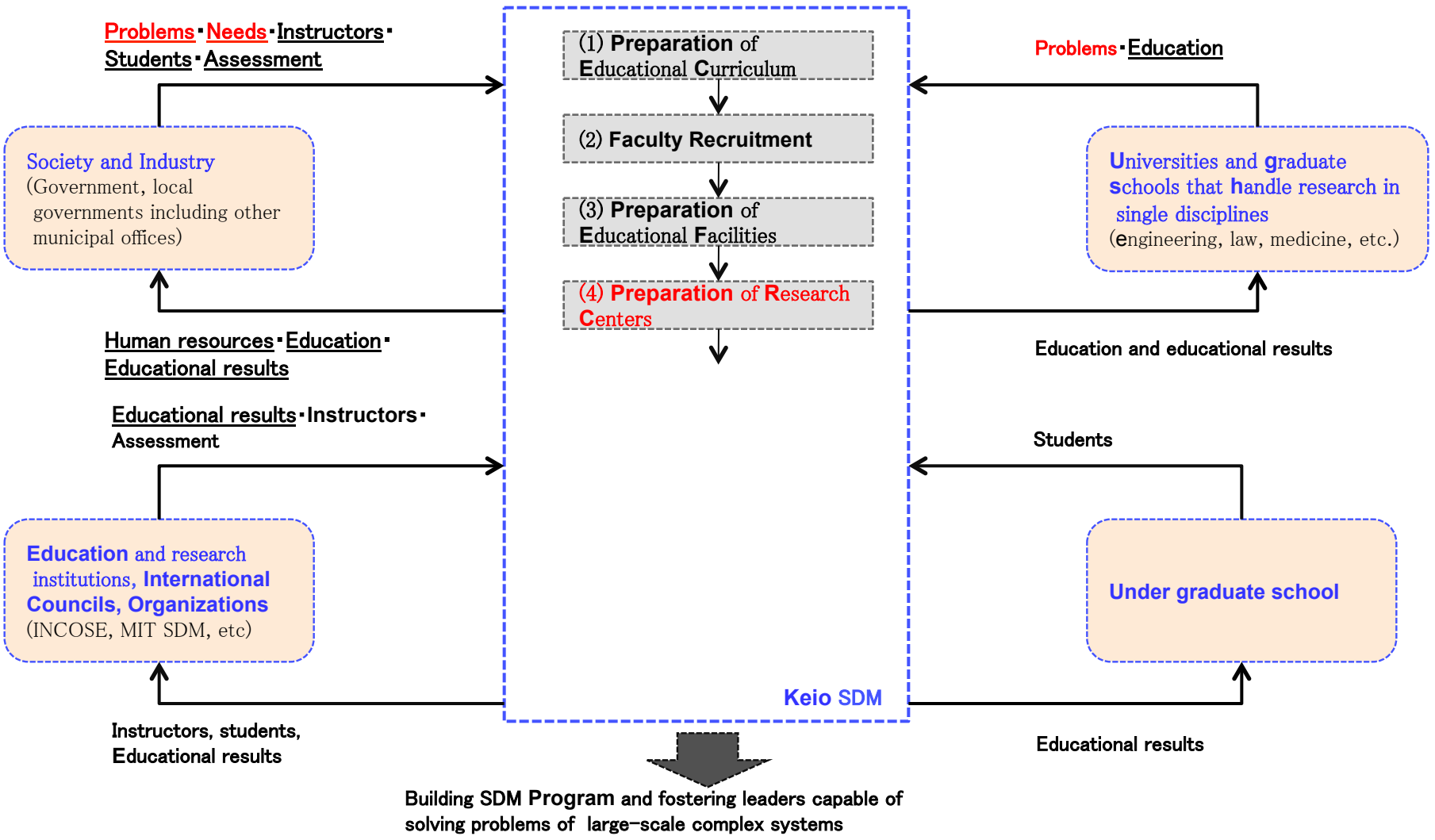

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