MEMS Innovation at Tohoku University

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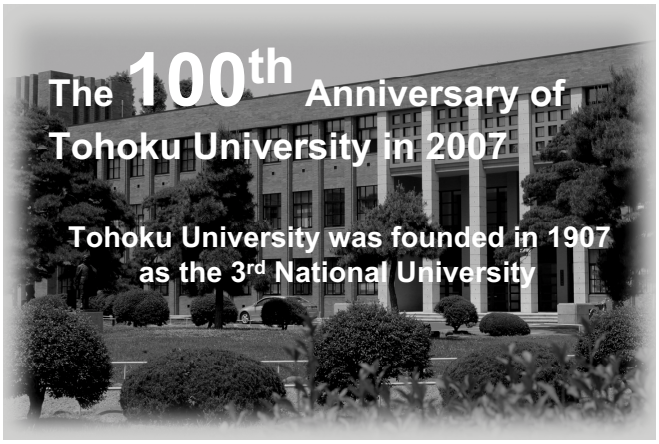
Assistant Professor

Office of Cooperative Research and Development

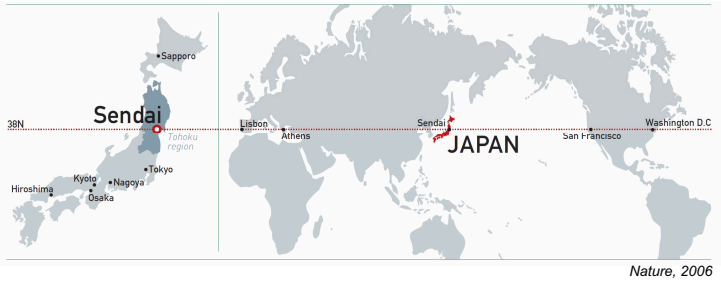
Tohoku University

JUNBA 2008, January 11, 2008

TOHOKU UNIVERSITY Sendai, Japan



TOHOKU UNIVERSITY Sendai, Japan



Nature, 2006

From Tokyo to Sendai: 96 min
Population of Sendai: 1 million
Result of popularity vote in 2004 :
1st: Sapporo, 2nd: Shizuoka, 3rd: Sendai, 4th: Tokyo

Bullet train "Shinkansen"

TOHOKU UNIVERSITY Sendai, Japan

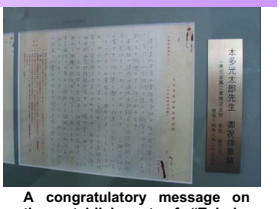
Fundamental Policies

1. "Research-intensive University"
   as its mission
2. "Have University's doors open to the World and Community"
   as its principle
3. "Development of Leading Human Resources"
   as its educational goal

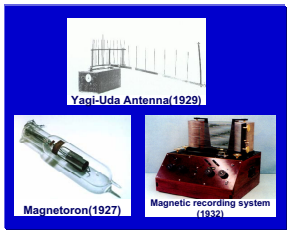
TOHOKU UNIVERSITY Sendai, Japan

Major Research institutes with our tradition of "Practical Science"

- Institutes for Materials Research
  – KS steel by Dr. Kotaro Honda
- Research Institute of Electrical Communication
  – Yagi Antenna by Dr. Hidetsugu Yagi
- Semiconductor Research Institute, Semiconductor Research Foundation
- Research Institute for Electric and Magnetic Materials



A congratulatory message on the establishment of "Tohoku Metal Industries Co., Ltd" by Dr. Kotaro Honda

