

Collaboration between Universities and Society, Business & Industry in Research and Innovation

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The Fourth Industrial Revolution



We stand on the brink of a technological revolution that will fundamentally alter the way we live, work, and relate to one another. In its scale, scope, and complexity, the transformation will be unlike anything humankind has experienced before.

By Klaus Schwab, https://www.weforum.org/agenda/2016/01/the-fourth-industrial-revolution-what-it-means-and-how-to-respond/





Industrie 4.0



Horizontal and Vertical value chain integration

Horizontal value chain

Vertical value chain



Information transparency actualizes a highly effective business management and an authentic product lifecycle management



□ Japanese Core Competence



- Advanced research, Ability to develop new products

 -especially in Automation Engineering, Implementation of best practices
 in manufacturing operation
 World leader in major fields such as automotive and electronics industries
- Usage data of enormous amount of products
- High quality manpower
- Advanced skills, artisanship



Society 5.0





-gatherer society



Society 2.0



Society 3.0

Industrial society



Society 4.0 Information society

Society 5.0

Super Smart Society

The super smart society service platform

Standardization of Interfaces and data formats

Security advancement and use in society

Use of standard data

Consolidated development of ICT infrastructure

Reform of regulations and systems for new services

Human resource development

Optimizing the energy value chain

Building a global environment information platform Maintenance and upgrade of an efficient and effective infrastructure Attaining a resilient society against natural disasters Intelligent transportation systems New manufacturing systems Integrated material development systems Promoting integrated community care systems

Hospitality systems Smart food chain systems Smart production systems

Japanese Universities are expected to undertake cutting-edge R&D before commercialization in order to realize Society 5.0, utilizing Japan's superiority in Industry 4.0





"Joint Research Chair" system originated by Osaka University (since 2006)

Joint Research Chair **Industry etc. Osaka University** provides funds, provides researchers, Osaka University researchers, research premises, facilities etc. Sponsoring corporations materials etc. (temporary transfer) Other organizations Screening Joint Research Chair / Joint Research Division Staff At least one Professor or Associate Professor Duration: 2 to 10 years plus, Fully devoted to joint research one researcher of occupational level between Arrangement with emphasis on use of Associate Professor and Associate Professor intellectual properties Jointly operated by sponsoring Corporate researcher corporations and Osaka University Postdoctoral Fellow, Graduate Student Concurrent Professor, Associate Professor etc. Reflect social demands Administrative staff

Enhance university's research function

• Financial independence - leading to medium or long term continuity

 \rightarrow U of Tokyo, Kyoto U, Nagoya U, etc. followed Osaka U



Comprehensive Collaboration Agreement between the Center for iPS Cell Research and Application (CiRA), Kyoto University and Takeda Pharmaceutical Co., Ltd. (from April 2015)

• Takeda will provide research facilities and collaborative funding of 20 billion yen as well as more than 12 billion yen worth of research support (facility, equipment, Takeda researchers and various research services) over a 10-year period

 Around 10 projects on iPS cell technology applications will be pursued concurrently

•About 100 researchers engaged in joint research, with each contributing about 50 researchers

Comprehensive Collaboration Agreement between the Osaka University Immunology Frontier Research Center (IFReC) and Chugai Pharmaceutical Co., Ltd. (from April 2017)

• Total of 10 billion yen contribution over 10 years to IFReC to support IFReC basic research

 IFReC is going to disclose its research results to Chugai twice a year

• "Collaboration Promotion Laboratory" will be set up at IFReC to pursue 5 to 10 projects concurrently









World Premier International Research Center Initiative (WPI)



Program Summary

The WPI provides concentrated support for projects to establish and operate research centers that have at their core a group of very high-level investigators. These centers are to create a research environment of a sufficiently high standard to give them a highly visible presence within the global scientific community—that is, to create a vibrant environment that will be of strong incentive to frontline researchers around the world to want to come and work at these centers.



The WPI holds the following vision with regards to the research centers being established.

- \cdot 7-10 or more top-level principle investigators (centers selected in FY 2007 and FY 2010 had 10-20 or more)
- · Total of 70-100 or more researchers and staffs (centers selected in FY 2007 and FY 2010 had 100-200 or more)
- \cdot 30% or more overseas researchers









WPI Nano Life Science Institute (WPI-NanoLSI)



Human Body



Cell



Life Phenomena

- Development
- Disease
- Aging

Nanodynamics in Cell Proteins Metabolites Nucleic acids



WPI Nano Life Science Institute (WPI-NanoLSI)





"Nanoprobe Life Science"

Nano-level understanding of life phenomena by nanoprobe technologies





Motor Protein (Myosin V)

Fluorescence

HS-AFM





Nature (2010)

BBRC (2000)





JMB (2012)



The Center of Innovation Program (COI STREAM)





http://www.jst.go.jp/coi/etc/COI-brochure2017.10EN.pdf

□ The Center of Innovation Program (COI STREAM)





KANAZAWA UNIVERSITY 14

Kanazawa's Challenge: Construction of next-generation infrastructure systems using innovative materials





KANAZAWA

http://www.icc-kit.jp/coi/en/feature/02.html

Kanazawa's Challenge: Development of Carbon Fiber Reinforced Plastic Derived from Plant Biomass







Development of Carbon Fiber Reinforced Plastic (CFRP) based on Cellulose acetate butyrate (thermoplastic resin)









$\langle { m Objectives \ of \ establishing \ OILs} angle$

- (1) Carrying out successive research and development from basic research to demonstration in a seamless manner.
- 2 Accelerating research with a cross-appointment system, in which professors of the universities can also work as AIST researchers.
- (3) Developing doctoral researchers with open-minded and practical visions, capable of playing active roles in industries.