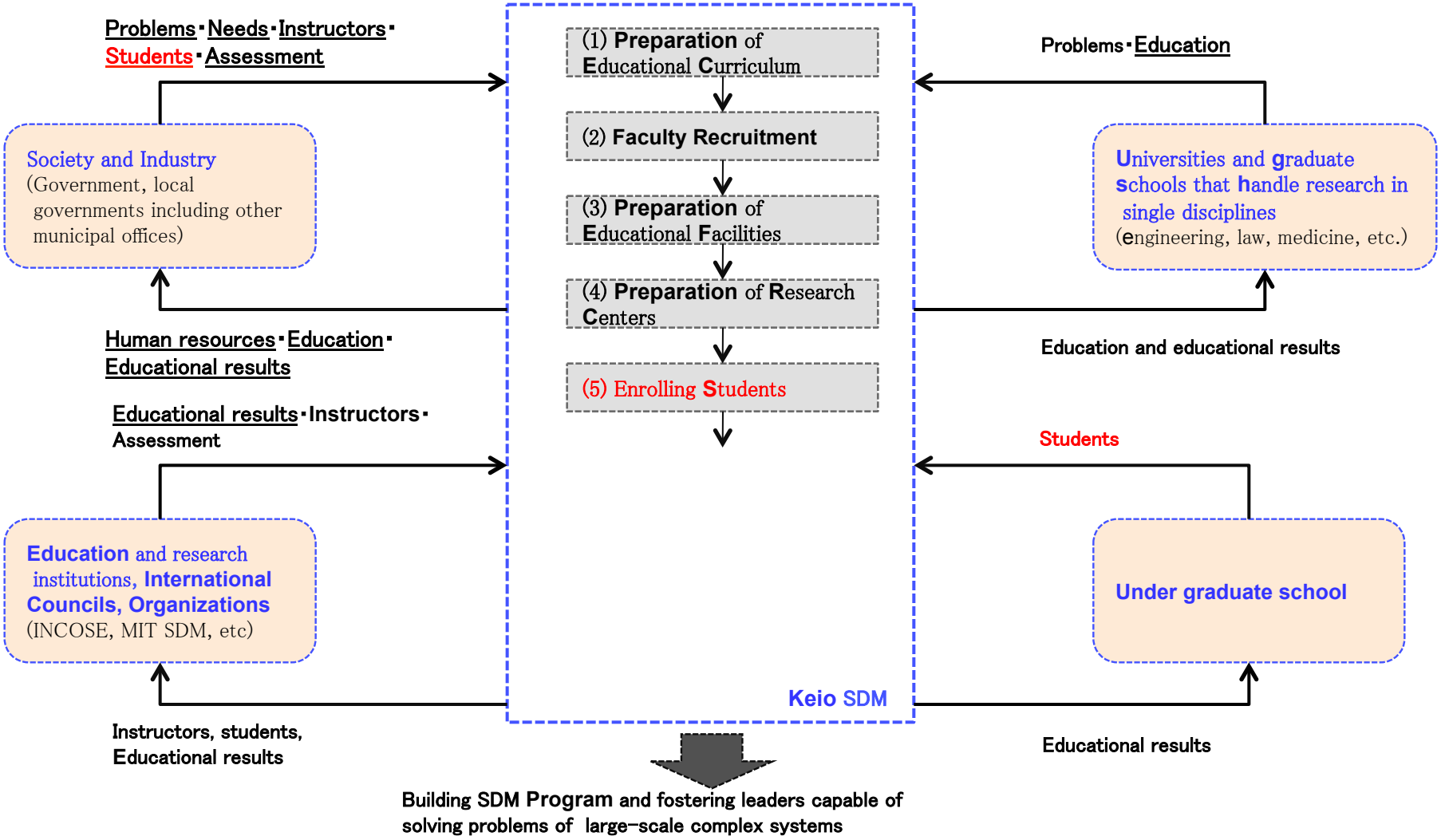
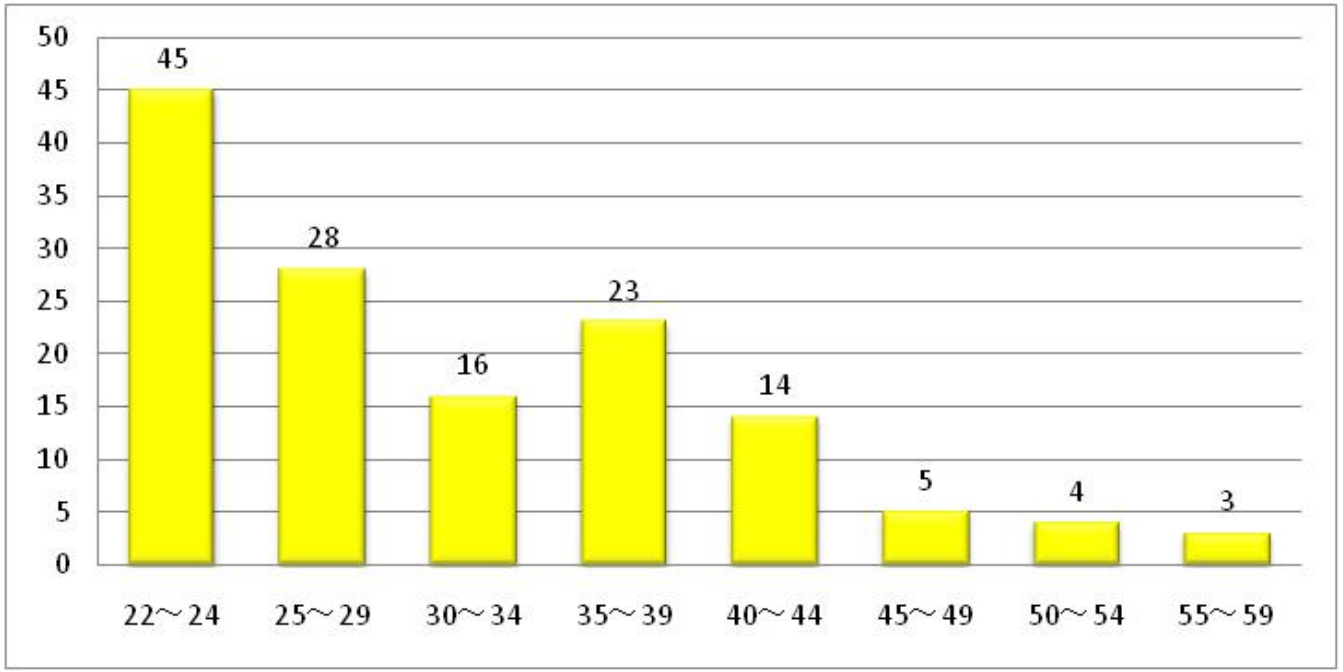


