JICA’s support to engineering higher education is classified into three approaches: 1. development of leading universities of each country (Hub type); 2. formation of an international network of universities including Japanese ones (Network type); and 3. support for building institutions (Institution-building type). In order to strengthen “education”, “research”, “industry-university collaboration”, and “university management”, JICA has various menus besides LBE, such as curriculum revision, facilities and equipment development, and university-industry joint research, and carries out its support in a way that responds to the current situation and needs of developing countries, while working closely with Japanese universities to take advantage of Japan’s experience. Because of the strong economic and academic tie with Japan, JICA’s support has been mainly targeted to Southeast Asian countries, however it is also spreading to East Asia, South Asia, Middle East and Africa in responding to growing needs of those regions and internationalization of Japanese universities.

### Main cooperations of JICA in engineering higher education

#### Egypt

**Egypt-Japan University of Science and Technology (E-JUST) (Hub Type)**

This University was established with the cooperation of both Japan and Egypt with the aim of developing advanced human resources in the fields of science and technology, in the Middle Eastern/African region. Japan side has established a mechanism to support E-JUST with close collaboration among industry, academia and government. Amongst all, the top 12 universities in this Mediterranean region started to develop the model of global university with the rich experience in engineering education centered on the introduction of LBE.

#### Malaysia

**Malaysia-Japan International Institute of Technology (MJIIT) (Hub Type)**

MJIIT has been providing education for developing advanced human resources with applied skills and research and development capacity through the introduction of “i-kohza” which utilizes the characteristics of Japanese style engineering education, especially LBE. Furthermore, in order to carry out human resource development that meets the needs of Japanese and Malaysian industries, MJIIT has built an international network of universities including Japanese ones and local Japanese companies. Also MJIIT has received students from ASEAN and Middle East countries with the objective of achieving an international hub of Japanese style engineering education in the future.

#### Kenya

**Kenya-Pan African University (PAU)/Jomo Kenyatta University of Agriculture and Technology (JUAST) (Hub Type)**

Under the leadership of the African Union Commission (AUC), PAU has established the Pan African University—Jomo Kenyatta University of Agriculture and Technology (JUAST) in 2009, with the aim of creating the first African University in 2015. Supported by AUC and JICA, JUAST intends to promote higher education in science, technology, engineering and agriculture through institutional reform and capacity building. The University has established an international network of universities and industries for the purpose of providing advanced education and research opportunities for students and researchers from African countries, in collaboration with local industries and universities, while cultivating a new generation of advanced human resources.

#### Indonesia

**Indonesian Institute of Technology (ITB)-Hyderabad (IIT-H) (Hub Type)**

IIT-H is one of the leading universities in science and engineering in India. JICA is providing multi-faceted support to IIT-H such as laboratory and research facilities development, joint research promotion with the aim of creating research networks with Japanese universities and industry, as well as developing advanced human resources.

**Establishment of Indonesian Accreditation Board for Engineering Education (ABEIE) (Institution-building Type)**

To strengthen the objective of improving the quality of engineering education in Indonesia, JICA has supported the establishment of Indonesian Accreditation Board for Engineering Education (ABEIE) and has also given support and training for accreditation inspectors.

#### ASEAN Countries

**ASEAN University Network/ Southeast Asia Engineering Education Development Network (AUN/SEED-Net) (Network Type)**

With the objective of developing advanced human resources in engineering field in the ASEAN region, JICA has supported the development of a network among ASEAN universities through research study programs of academic staff and promotion of joint research. JICA is aiming to develop it into a self-supporting network in the future.

Development of quality human resources in engineering field has become a major need in developing countries, and JICA has been responding to it by introducing Laboratory Based Education (LBE) to engineering education in universities. Whereas, in general, course work and individual guidance are the cornerstones of research activities implemented on a laboratory-by-laboratory.

At a laboratory, which is headed by faculty members and composed of post-doctoral students, graduate students, and 4th-year undergraduate students, students can obtain not only expertise and problem-solving ability but also soft skills such as management and communication skills by practical education through research.