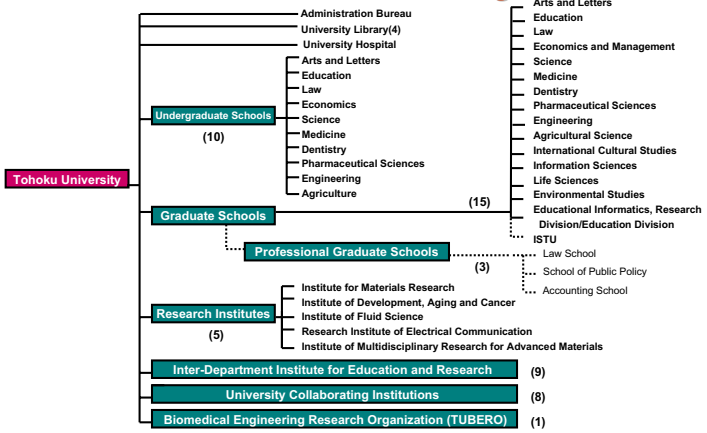


Forerunner of University Ventures before the Second World War

- Tohoku Metal Industries Co., Ltd. (present: NEC TOKIN Corporation)
- Yagi Antenna Co., Ltd (present: Hitachi Kokusai Electric Inc.)

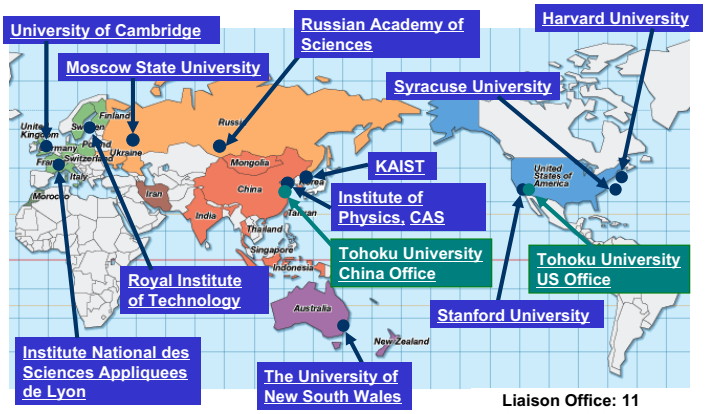
Overview of TOHOKU UNIVERSITY

Research and Education Organization



Overview of TOHOKU UNIVERSITY

Liaison and Overseas Offices (As of July 2007)



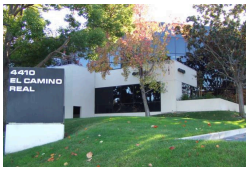
Liaison Office: 11
Overseas Office: 2

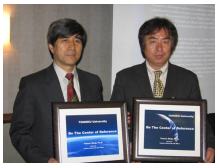
Overview of TOHOKU UNIVERSITY

Tohoku University US office

- Supporting strategic application of research achievements to the world
- Supporting collaboration with overseas academia and international organizations (planning and holding symposium and seminar; developing collaborative researches and contract researches)
- Supporting cooperative educational opportunity with overseas academia and international organizations for symposium, distant learning, e-learning, short- and long-term overseas education
- Supporting Tohoku University Global Promotion Center
- Supporting formation of alumni organization in US and its activity

- 4410 El Camino Real, suite #111, Los Altos, CA94022, USA
- Tel; +650-947-0664 Fax; +650-947-0244 Web; www.tohoku-u.us





Overview of TOHOKU UNIVERSITY

Research Paper Citations

National Ranking	International Ranking	Field	Citations	Papers
1	3	Materials Science	27,139	4,782
2	9	Physics	101,289	10,390
4	18	Chemistry	59,753	5,935
2	36	Engineering	11,448	3,173
6	66	All Fields	337,898	38,371

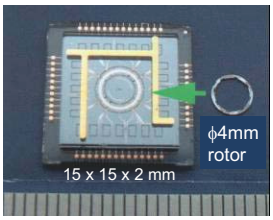
Resource: ISI Essential Science Indicators[SM], January 1, 1997 – February 28, 2007

What's MEMS

MEMS: Micro Electro Mechanical Systems

Tiny system combining electrical and mechanical components

Small and high performance sensor and actuator



ex.) Gyroscope, TOKIMEC, Japan

2-axis angular velocity and
3-axis acceleration

Mechanical part
ϕ4mm silicon rotor

Electrical part
Electrostatic levitation control

rotation speed: 12,000 rpm

working as "the heart" or "the key" in a system

MEMS R&D at Tohoku Univ ~*over 30 faculties*~

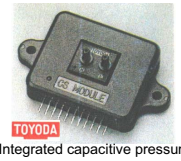
MEMS products from Tohoku Univ-Industry collaboration