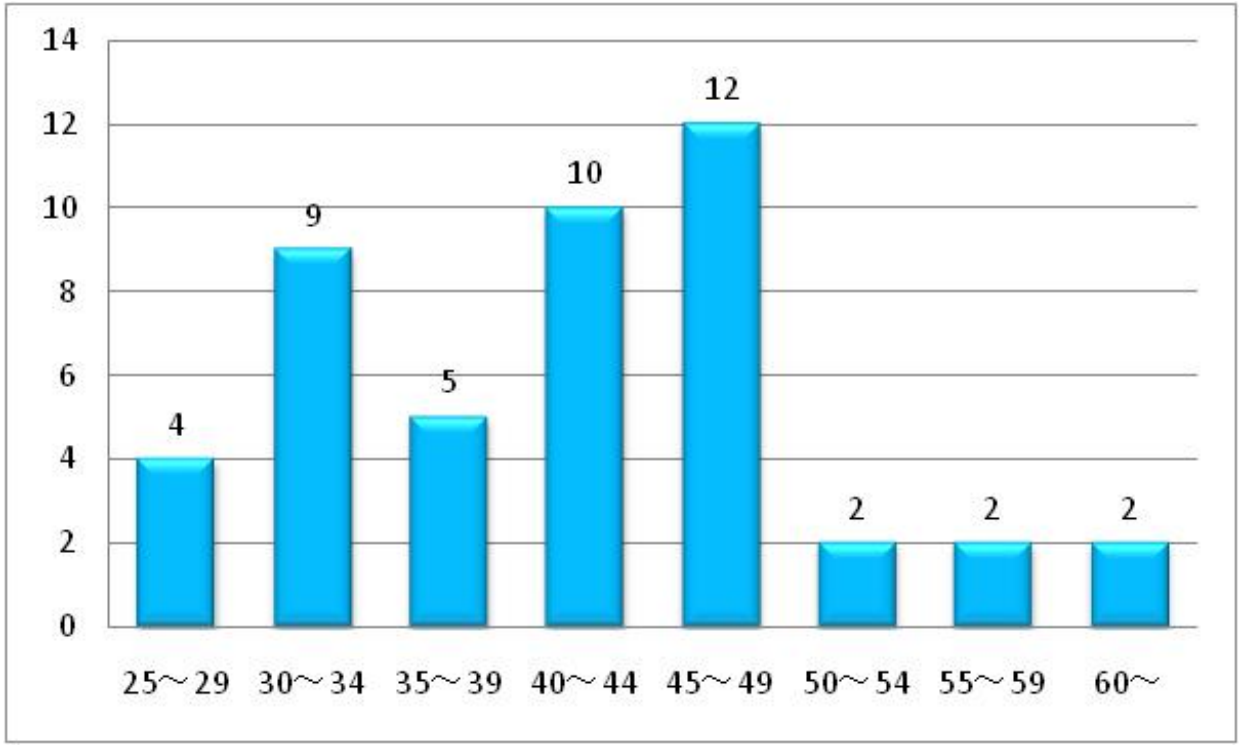
Composition of Students

- Wide range of ages, various fields and nationalities
  - Age
    - Master Course: 20s through 50s with an average of 32
    - Ph.D. Course: 20s through 60s with an average of 42

