Social and Technical Innovation and Societal Impact in the Context of the Engineering Sciences
- In the case of Saitama Univ., a mid-sized national university -

Hiroki YAMAGUCHI
President, Saitama University

Congratulations!
Nobel Physics Prize 2015
Prof. Takaaki Kajita
(graduated from SU in 1981)
### Fast Facts of Saitama University (SU)

**Founded in 1949**  
2016: 67 years old

As of May 2016

<table>
<thead>
<tr>
<th>Undergraduate</th>
<th>Student</th>
<th>Graduate School</th>
<th>Student</th>
<th>Exchange Student Etc.</th>
<th>Total No. Student</th>
<th>Faculty</th>
<th>Staff</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Master</td>
<td>Doctor</td>
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<tr>
<td>Liberal Arts</td>
<td>847</td>
<td>Humanities &amp; Social Science</td>
<td>179</td>
<td>73</td>
<td>2,572</td>
<td>102</td>
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<tr>
<td>Economics</td>
<td>1,473</td>
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<td>87</td>
<td>9</td>
<td>2,118</td>
<td>108</td>
<td>14</td>
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<tr>
<td>Education</td>
<td>1,974</td>
<td>Education</td>
<td>144</td>
<td>9</td>
<td>2,118</td>
<td>108</td>
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<tr>
<td>Science</td>
<td>902</td>
<td>Science &amp; Engineering</td>
<td>843</td>
<td>174</td>
<td>3,894</td>
<td>227</td>
<td>14</td>
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<tr>
<td>Engineering</td>
<td>1,975</td>
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<td>98</td>
<td>98</td>
<td>2,118</td>
<td>108</td>
<td>14</td>
</tr>
<tr>
<td>Others (Education Bureau, Research &amp; Development Bureau)</td>
<td>126</td>
<td>126</td>
<td>34</td>
<td>8</td>
<td>126</td>
<td>126</td>
<td>34</td>
</tr>
</tbody>
</table>

| Total         | 7,171   | 1,166 | 247 | 126 | 8,710 | 471 | 224 |

**Number (included in Number):** International Student, Faculty and Staff
International Partnerships with SU

As of October 2014

International Partnerships with SU

Germany:  
- Esslingen Univ. of Applied Science
- University of Munich
- Brandenburg Univ. of Technology Cottbus
- University of Hamburg
- University of Hohenheim
- Friedrich Schiller Univ. of Jena
- Rhein-Wall Univ. of Applied Science

Europe: 30 → 48

Asia: 41 → 58

North America: 20

Latin America and the Caribbean: 4 → 5

As of May 2016

International Partnerships with SU

Japan: 99 in total  
- As of October 2014

Europe: 139 in total  
- As of May 2016

“Just 50 km North of Tokyo”
How can universities in Germany and Japan react to current societal demands while at the same time safeguarding the true mission of universities?

Missions of and Societal Demands to National Universities in Japan

- 86 National Universities in Japan since 2004 Incorporation
  - Globalization, Innovation
  - University reform, Functional enhancement

- National University Management Strategy (2016～)
  - To maximize the creation function of intellect as an engine of social reform
  - International (Global), National, Regional, Specific field

Way of Achieving True Mission and Reacting Societal Demand

- In the Case of Saitama University
  - COE in Specific Fields of Studies: Strengthening of Research & Education Functions
  - Regional R/D & Education Center: Importance of Int. Cooperation
National Universities in Japan since 2004 Incorporation

Objectives of Incorporation
• Activation of national univs. In self-directive environment
• Promotion of active actions for good education and unique research
• To realize more attractive national universities

Changes of Environment
• Globalization
• Aging society with child birthrate falling
• Competition intensification by the rise of emerging countries

The 1st Period of Medium-Term Goals
(2004 - 2009)
Start-up period of national univ. corporation system

The 2nd Period of Medium-Term Goals
(2010 - 2015)
Implementation of full-scale university reform utilizing merits of incorporation

The 3rd Period of Medium-Term Goals
(2016 - )
Toward national universities producing high added values with sustained competitiveness

National University Management Strategy
To maximize the creation function of intellect as an engine of social reform

The National University Reform Plan (Nov 2013)
Creation of system for self-directive advancement

Concept for further functional enhancement of national universities (June 2013)

Period to accelerate univ. reforms
Globalization, Creation of Innovation, flexibility in personnel/payroll system

Redefinition of Missions

Start of the National University Corporation

The 2013 academic year (April 2013) The 2016 academic year (April 2016)