Nikei-Sangyo (Dec.12,2003)
Highest evaluation by industry

Catheter pH, PCO_2 monitor
(Nippon koden)

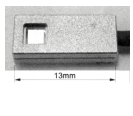
Portable pH sensor
(Shindengen)

Pyroli detector
(Nippon koden)

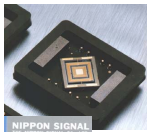


Integrated capacitive pressure sensor (JTEKT)

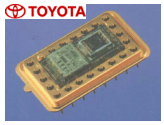
Diaphragm vacuum gage
(Canon anelva)



MEMS microphone
(NHK, Panasonic)

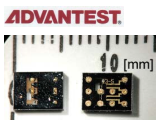


2-axes optical scanner
(Nippon signal)



Resonating gyroscope
(Toyota motors)

Electrostatically levitated rotational gyroscope (Tokimec)



MEMS relay for LSI tester
(Advantest)

Sacrificial dry etcher
(Chemitronics)

MEMS R&D facility at Tohoku University

120 m² MEMS clean room
400 users and 40 laboratories registered

Micro/Nanomachining Research and Education Center (MNC)
600 m² CMOS and MEMS clean room and evaluation facilities
500 users and 100 laboratories registered

2 cm x 2 cm, 2 and 4 inch facilities

More than 100 companies dispatched their researchers (full time)

National project on MEMS at Tohoku University

Special Coordination Funds for Promoting Science and Technology
supported by MEXT (Japanese Ministry of Education, Science, culture, sports)

Formation of Innovation Center for Fusion of Advanced Technologies on;

Tohoku University R&D Center of Excellence for Integrated Microsystems

Term: 2007~2016 (Max.)
Budget: ~$70M

Concept

R&D center based on open innovation
- Next generation industry-university linkage system
- Human resource development beyond several fields

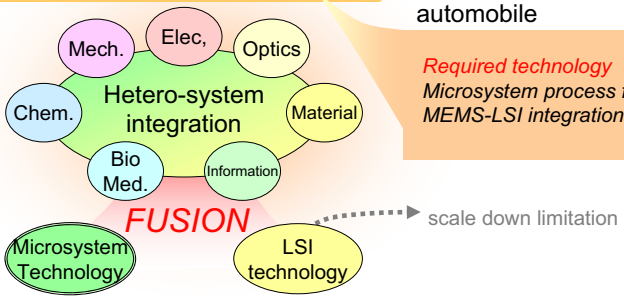
Innovation

Creative space for intelligent production

Safety space for automobile

- Seeds of next generation industry
- Integrated microsystem technology

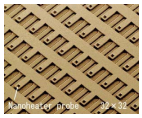
Required technology
Microsystem process for MEMS-LSI integration



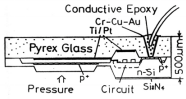
R&D Center of Excellence for Integrated Microsystems

(Formation of Innovation Center for Fusion of Advanced Technologies sponsored by Ministry of Education...) 2007~2009 (2016)

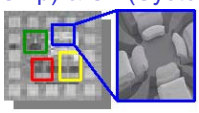
MEMS + LSI (SoC(System on Chip) & SiP(System in Package))



Arrayed MEMS,



Capacitive sensors,



RF integrated MEMS, Disposable devices

Realize MEMS having good mechanical property on advanced small feature size LSI

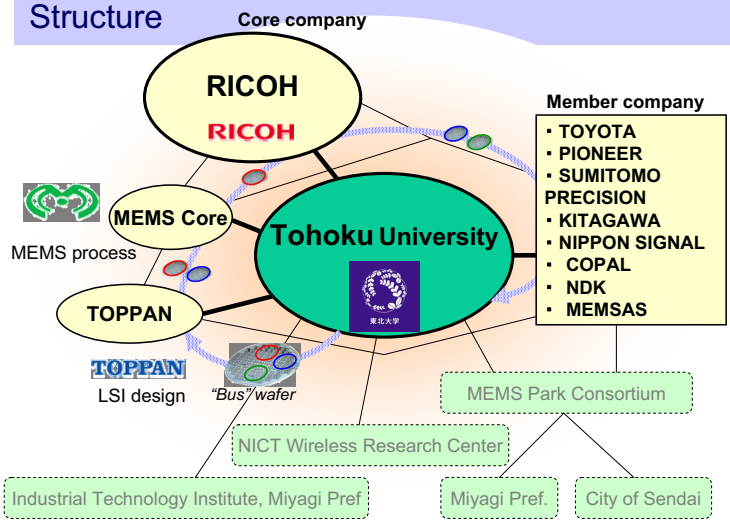
Problems to be solved :