Age Distribution of Master's Students



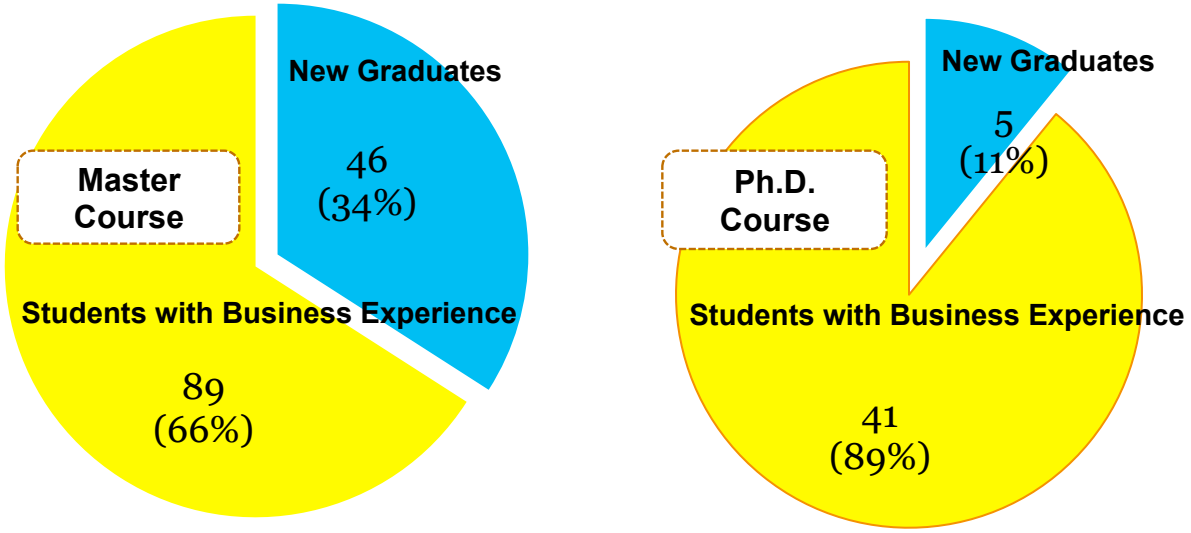
Age Distribution of Ph.D. Students



Composition of Students

- Wide range of ages, various fields and nationalities
  - Age
    - Master Course: 20s through 50s with an average of 32
    - Ph.D. Course: 20s through 60s with an average of 42
  - Business Experience
    - Master Course: Experience 34% No Experience 66%
    - Ph.D. Course: Experience 89% No Experience 11%

Occupation Distribution of Students with Business Experiences



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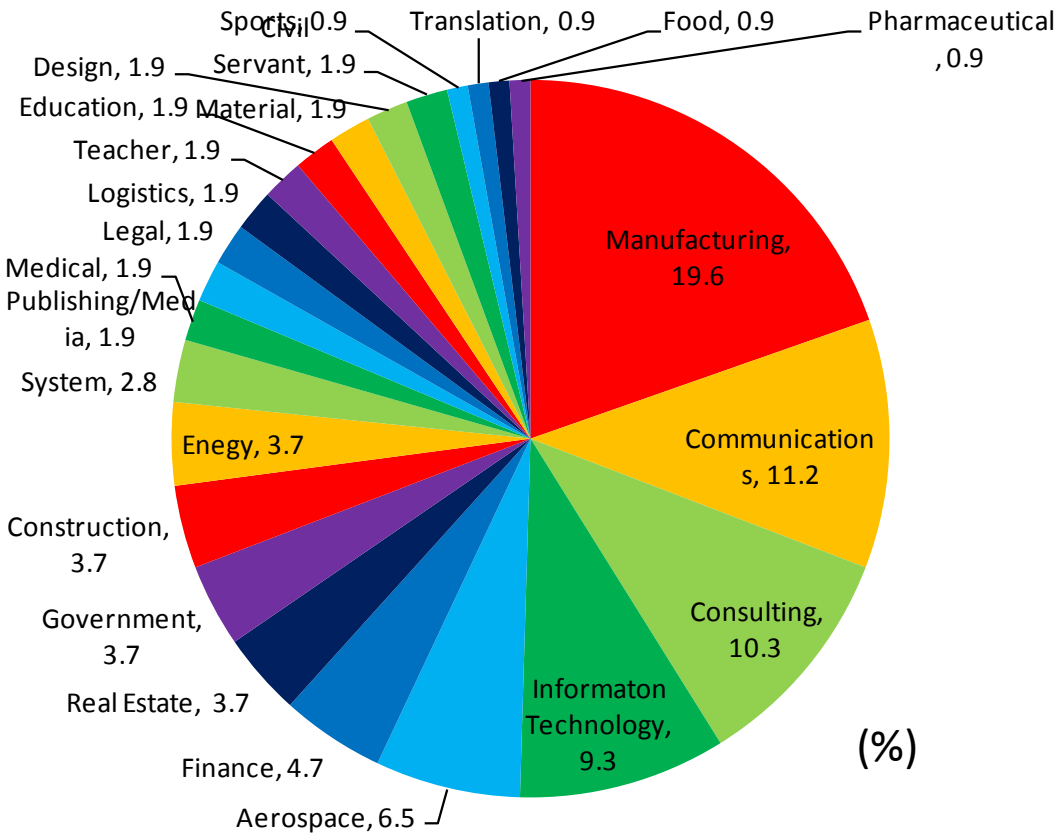
  - Occupation Distribution
    - Many fields (Manufacturing, Communication, Consulting, IT, Aerospace, Finance ..)

