Challenges and Collaboration in Engineering Education for Innovative Era

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Huge disaster
Earthquake & Tsunami

Kumamoto – Seoul
- Shanghai
- Beijing
- Taiwan

<~ 1500 km

Kumamoto... Close to Asia
Kumamoto University

Sai-shun-kan Medical College (1756)

The 5th National High School (1887)

New Kumamoto University (1949)
Incorporated together with Kumamoto Medical College, Kumamoto Pharmaceutical College, Kumamoto Technical College and Kumamoto Teachers College

4 Campuses; 7 Undergraduate Faculties
8 Graduate Schools, 13 Research Centers
Rich tradition

High-profile teachers/graduates:

Lafcadio Hearn
Author - also known as Koizumi Yakumo after gaining Japanese citizenship. Best known for his books about Japan.

Soseki Natsume

Hayato Ikeda
The 58th, 59th and 60th Prime Minister of Japan from 1960 to 1964. Advocated the "income-doubling plan" and "politics of patience and reconciliation,"

Eisaku Sato
The 61st, 62nd and 63rd Prime Minister of Japan from 1964 to 1972. The longest serving Prime Minister in Japan’s history.
Contents

1) Introduction: What is engineering

2) Engineering Education for the Innovative Society
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   Collaboration with engineers in industries in both education and research
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4) Conclusion
World-leading universities are expected to play important roles to make our (local, national and global) society more active and innovative for the promising future, through producing not only new research achievements but also new world-leaders.

Engineering is the fundamentals of the society based on science and technology, and

Engineers are “”Social Doctors”, who need to keep the society healthy and treat properly for recovering the society healthy when the society has problems.
Thus, engineers need to be highly educated not only in science and technology but in social sciences including ethics.

Today’s, highly developed and complicated global society, the productive engineering education has become impossible to complete only by the traditional education systems, but should be made by collaboration with various organizations and the global society.
Keyword for recent challenges and direction in “Engineering Education”

The important aspects in the productive engineering education for the innovative era should be:

Collaboration with various organizations and the global societies
Summary of expected abilities for engineers for the coming 20 years (1)

Engineers are commonly required:
* Innovative and challenging mind;
* Basic scholastic achievement and ability to understand or find various social needs and solve various problems and challenges;
* Logical thinking (with Mathematics/ Natural sciences fundamentals) etc.

==⇒ Create new values
==⇒ Analyze components/ Plan the process design (Engineering Design)

In addition
Summary of Expected Abilities for Engineers for the coming 20 years (2)

and to

* Understand the different culture/relation of science and technology with society;
* Make clear the current problems and solve (or suggest practical solutions) them;
* Manage (control) the business (what to do and how to do/ process plan etc.);
* Tune and integrate ideas (team play);
* Manage of horizontal international specialization under international standard etc.

>>> can act as a leader of an international team

Now, how to realize such tough educational work!!
(human resources development; manpower training; talent training)
Engineering education for the innovative society

The authors’ opinion

The directions for challenges and collaborations should be:
1) Mixing more of fundamental science and technology
2) Practical collaboration with engineers in industries in both education and research,
3) Collaboration with people from various fields for mixing ideas to design and create new values,
4) Increase in number of women engineers to create new ideas, concepts and values,
5) International collaboration to exchange knowledge and ideas.
Mixing of fundamental science and technology (1)

Students: human resources (treasure) for the future society

Role of Engineering: make the society more comfortable

1) Students should be educated not only the present-going technology but more importantly very basics essential aspects of science and technology for the future.

2) Teaching professors should be studying at the front of science and technology, meaning teaching professors are more required to be world-leading researches as well.
Mixing of fundamental science and technology (2)

Science and technology are more integrated in their roles. Science needs to consider more about the society in the viewpoints of both short- and long-range perspectives, and technology needs to take into account more recent scientific achievements to solve the present problems.

Science becomes more valuable when its findings are applied to be visible in the society through technological achievements, only by which the society can change to be improved.

Technology needs to be more deeply based on scientific fundamentals.

cf: Nobel Prize
Collaboration with **engineers in industries** in both education and research

Effective for students to understand how the current forefront of industrial productions and needs-oriented researches are going.

University professors need to analyze the essential importance in the industrial products and R&D, and show students how the subjects learning in the classes are related to the products.

**⇒** Collaboration gives students a chance to consider about the problems at present and what students need to do for the society.