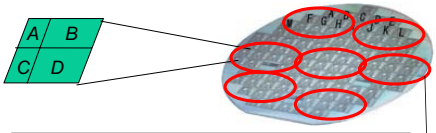
○ Low temperature processes (bonding or deposition) for MEMS having good mechanical properties for micromechanical resonator, switch etc..

○ Damage-free and compatible processes (temperature, etching, electrostatic discharge etc.)

○ Packaging, Test, Interconnection and so on.

Structure





Ricoh
Toyota motors
Pioneer
Nippon signal
Kitagawa machine works
Sumitomo precision
Nippon densan copal
Nippon denpa
MEMSAS
Tohoku Univ.

Shuttle service shared in project
(Toppan technical design center)

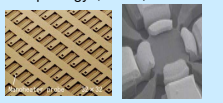
Low temperature additive MEMS process
(MEMS core)

Shuttle service shared in our project
+ Low temperature MEMS process

Next generation wireless system group

Esashi, Yamaguchi, Yugami, Tanaka, Ono

Toppan TDC, Pioneer, Nippon Denpa Kogyo, Ricoh, NICT

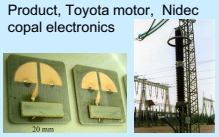


Multiprobe data storage On-chip filter

Wireless sensor, Ultra-Sensitive sensor group

Miura, Kumano, Esashi, Ono, Tanaka, Nagasawa

Kitagawa, Sumitomo precision Product, Toyota motor, Nidec copal electronics

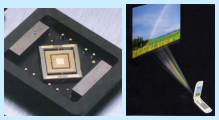


Wireless sensor for harsh environment

Optical microsystem group

Hane, Kanamori, Totsu, Kawai

Ricoh, Nippon signal

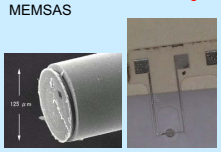


2D optical scanner Laser projector

BioMedical Microsystem group

Matsue, Nishizawa, Abe, Haga

MEMSAS

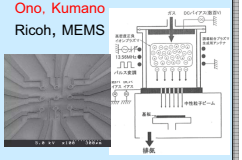


Blood pressure sensor Biosensor