Ratio of Newly Graduated Students to Those with Business Experiences



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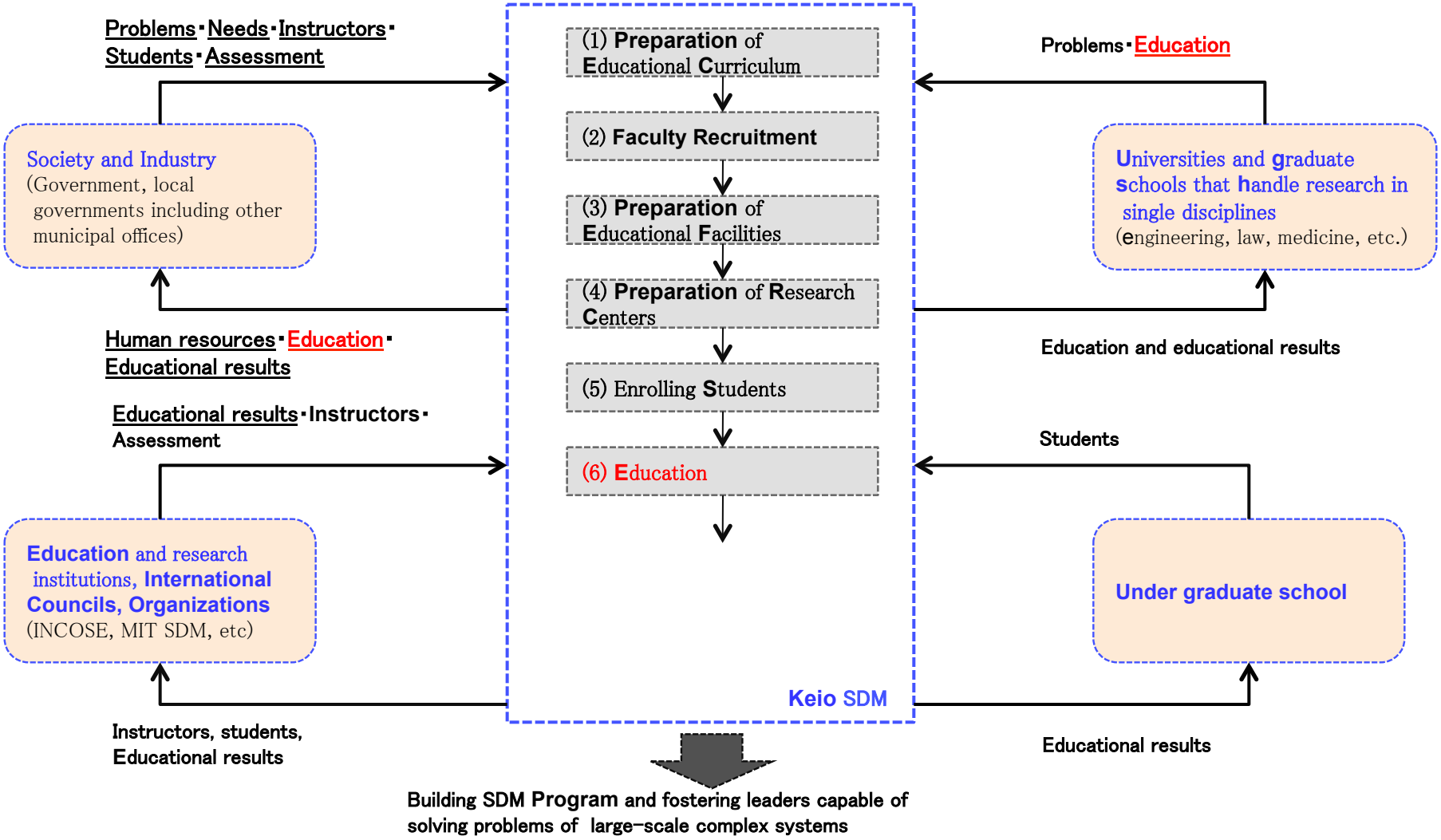
  - Business Experience
    - Master Course: Experience 34% No Experience 66%
    - Ph.D. Course: Experience 89% No Experience 11%
  - Occupation Distribution
    - Many fields (Manufacturing, Communication, Consulting, IT, Aerospace, Finance ..)
  - Nationality
    - Japanese 80%
    - Non Japanese 20%

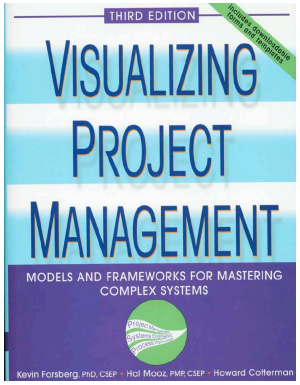
Scenario for Achieving Goal and Relationships with Stakeholders



Lecture Example: Introduction to Systems Engineering

- Basic strategic systems engineering using the V-model in a development process
- Practical training to experience development of actual systems
  - Example: “Automatic cleaning system that can be remotely controlled when the user is not home”

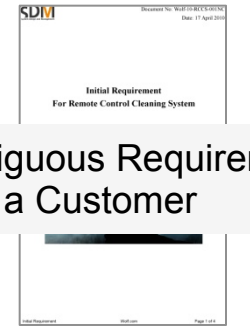
Roomba 577



by K. Forsberg et.al

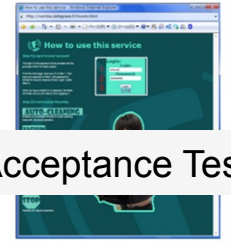
1	Review of basics of Systems Engineering by Textbook up to Ch.1, Quiz and Questionnaires.
2	Review of basics of Systems Engineering by Ch.2, Teaming and task assignments.
3	Start of Hand-on project using COTS. Discussions on scheduling and assignment.
4	Identification of customer requirements determination of system under insufficient information.
5	Analysis of customer requirements and architecting leading to the system requirements.
6	System/Interface design and test planning with proposing the CONOPS
7	Implementation and verification tests of system modules from the systems requirements.
8	Implementation and verification tests based on refinement and optimization of systems design.
9	Perform verification tests of system modules to get information on acceptability.
10	Integartion and verification tests of the total system for acceptability and modifications.
11	Validation tests and delivery of product, first to the class, and then to the client.
12	Presentation of Implementation results with documents. 13,14: Beck up