The program at KU named “Project X in Faculty of Engineering”, for example, works well.
Collaboration with people of various fields

Society: the mixture of different values, cultures etc.,

\[\Rightarrow\text{mixing ideas to design and create new values would be very important}\]

Engineering is required to create desirable society at present and for the future by solving the problems and visualizing human dreams within a reasonable cost.

\[\Rightarrow\text{engineers (to be world-leaders, not only students but professors) need to have more contact with the society.}\]

The words of human-friendly, environmental-friendly etc. are such concepts for new innovative era.

New concept: Healing (therapy) Robot
Responsibility of Science and Technology for the Society: After the disaster and nuclear power plant accidents

We, Japanese, especially engineers should face to the "Higashi-nihon (North-east Japan) Disaster" in various ways to solve serious problems as new challenges of engineering.

Important point: Science and technology is not all mighty, but so far works well to provide wealthy and affluent society. Science/Technology should help decision (policy) making based on the scientific data.

We, all together, need to solve problems.
New education programs

Engineering education with subjects of new liberal arts and well-organized fundamental engineering curriculum (responsibility/ethics are included).

==> Standard curriculums are now preparing in Japan!

Internship in industry is also one of the common systems for the students to join the society during the college life.

Professors, especially young professors, would also have very good opportunities, if effective “Professor’s Internship” or a similar system were provided.

Collaboration of both university and industry as a new social system for the promising future.
Increase in number of women engineers

The number of female students has been increasing

==> Encouragement of female engineers has become more important: because:

1) People who are going to study in the fields of engineering decreases. On the other hand, the required number for innovative engineers is increasing ==> women engineers are essentially important.

When the environments such as campus, working place and the conditions for studying and working have been changed.

In Japan, now the work-life balance and equal-partnership of male and female is becoming more popular. ==> should be improved more!

2) For human-friendly and/or environmental-friendly society, new ideas, concepts and values from view points of female are essentially necessary, because they have very sensitive minds in such aspects.

New environmental-related businesses came up as small- businesses (exa. Natural cosmetics/ food/ clean-up environment business etc.)
International collaboration

When we meet differences in culture, thinking way etc., new concepts and new challenges can be born and something changes to start new businesses in some cases. ==> the origins of new powers for the innovative society.

Since the historical, cultural, environmental and/or economical backgrounds of the partner countries are largely different from Japan, international collaboration gives large impacts for Japanese students, and vise versa.
KU activities

KU now has more than 120 partner universities all over the world and ca. 400 international students. We send more than 150 (including short visit) students abroad every year.

In the engineering school: “Mono-zukuri = manufacturing) Camp” in summer with the collaboration of Ajou University Korea, for example.
KU activities

KU have been encouraging research activities related to the environmental-friendly science and technology, such as green energy (solar cell and its new applications including smart-grid technology, bio-fuel battery, new organic thin-films etc.), water management, new magnesium alloy as a new energy-saving material, and many other green sciences and technologies.

Through such world-leading researches, the university provides an excellent education for both undergraduate and graduate students and research experiences to students from all over the world under international collaboration.
壁面への設置
サンシェード
ビニールハウスへの設置

ブラインド型
フィルム型太陽電池
災害時の非常用電源

アーケード型

CO2排出量
太陽光: 53 g-CO2/kWh
天然ガス: 500~600 g
石油: 742 g
原子力: 22-25 g
Bio-Fuel Cells

Direct Energy Conversion of Bio-mass to Electricity

Glucose 1 g : 4.4 Wh
U-3 Alkaline Dry cell (8.3 ml; 17 g): 3 Wh

A cup of rice = 75 U-3 cells
Sake (Rice wine) 3 ml = One U-3 cell

New Improved Glucose-Air Bio-fuel Cell
Max power: 12.2 mW/cm²
Max current: 72 mA/cm²

==> Need to develop higher performance electrodes
Future applications of bio-fuel batteries

Smart grid experiment in campus
KUMADAI Magnesium Alloys

As a leading-research organization for new science & technology

Platform for the Next-Generation Mg Alloys

- during Project (2006~)
  - Project Operation Division
  - Core Laboratory (500m²)
  - Sub-Core Laboratory (370m²)
  - Commercialization Support Division

- after Project (2011~)
  - Platform Management Headquarter
  - Trial Manufacturing Center
  - Research & Development Center
  - Commercialization Support & Human Resource Development Center

Kumamoto TLO
Technology Transfer through
Trial Manufacture & Intellectual Property & Human Resource Development

- Licensing of Technology
- Collaborative R&D
- Supply of Prototype

Now collaboration with Asian countries (Korea/ China/ Taiwan etc.)
Extremely High Power
(>1000 GW~ comparable to the total power usage in the world)