The 2013 academic year (April 2013)
Redefinition of Missions

The 2016 academic year (April 2016)
Redefinition of Missions

Base reinforcement as an intellectual institution

Self-branding as Saitama University

Saitama University, All in One Campus at Capital Sphere, Saitama - Embodiment of Diversity, Synergy and Integration (2016-2022)

2013 National University Reform Project

2013 Reform of Saitama Univ. by reorganization/corporation of schools - Extensive enhancement of research and education functions (2013-2018)

2016 Budgetary request for functional enhancement

Actions of SU

就英大学
1. Promotion of functional enhancement based on future vision of university

A framework of 3 Priority Supports is introduced in the national budget allocation to carefully support a functional enhancement action of each national university. In this way, national universities are converted into the organizations performing the development of frontier research areas and the human resource cultivation depending on regional needs.

Priority Support 1  Promotion of HRD and research depending on regional needs

55 national universities

Priority Support 2  Promotion of establishment of COE and network in specific field covered by univ.

15 national universities
THE World University Ranking 401–500: Tokyo Medical and Dental U,  601–800: Kyushu Institute of Tech

Priority Support 3  Establishment of COE in competition with the world’s top university

16 national universities
THE World University Ranking 43: U of Tokyo,  88: Kyoto U,  201–250: Tohoku U, Tokyo Institute of Tech
**Direction of Functional Enhancement: COE in Specific Fields of Studies**

**Strengthening of SU’s Research & Education Functions**

**Strengthening of Research Function**
- Strategic Research Unit in Graduate School of Sci. & Eng.
- Material Science Unit
- Industrial Science Unit
- Life Science Unit
- Life•Nano-bio
- Envi. Science•Infrastructure Unit
- Man-Machine Interface
- Math-Info. Science Unit

**Strengthening of HRD function in Humanities & Social Science**
- School of Economics
- School of Liberal Arts
- Grad. S. Cultural Sci.

**Intensifying of Human Resources**

**Established in 2014**
- 15 researchers including 5 int. ones

**6 int. academic stuffs are newly hired.**
- To ensure evening program education

**Strengthening of teacher training in Education**
- School of Education (480→380)
- Graduate School of Education

- Teaching Profession Grad. S. (April 2016)

**Bachelor-Master Integrated Program**
- Increase of Master enrolment limit (308→508)
- Step-by-step increase of enrolment with integrated program

- Reorganization of Schools of Science and Eng. (2018)
Saitama University, All in One Campus at Capital Sphere, Saitama
- Embodiment of Diversity, Synergy and Integration -

- Liberal arts, economics, education, science and engineering in one campus
- Japanese students, overseas students and adult students in one campus
- Various regions and regional problems because of Saitama
- Many overseas and adult students gathered in SU because of the capital sphere, Saitama
- From Saitama to the world! (Local ⇔ Global)

SU aggressively takes a role of regional R/D & Education center to activate the capital sphere around Saitama by the industry-university-government collaboration and by the regional communication.

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<tbody>
<tr>
<td><strong>Action 1:</strong> Establishment of Graduate School of Integrated Technology &amp; Service</td>
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<td><strong>Action 2:</strong> Doctoral expert in tech.</td>
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<tr>
<td><strong>Action 3:</strong> Establishment of Frontier Industry International Laboratory</td>
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</tbody>
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<table>
<thead>
<tr>
<th>Strategy 2: HRD and teacher training based on regional needs</th>
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</thead>
<tbody>
<tr>
<td><strong>Action 4:</strong> Establishment of Career Center SU</td>
</tr>
<tr>
<td><strong>Action 5:</strong> Establishment of Teaching Profession Graduate School and its enhancement</td>
</tr>
<tr>
<td><strong>Action 6:</strong> Advancement of teacher training</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Strategy 3: Establishment of COE in specific fields of studies</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Action 7:</strong> Promotion of international joint researches in Strategic Research Units, Grad. S. of Sci. &amp; Eng.</td>
</tr>
<tr>
<td><strong>Action 8:</strong> Enhancement of Graduate School of Science &amp; Engineering</td>
</tr>
<tr>
<td><strong>Action 9:</strong> Lab-to-Lab Program in Sci. &amp; Eng.</td>
</tr>
<tr>
<td><strong>Action 10:</strong> Enhancement of global human resource development at SU</td>
</tr>
</tbody>
</table>
THE World University Rankings among 18,000 Univs.