Lecture Example: Introduction to Systems Engineering (cont)

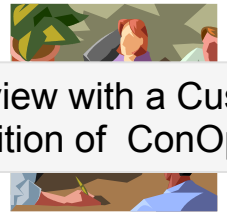


Ambiguous Requirements from a Customer

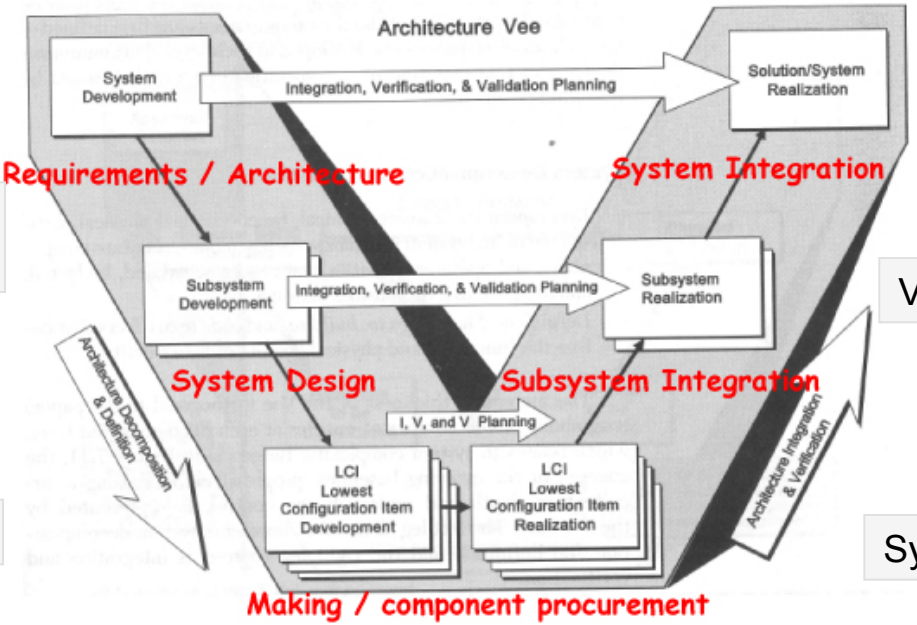
- Three instructors
  - as a Lecturer
  - as a Customer
  - as an Adviser

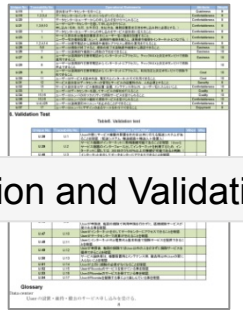


Acceptance Test by a Customer

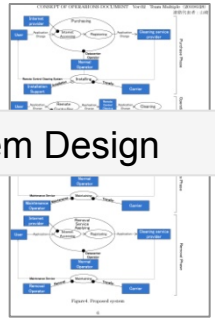


Interview with a Customer
Definition of ConOps





Verification and Validation

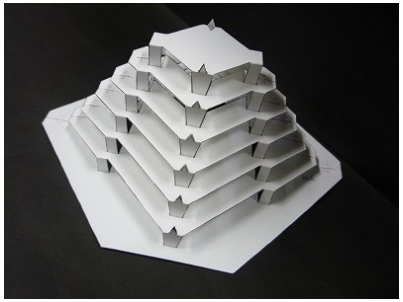


System Design

System Integration

Lecture Example: Project Management Exercise

- Building paper tower competition with small teams



- Specific roles such as a project manager and an architect
- Preparation and construct a tower according to management process that comply with PMBOK

- Competition to build the highest and most stable tower within a set budget and before the deadline to assess the result of each project manager
- The price of paper used and the hourly work rate for each student had been estimated in advance

Lecture Example: Design Project *ALPS*

- Active Learning Project Sequence (Project-based course)
- Lectures are delivered by international faculty
- Teach theory in modules ("workshops") of about 2 days of instruction each (about 8-9 hours of classroom instruction)
- Apply theory to a new product or service development situation. Application during sessions, but continued in intermediate work periods
- Deliverables must be produced and presented
- Each team has assigned faculty and/or industry mentors
- Perform in small mixed teams (~6 students per team)
- Actual themes are provided from industries (17 companies in 2010)
  - Enhancing Senior Life in Japan (2008)
  - Sustainable Community (2009)
  - Safety and Security (2010)

Lecture Example: Sequence for ALPS Class of 2008

May 2008

September 2008

February 2009

Team Formation
Thema Analysis
Stakeholder Identification
Scenario Generation
Concept Generation

System Architecture
Quality Function Deployment
Net Present Value Analysis
Concept Presentation