Energy = Power × Time

100 W × 100 s = 10 kJ

Pulsed power refers to the extremely high power in a short period of time, produced by means of the temporal and spatial energy compression.
“Groundwater Environmental Leader Program of KU”
for International leader for Water Management
for Sustainable Earth with Water
諸外国の課題やニーズに対応した機動的な人材育成

＜アジア・アフリカに共通の問題＞

-工業・農業・都市域の発展地下水への依存度急増
-地下水水質保全、汚染防止、水質浄化
-汲み上げ量の管理、地下水涵養域の保全と涵養量の保持

地下水環境リーダー育成
国際共同教育拠点
-熊本大学-

-地下水の種々の問題の解決法
-地下水資源の持続的利用
-のための理学と工学
-地下水の公共政策、地下水法
-地下水資源管理学

論文参考文献

1. 阿部 豊, 他: 地下水の管理と利用に関する研究, 日本地下水资源学会, 2021年
2. 田中 和, 他: 地下水汚染防止・浄化技術の開発, 日本水質学会, 2020年
3. 井上, 他: 地下水環境の保全に関する研究, 日本地球環境学会, 2019年
Recent Activities for International Collaboration
Program of Faculty
of Engineering, Kumamoto University (KU)

1) New approaches in education based on so-called project based learning (PBL), where an international co-operation is also strongly promoted, and the newly organized “Creative Engineering & Design Education Center” arranges and supports the programs.

2) Encouragement of the education programs to be of an international-standard such as JABEE and ISO.

3) Promotion to make students possible to communicate internationally in English.

4) The “Forum” in abroad, under the university-government-industry collaboration, and the “International Offices” abroad, as information centers of the university to keep continuous support for the graduates in Asian countries, Turkey etc.

==>These programs made students active and possible to expand the human strong network for their future.
Recent Activities to Improve Educational Systems of KU

Project Based Learning (PBL)

New approaches have started in education of engineering based on so-called project based learning (PBL) from viewpoints of encouragement in producing new concepts, harmonizing different fields, and creating new human/environmental-friendly technologies.

For this purpose, the educational center, Creative Engineering & Design Education Center, was established in 2005 and so far did more than 150 events within a year.

- a laboratory in town (Machi-naka Kobo, an off-campus lab) opened, as a show-window of the university and a Creative Design Atelier (Mono-Kuri Kobo, in Japanese) inside the campus, as a head-quarter laboratory to promote the new concept based education, where students are able to try their ideas to be realize with the aid of professors and technicians.
Quality of Education: JABEE and ISO accreditation

KU has been encouraging to get a certificate of JABEE and ISO, as an international-standard accreditation to evaluate the quality, for our educational programs.

In 2006, faculty of engineering got the JABEE certificates for the education programs of civil engineering, architecture, machine engineering, electric engineering, and materials. In addition, faculty of engineering had the ISO-14001 certificate for eco-oriented environmental education system for chemistry-major students based on the program of department of Applied Chemistry and Biochemistry.

Through these international-standard accreditations, not only the quality of education, but also the minds for education of both students and professors have been changed a lot.
日本工学教育協会H18年度大会（H18.7.29、北九州、第54年次大会）業績賞 受賞表彰
「JABEE/ISO取得による全学部的国際標準工学教育の実施」熊本大学工学部（団体）
全国都市再生まちづくり会議2006「まちづくり大賞」受賞
2008「まちづくり賞」受賞
English Education

To promote communication internationally in English:

KU is asking undergraduate students (especially for the first-year students) to have TOEFL (or TOEIC) examination.

The so-called CALL system helps students to learn English, Special course for learning English in Canada (Alberta University, Edmonton Canada) during the summer-vacation time.

To promote academic exchange programs with various organizations of all over the world, KU provides supports to send not only professors but also students to the counter-part organizations and receive student and/or professors from these organizations. The foreign guest-professors contribute a lot so far to give classes in English, which are also helpful to encourage students to communicate in English.
University welcoming the international society

- Create an *international campus* environment

- Offer an *internationally viable education* and at the same time improve the University’s environment to accept more international students

- Aim to *increase the number of international students*

- International students educated on Japanese language and Japanese culture take active roles all over the world, and also take contributing part to the *internationalization of Japanese students*

- Become *the core university* in Kyushu to promote ‘globalization’
**KU Forum abroad**

Introduction of KU abroad so-called “KU Forum” has been carried out in Asian countries:

by several reasons:

1) The *distances* between Kumamoto and Asian cities

2) Many students from *Asian countries*: the name of “Kumamoto” should be well known in Asian cities for these foreign students for their status after going back to their mother countries.

