Enhancing Quality of Doctoral Education
–Fostering Innovative Leaders for Sustainable Development–
博士課程教育の質の向上を目指して
～持続可能な発展を牽引するイノベーションリーダーの育成を～

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Innovation: Creation of new socio-economic value combining new discovery and inventions coupled with social systems.

The Innovation every country should pursue in the 21st Century

1. National & Regional Sustainable Innovation
2. Global Sustainable Innovation
**Issue 1: To nurture human resources for the sustainable innovation eco-system**

Need to enhance higher education including doctoral course based on the design concept of “Integrating education, research and innovation”

**Issue 2: To build up global sustainable innovation networks**

Need to enhance the competence of post-graduates with “Meta-national capability” in higher education including doctoral education.

Tracking Careers of Doctorial Graduates should be conducted coupled with these issues and competence the doctoral graduate has.
Learning from the Innovation of the Solar Battery

**Contribution to the World**
- Innovation in solar power
- Application R&D with integration of wide range of science and technology knowledge creation (Sun-shine Pj Japan, 1979)

**Renewable Energy**
- Solar power generation
- Underground water extraction
- Desalination of seawater
- Solar Town
- Mobile power

**Creation of Innovation in 21st C.**
- Basic Research
- Nano-Science
- Chemical Material
- Knowledge Creation
- Incubation of diversified seeds & technologies
- Basic Technologies
- Electrical Engineering
- Micro Machining

**Invented at Bell Laboratory USA, 1954**
Lesson learned from the innovation history

“Science & Technological evolution” and
“Integration of various knowledge through Innovation Pipeline Network” connecting academia, industry & government are the key to the sustainable innovation eco-system.

Innovation needs multi-disciplinary PhDs with the base of own speciality!

“Their social mission is to form the Innovation Pipeline Network domestically and globally”
Innovation Pipeline Network

Socio-economic Value Creation

Product & Service A
Derivative Tech.
Reevaluation of seeds
New Project.
Targetting
StageGate 1
S&E Needs
StageGate 2
S&E Value
Seeds
StageGate 3
R&D
S&E Value

Product A’
Standard
Field Test
Product C
Product B
Deregulation
Reevaluation of seeds
Back to Science

New Project Creation
Open to Other Tech.
Derivative Tech.
Research Area A
R-Area B
Academic Disciplinary Diversity

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Stages of Value Creation
Non-linear & Stochastic value creation
Difficulty of the Innovation in 21st Century

20th Century: Catch up type

21st Century: Front Runner

- Higher Performance
- Reliability
- Mental Satisfaction
- Wider Spectrum of Tech.

Required Capabilities for Innovation
1. Creation of Knowledge and Core Technology
2. Integration of the knowledge and technologies
Creating Socio-economic new Value
Human Resources Required for the Innovation

Human Resources should be nurtured

Type-D : Creation of differentiator technology

Type-E : Creation of enabler tech.

Type-B : Basic tech. & skill for high value added manufacturing and services

Type-Σ : Integrator of Innovation structure vertically & horizontally creating socio-economic value

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Human Resources Creating Innovation Pipeline Network

Stages of Value Creation

Socio-economic Value Creation

Product & Service A

Product A'

Standard

Service D

Product B

Deregulation

Derivative Tech.

Project A

New Project

Field Test

Knowledge Creation

Targeting

Research Area A

R-Area B

Academic Disciplinary Diversity

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Building up Innovation Networks

Network of Trans-disciplinary Value Combination

Network of Academic Value and Socio-economic Value Combination

Σ-Type PhDs have the Mission to be Leader for National & Global Innovation Network

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\(\Sigma\)-type Human Resource is indispensable for the Innovation

- **Meta-national Capability**
  (The capability of thinking & acting globally keeping the based on his/her nationality)

- **\(\Sigma\)-Type**
  - Management Capability
  - Wide Range of S&T competency with own Speciality

Direction of enhancing doctoral education!

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Nurturing $\Sigma$-type Capability

PhD has mission to be leader of innovation

Base-1: Wide Spectral Knowledge with One or More Specialties (Natural, Social Science)

Base-2: The Capability of Defining the Issues and Designing Approach for the Solution

Base-3: The Capability of Global Communication, Team Working and Collaboration

Base-4: Strong commitment to take Leadership either in Academic, Education or Industry

Leader of University/Government

Leader of Innovative Industry and Business world
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Summary

1. Innovation is not a simple technological revolution, but the creation of socio-economic value with the new combination of technological & social breakthrough

2. Learning from INNOVATION case studies
   (1) Non linear & Multi-disciplinary Uncertain & Stochastic process
   (2) 10-30 years incubation

3. Importance of National & Global innovation pipeline network, being integrated by Σ-type human resources

4. Importance of nurturing Σ-type human resources for the innovation eco-system with the base competency Type-D or Type-E or Type-B

Tracking Careers of Doctorial Graduates must cover these aspects with eyes what are missing!