FabricationTest Equipment group

Samukawa, Miura, Yamaguchi, Ono, Kumano

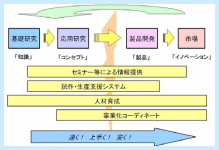
Ricoh, MEMS



Parallel EB exposure system Neutral beam etching system

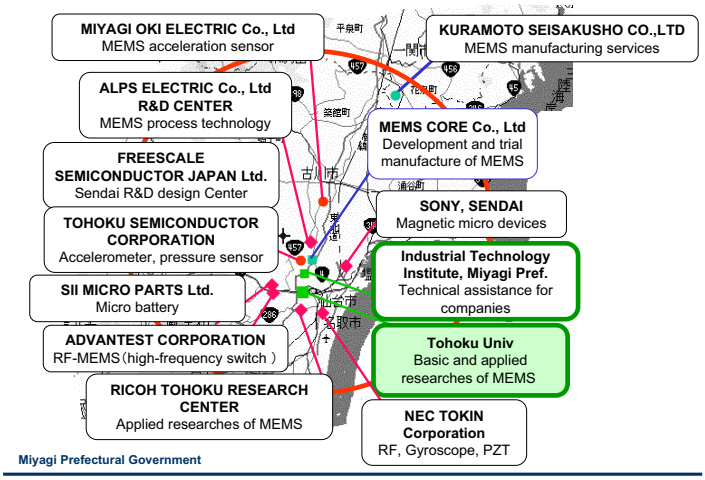
Technology Society System group

Ueyama, Kumano, Totsu, Takahashi



Industry-univ. collaboration system

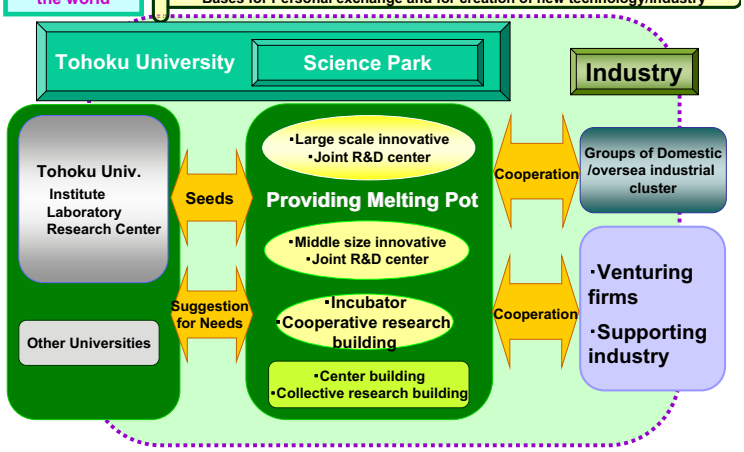
MEMS activity in Sendai area



University opened up to the region and the world

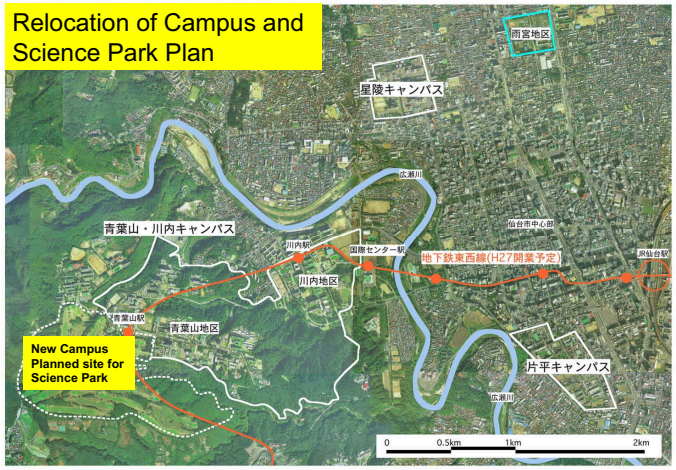
"Science Park" Plan

- Creation of new academic integration and integrated field of Industry-University-Government relations
- Bases for Personal exchange and for creation of new technology/industry



TOHOKU UNIVERSITY Sendai, Japan

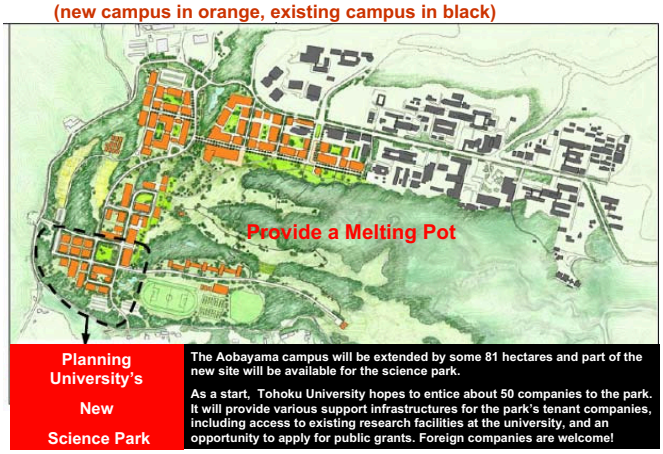
Relocation of Campus and Science Park Plan



TOHOKU UNIVERSITY Sendai, Japan

New Aobayama campus framework plan

(new campus in orange, existing campus in black)



Planning University's New Science Park

The Aobayama campus will be extended by some 81 hectares and part of the new site will be available for the science park.

As a start, Tohoku University hopes to entice about 50 companies to the park. It will provide various support infrastructures for the park's tenant companies, including access to existing research facilities at the university, and an opportunity to apply for public grants. Foreign companies are welcome!

Thank you for your attention!!

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