Final Presentation
Showcase Prototype
Elevator Pitch

Kickoff

Visit 2

Mid-Term Review

Visit 4

Final Review

Team Project

Visit 1

Visit 3

Visit 5

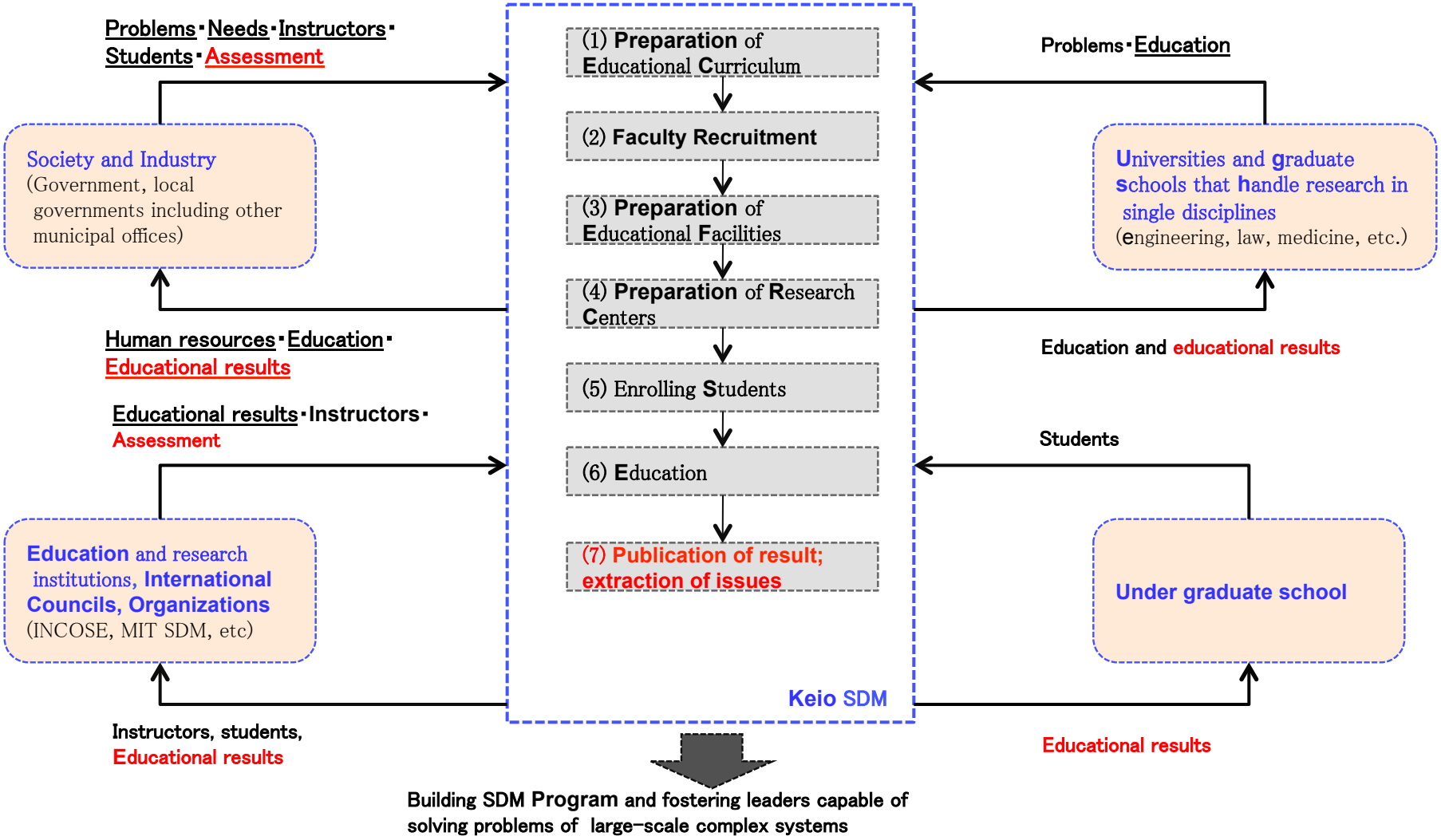
Interviews, Observation
Value Chain Analysis
Concept Selection
Preliminary Design

Detailed Design
Robust Design
Customization
Prototyping

June 2008

November 2008

Scenario for Achieving Goal and Relationships with Stakeholders



Master's Research: Some topics in 2009

- can be applied to many systems ranging from technological systems to social systems
- enables design and management conforming to the requirements of various stakeholders
- insistence on verification of results and check of its effectiveness

Research topics
Measurement of CO2 reduction effect by battery sharing alongside solar power generation
Carbon tax design using Life Cycle Assessment for the diffusion of clean energy vehicle
System design for symbiotic city-rural society centering on biomass energy technology
Evaluation of sustainability of copper supply with consideration for recycling in Japan
Proposal for safety management system in large-scale chemical plant
Devising global maritime security policy to stabilize international shipping systems
Research into future outlook for electronic books and structural changes in the print industry
Investigation and plan for verification test for the business model for launch space vehicle using the ocean – for realization of Japanese manned spacecraft