**Saitama University**

<table>
<thead>
<tr>
<th>Area</th>
<th>Performance indicator</th>
<th>Weight (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teaching</td>
<td>Reputation survey</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>Staff-to-student ratio</td>
<td>4.5</td>
</tr>
<tr>
<td></td>
<td>Doctorate-to-bachelor’s ratio</td>
<td>2.25</td>
</tr>
<tr>
<td></td>
<td>Doctorates awarded-to-academic staff ratio</td>
<td>6.0</td>
</tr>
<tr>
<td></td>
<td>Institutional income</td>
<td>2.25</td>
</tr>
<tr>
<td>International Outlook</td>
<td>International-to-domestic-student ratio</td>
<td>2.5</td>
</tr>
<tr>
<td></td>
<td>International-to-domestic-staff ratio</td>
<td>2.5</td>
</tr>
<tr>
<td></td>
<td>International collaboration</td>
<td>2.5</td>
</tr>
<tr>
<td>Industry Income</td>
<td>Knowledge transfer</td>
<td>2.5</td>
</tr>
<tr>
<td></td>
<td>Reputation survey</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>Research income</td>
<td>6.0</td>
</tr>
<tr>
<td></td>
<td>Research productivity</td>
<td>6.0</td>
</tr>
<tr>
<td>Citations</td>
<td>Research influence</td>
<td>30</td>
</tr>
</tbody>
</table>

- Academic staff in Science and Engineering is about 50%.
- Quality of research paper is relatively high.
New Scheme of Cooperation in HE at Saitama Univ.

2014- : **Lab-to-Lab Program** for Graduate Students in Science & Engineering
- A research-oriented student exchange program based on Lab-to-Lab or Prof-to-Prof relation with partner universities.

**Strategy Building Ability**
- **Lab-Based Student Exchange**
- **Overview of Peripheral Areas**
  - On-Campus Across-Labs Project
- **Learn from Pioneers**
- **Strategy Understanding**
  - Analysis of Research Strategy
- **Global Adaptableness**
- **International Cooperation**
  - Lab-to-Lab Outbound Scheme
  - Lab-to-Lab Inbound Scheme
  - Joint Project to study the process from extraction to resolution of problem with counterpart professor
  - Understanding of diversity

Lab-to-Lab

**Prof. S. Nakabayashi**
and his Lab students
Saitama University, Japan

**Prof. I. Ortega-Blake**
and his Lab students
National Autonomous Univ. of Mexico

Physical Chemistry

Biophysics
How do we define “innovation” and “societal impact” in the context of engineering science?

Science and Technology Policies in Japan

- The 5th Science and Technology Basic Plan
  Realizing a world-leading “super smart society” *(Society 5.0)*

- Japan Revitalization Strategy 2016
  For the 4th Industrial Revolution
  The most important key is innovation.

What is innovation?

  Innovation is not mere technology renovation nor a spark of genius, but overall new concept to spread in human society.  Paradigm Shift

- Innovation in Earthquake Engineering
  New Technology of Seismic Isolation and Control
  New Concept of Resilient Society
Realizing a world-leading “super smart society” (Society 5.0)
where the various needs of society are finely differentiated and met by providing the necessary products and services in the required amounts to the people who need them when they need them, and in which all the people can receive high-quality services and live a comfortable, vigorous life.

The 5th Science and Technology Basic Plan (Jan. 2016, CITI, Japan)

Japan Revitalization Strategy 2016 - for the 4th Industrial Revolution – (June 2016)
The 4th industrial revolution
which creates new businesses that resolve social issues and arouse consumers’ potential needs by using the technological breakthrough of IoT (Internet of Things), Big Data, Artificial Intelligence and robot sensor.

In promoting the 4th industrial revolution, we will coordinate with the consideration of the basic policy of the Society 5.0 strategy.

The most important key is innovation.
Innovation in Earthquake Engineering

The Great Hanshin/Awaji Earthquake (Kobe Quake M7.3) Jan. 17, 1995
- World's pre-eminent antiseismic techniques → Disillusionment with Japanese seismic engineering
- The honest explanation of bridge engineers: "The earthquake far exceeded what was assumed in the design."

⇒ Improvement of design standard and introduction of seismic isolation & control

Science & Technology Innovation

The Great East Japan Earthquake (Tohoku Quake M9.0) Mar. 11, 2011
- No severe damage of bridges by direct quake action ← Experience and lesson of Kobe Quake
- The disaster and accident due to the tsunami were far beyond imagination!

⇒ Introduction of new concept of Resilient Society

Creation of resilient society is to create a disaster-resistant and flexible community.