Utilizing the Cross-Appointment System
Universities → AIST: 39 persons
AIST → Universities: 14 persons
(As of Oct 1, 2017)



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AIST-NU GaN Advanced Device Open Innovation Laboratory (GaN-OIL)

Based on the technology of blue LED which Japan realized first in the world, we aim at early practical application of power semiconductors using GaN (gallium nitride).



AIST-UTokyo Advanced Operando-Measurement Technology Open Innovation Laboratory (OPERANDO-OIL) Operando-measurement technology will lead to elucidation of functional mechanisms and visualization of manufacture processes. The acceleration of development of materials, devices is expected.



AIST-TohokuU Mathematics for Advanced Materials Open Innovation Laboratory (MathAM-OIL) We will systemize technology for materials modeling research by means of mathematical science, such as discrete geometric analysis, and computational materials science. We will clarify the principle of correlation among the structures, functions, and processes of materials, and will accelerate materials development.



AIST-Waseda University Computational Bio Big-Data Open Innovation Laboratory (CBBD-OIL) We are aiming at elucidating life phenomena and mechanisms of diseases and the creation of innovative drugs and supplements, by integrating biological big data and information infrastructure technology with technology for life information analysis.



AIST-Osaka University Advanced Photonics and Biosensing Open Innovation Laboratory (PhotoBIO-OIL) We will conduct research and development of biosensing technology to elucidate mechanisms of organisms and to realize epoch-making drug creation, drug effect, toxicity evaluation, and infectious disease diagnosis, by integrating nanophotonics technology and biodevice technology.



AIST- Tokyo Tech Real World Big-Data Computation Open Innovation Laboratory (RWBC-OIL) Our mission is to advance the high-end processing and applications of big data in the real world, utilizing high performance, scalable computing as well as AI-based analysis technologies on world-leading computing infrastructures.



AIST-Kyoto University Chemical Energy Materials Open Innovation Laboratory (ChEM-OIL) By creating innovative materials based on new concepts and developing them into chemical energy devices, we will contribute to realizing a low carbon society by 2050 that is aimed at in the Energy and Environment Innovation Strategy.



"Comprehensive strategy for town, people, creation" project AIST-Kyushu University Hydrogen Materials Laboratory (HydroMate)

By developing materials for safe and economical utilization of hydrogen, we aim to expand utilization and application technology of hydrogen.

KU-AIST Collaboration ~ Personnel Exchange and Research Base~





Areas: computer science, materials, environment (Faculty, School)

SAKIGAKE Project

"Creation of innovative Energysaving device"

Assoc. Prof. Norio Tokuda (Faculty of Electrical Engineering and Computer Science)

InFiniti

"Renewable Energy Unit"

Prof. Tetsuya Taima (RSET) ... and others

Research assistant system by our graduate students

- ✓ Taking part in research development project by AIST
- ✓ Offering hands-on research experience
- ✓ Utilizing research outcomes in degree thesis



Developing joint research in wider scope based on researches accelerated by collaboration and personnel exchange

Cross-appointment system of faculty and researchers

- Revitalizing research environment
- Fluidization of research personnel
- Organizing a system to implement bridging research



Areas: energy and environment (materials, chemistry,

electronics, manufacturing)

Advanced Power Electronics Research Center • Diamond Device Team

Research Center for Photovoltaics

Renewable Energy Research Center

... and others

Joint application for major international grants

✓ Formation of the exceptional research base





Example of fusion between the technology developed by Assoc. Prof. Tokuda

and the Device technology of AIST





14-11 V_ = -12 V

-2 -1 0

Personnel Exchange through Collaboration (Organic Thin Film Solar Energy)





InFiniti Renewable Energy Unit Members (10 members : 3 in solar battery)

Fabrication process of organic solar cells in ambient atmosphere





Developing organic (Perovskite) solar cells by vacuum evaporation





Synthesizing new organic semiconductors









Overall Picture of the Innovation System





 $K_{U \ N \ I \ V \ E \ R \ S \ I \ T \ Y}^{A \ N \ A \ Z \ A \ W \ A} http://www.meti.go.jp/committee/sankoushin/sangyougijutsu/keihatsu_innovation/pdf/report01_02.pdf 23$

Conclusion



- Expanding and deepening joint researches (Large-scale Institution-to-Institution joint research)
- Research consortium at an under-one-roof type base (Joint research in noncompetitive areas by multiple universities and businesses)
- Utilization of cross-appointment system (vitalization in university-AIST collaboration)