Comparison of Consciousness of SDM and Engineering Students

- An opinion poll was carried out on 2nd year student on master course
  - 36 students in graduate school of SDM, Keio university
  - 23 students in graduate school of Science and Technology, Keio university
- Concerning the abilities they considered to have improved through education in the graduate school in the one year since matriculation
- Six grade for each item

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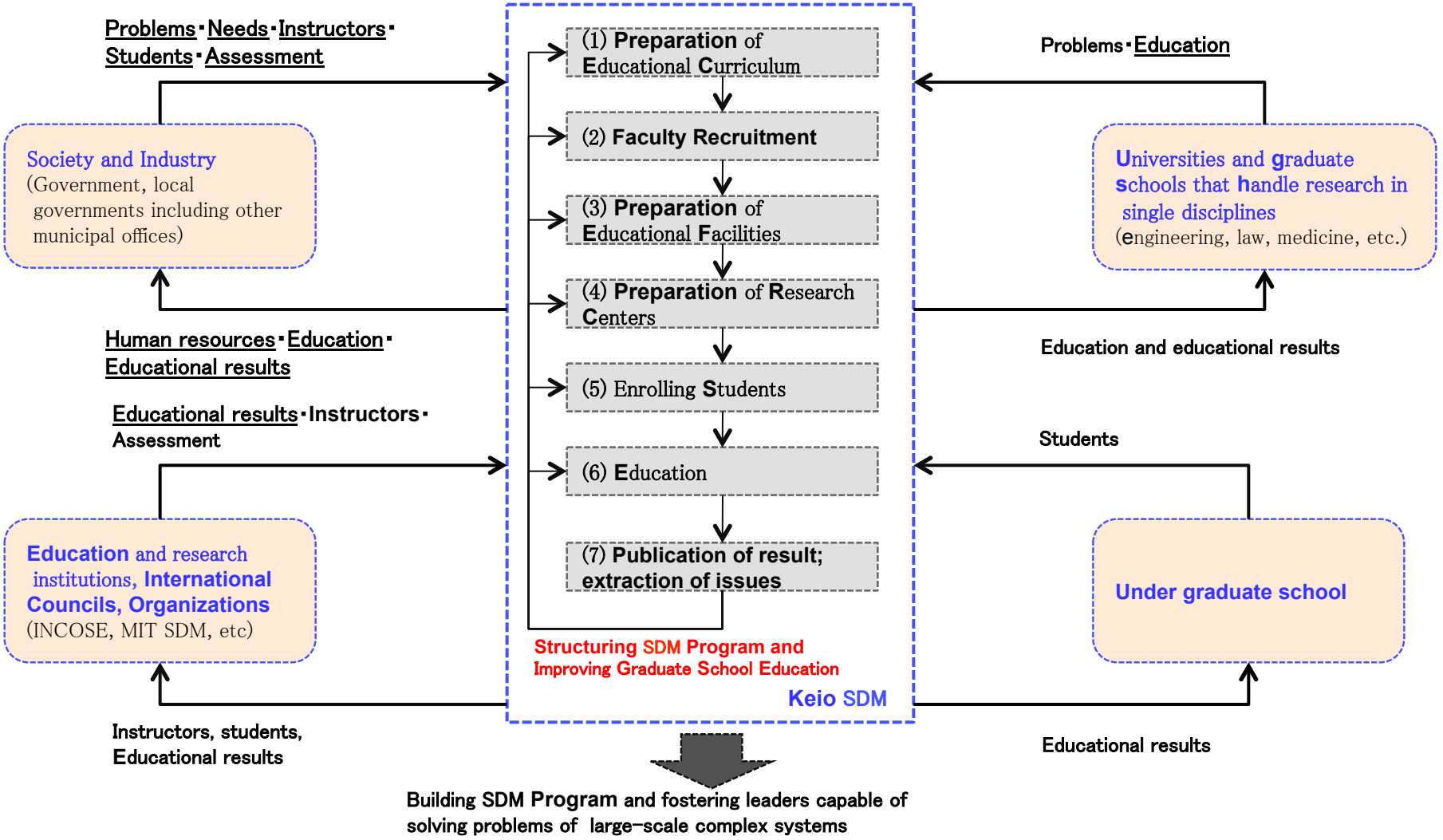
Although this result is a self-assessment by students ..

- The education and research of the SDM program almost meets the expectations made of a university and graduate school by industry

Cooperation with Society and Industry, and Institute

- Collaborative Education and Research
  - Systems Engineering Seminars
  - Collaborative Researches
    - Thermal/Acoustic trade-off design for consumer electronics
    - Evaluation of the alliance system designed by “Enterprise Currencies”
    - A Method for analyzing fundamental kinesiological motions of human body
- External Assessment
  - Five review committees

Scenario for Achieving Goal and Relationships with Stakeholders



Conclusion

- Large-scale complex technological and social accidents and disasters can not be solved by a single discipline
- Keio SDM was established to provide education in a multi-disciplinary approach to solve the large-complex accidents and disasters in 2008
- The graduate school was designed based on expectations of universities and graduate schools from industries and government
  - 66% master students have business experience
  - Most research themes are from industries and government
- According to the self-assessment by students, the SDM program almost meets the expectations from industries and government

Keio University

1858

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