The hardware measures for disaster prevention which only prepare for a disaster as "pre-risk" based on the past way of thinking for natural disaster, are powerless when the "outside assumption" happens.

A new way of thinking is to create the society, which is resilient to natural disaster, by adding "on-risk" at the time of disaster and "post-risk" after disaster to "pre-risk" before disaster.

Innovation by integration of Science & Technology and Humanities & Social Science

Looking back on the history, human beings have always learned from tragic disasters and moved forward.

The 2016 Kumamoto Earthquake ⇒ ?

International Institute for Resilient Society

All in One Campus at Capital Sphere, Saitama: Diversity & Synergy

which aims at research, education, and international contributions in the areas of disaster prevention, environment, and infrastructures for constructing truly resilient society.
What kind of training and education do today’s graduates in the engineering sciences require to act successfully as technically expert and interculturally sensitive citizens of the world?

In the Case of Saitama University

- Frontier Industry International Lab. & New Graduate School
  - Globalization, Innovation
  - Liberal Arts, Technology and Service
  - Integration of Arts and Sciences

- Frontier Industry Creation Project by Saitama Prefecture
  - Project Based Learning
  - Industry-University-Government Collaboration

Innovation is not a spark of genius. An ability to take the initiative in solving problems with a diversity of people is a key factor for innovation.
Frontier Industry Creation Project by Saitama Prefecture (2014～)

**Year 2025 problem**

The baby-boom generation becomes elderly aged 75 or over. ⇒ Explosive increase in medical demand and drastic decrease in productive age population ⇒ Shrinkage of workforce and economic recession

**To increase regional ‘earning power’**

Promotion of the Project to plant a seed of next-generation industry and to cultivate it

**Frontier Industry Creation Project** is promoted to strongly support practical realization, productization, commercialization and industrialization, by integrating advanced study seeds of university/research organization and superior technologies of industrial firm.

It aims to bring up pioneering industries in 5 key areas and to accumulate them in Saitama prefecture by the cooperation with AIST, NEDO, and financial institutions.
Project 1: Quick detection for Toxins and Infectious Viruses on the basis of Next Generation Antibodies

ELISA & ImmunoChromatography, etc.

Vero toxin, Influenza viruses, Noro Viruses, Dengue Viruses, etc.

ImmunoChromatographic assays

Project 2: Quick diagnostics for Cancer (Tumor) Markers on the basis of Next Generation Antibodies

ELISA & ImmunoChromatography, etc.

Survivin, Other known tumor makers, etc.

Use of cDNA display method for screening

New Business

Successful Discovery Anti-Tumor Maker!! (Next-Generation Antibody)
Development of Rehabilitation Robots with Visualization Techniques

What is the merit of introducing robot to rehabilitation when robots are bulky, expensive? Additionally, it is less-skilled than therapists.

- Robot can measure accurately and automatically with the equipped sensors.
- Augmented reality is also good solution for enhancing rehabilitation.

Proposal in this project

Effective training based on visualization of force information

6 out of 7 participants had much shorter time after 1 month training. This is a possible beneficial effect of improvement in ambulatory function.
Solution-Processed Flexible/3D Curved Surface Organic Thin Film Solar Cells

Organic Thin Film Solar Cells by Electro Spray Deposition (ESD) method provide light weight, flexible / 3D curved surface and versatile applicability for mobile and energy-harvesting fields.

An example of flexible organic solar cell fabricated on a PEN substrate.

Typical C-V curves and conversion efficiencies of fabricated organic solar cells: (a) An inverse-type cell on a flexible PEN by spin-coating, 8.1%, and (b) A conventional-type cell on a glass by the ESD, 8.6%.

Light Weight, Thin and Flexible! Combination to Energy-Harvesting Applications! Diverse Design Capability!

First successful Electro-Spray to 3D curved surface (a) and fabrication of Dome-Shape Solar Cells (b) in cooperation with RIKEN.

We aim at cost-effective organic solar cell technology based on solution-processed approach in cooperation among industry, prefectural government and academia.
Concluding Remarks

In the case of Saitama University,

For true mission as an intellectual institution
  ➞ Global Center of Research & Education
  ➞ Co-existence

For innovation and societal impact
  ➞ Regional Center for Frontier Industry Creation & Human Resource Development

Important keywords:
  International Cooperation
  Industry-University-Government Collaboration
  Technology and Service
  Integration of Arts and Sciences

  ➞ Diversity, Synergy and Integration

THANK YOU!