3) Many *Japanese graduates* (> 500) of our university are working in Asian countries. They need a graduate association to exchange information and to help each other.

4) The university-university *exchange programs* are also important.

5) *Collaborations in education and research* among universities are also promoted.

6) Students, graduates and other people deliver world-widely the name of the university (KU), which will form a “*brand*” of the university.
Collaboration in the Yellow Sea Rim (East Asia) Area

- Kumamoto Univ. Forum 2005 in Shanghai
- Kumamoto Univ. Forum 2006 in Korea
- Kumamoto Univ. Forum 2010 in Vietnam

*Other country...
  - Surabaya, Indonesia 2008
University Office abroad:
Shanghai/ Jinan/ Dalian/ Daejeon/ Surabaya/ Izmir etc.

KU is planning to increase the numbers of international students (increasing to 500 and ultimately to 1000, 10% of all students) and of the partner universities (increase up to 150 organizations).
Kumamoto University International Summer Program

*open to students from exchange partner universities in Asia
*experience the Japanese language and culture
Improved the housing environment for international students and researchers:

* the number of dormitory rooms has increased from 112 to 232 rooms (November 2009)
Effect: All the efforts seem to be promising

1) Understanding/collaboration/exchange ideas in culture, science, technology and human life for young generation people.

2) Japanese students became active and positive.

3) KU has also succeeded to help Japanese industries open their factory and foothold in Asian countries by introducing our partner universities and foreign students studying in KU.

4) East Asia is a very important area from viewpoints of world economy and thus well-balanced harmonic development of this area is extremely essential.

5) Collaboration in education is one of the key subjects for future proper development in this area.
Conclusion

1) The currently-going and under planning new programs in education in Japan make students active, possible to produce new ideas and concepts in science and technology by mixing different ways of thinking, and to expand the human strong network to produce future leaders in the society.

2) KU will continue to respond creatively to the considerable challenges of our time the promising future.

All leading universities should act as organizations of not only regional but of national / international centers for researches and education.
Attractive Kumamoto…Active Volcano/ Forest/ Water

Castle

Hot spring

Active volcano

National Park

Japanese-style garden

River/stream

Castle

Glen

Water spring

通潤橋

石橋

Ready to ship

Attractive Kumamoto…Active Volcano/ Forest/ Water

熊本城

(日本三大名城)

雲仙天草国立公園

熊本城

(日本三大名城)

雲仙天草国立公園

観光都市

Ready to ship

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Ready to ship
Industry in Kumamoto Area

- 電子情報関連機器 (Electronics)
  <SONY/NEC/MITUBISHI FUJI-FILM/TOKYO ELECTRON>
- 環境・エネルギー (Energy/ Environmental)
  <FUJI-ELECTRIC/HONDA-SOLTECH/ AISHIN (TOYOTA)>
- バイオ (Biotechnology)
  <SUNTORY>

*Shin-kansen (新幹線) runs Fukuoka to Kumamoto in 33 min.*

- Fuji Electric Systems
- MITSUBISHI
- HONDA SOLTEC
- Sony Semiconductor Kyushu
- TOKYO ELECTRON KYUSHU
- FUJI FILM
- Chuo Denshi Kogyo
- KYUSHU DENSHE
- AISIN KYUSHU
- NEC Software Kyushu, Ltd.
- SUNTORY KYUSHU KUMAMOTO PLANT
- KOHJIN
- KYUSHU INOAC
- TOPPAN PRINTING
- Japan Electronic Materials Corporation (JEM)
Water Life: food
Festivals and Events of Kumamoto City

Plant Market (February to March)

Festival of Kiyomasa Kato (July)

Spring/Summer

Hinokuni Festival (summer festival)
Festivals and Events of Kumamoto City

Kumamoto Castle festival (October)

Fall
Why Kumamoto and Kumamoto University?

◆ Close to Asia and to the world
◆ High quality of life at Kumamoto
◆ Global economy is growing in Asia with accumulating various industries (very high potential for the future)
◆ World-class excellent education and research activity
◆ Challenging spirits for the future
◆ Excellent people and environment

→ Kumamoto is Green City with Clean Energy/Rich Environment

KU is Expanding International Collaboration for the Promising Future!
Land of Fire (R)/City of Forest (G)/ City of Water (B)
THANK YOU FOR YOUR KIND ATTENTION !!