Unique know-how, experience and technologies originating in Japan and cultivated at international cooperation sites around the world are proving useful in many developing countries. JICA is disseminating these methods and program models that are effective for solving problems to the rest of the world as the Japan Brand of international cooperation and promoting its use.
Growth of developing countries and development of human resources in engineering field

The growth of developing countries requires efforts in many ways, but human resource development is one of the essential elements. In particular, quality human resources in engineering field is required to respond to growing needs of infrastructure and industrial development, and to global issues such as natural disaster, climate change, energy issues, and others. One of the factors explaining the rapid economic development of Japan after the World War II was developing a large number of advanced human resources in engineering field. In Japan, from the late 1950s to the late 1960s, higher education in science and technology field expanded rapidly and developed human resources in engineering, who supported high economic growth.

In developing countries, development of human resources in engineering field is still to be achieved. It is indicated by the small number of researchers per one million person (i.e. 0.1 to 1 researcher) in developing countries while the one in developed countries is more than 10 researchers. A shortage in human resources in engineering field results in lack of industrial infrastructure, low productivity, and vulnerability of economic development as it was pointed out at the time of the Asian currency crisis in the end of the 1990s. Therefore, the expansion of higher education to develop human resources in engineering field is necessary.

Expansion of higher education in developing countries and challenges of engineering education

Higher education in developing countries has largely expanded quantitatively in the past 10 years – in terms of both the number of enrolled students and the enrollment rate. The causes of the expansion are growing demand for advanced human resources corresponding to the advancement of industrialization and the knowledge-based society, and growing number of applicants to higher education due to the expansion of primary and secondary education. On the other hand, the quantitative expansion of higher education is not necessarily leading to the qualitative and quantitative expansion of engineering education. In many developing countries, the development of human resources in engineering field is prioritized as a means to lead economic growth, however, quantitative expansion has been carried out mainly in humanities and social sciences because of severe financial conditions. In addition, the deterioration of education and research quality has become a challenge since faculty staff, facilities and equipment, and research funding, which are indispensable to secure/improve the quality of engineering education, are insufficient.

In developing countries, due to the lack of experiences, training equipment, and research funds, education centered on classroom lecture and memorization is often carried out, and makes it difficult to develop human resources with practical skills and application ability required by industry.

The characteristic of Engineering Education in Japan: LBE (Laboratory-Based Education)

Development of quality engineers has become a major need in developing countries, and JICA has been responding to it by introducing Laboratory-Based Education (LBE) to engineering education in universities. Whereas, in general, course work and individual guidance are the cornerstones of engineering education in the United States, and many of European countries, engineering education in Japanese universities emphasizes research activities implemented on a laboratory-by-laboratory basis. As a laboratory, which is headed by faculty members and development and maintenance of research equipment, laboratories: Out of 50 authorized LBE laboratories, 89% of the students were satisfied with LBE, and the average period to complete the Master's program was shortened (LBE student: 4.03 semesters vs. General student: 4.4 semesters).

Examples of LBE Introduction

- Development of LBE guidelines (clarification of LBE definition and authorization criteria)
- Authorization of LBE laboratories (monitor LBE definition)
- Seminar to share LBE experiences
- Monitoring and evaluation of LBE (development and utilization of guidelines)
- Commendation for distinguished LBE laboratories
- Support to research activities of authorized LBE laboratories

**Reputation of LBE in Developing countries and Japan**

"We want to grow practical human resources through LBE where senior and junior students are helping each other to resolve problems under the supervision by a faculty member. I expect graduates to fully use their thinking and discipline, developed through Japanese-style engineering education, at their jobs."

(Prof. Dr. Mabel Imbuga, Vice Chancellor of Jomo Kenyatta University of Agriculture and Technology, Kenya)

"In this university, we provide practical education based on the experience of engineering education in Japan. Industry has high expectation on our graduates as industry-ready engineer and values their potential for growth, since graduates show their strength in practical technology, and diligence based on excellent ethics learned from the Japanese."

(Prof. Dr. Masato Ishikawa, Vice Chancellor of Kyushu University of Agriculture and Technology, Korea)

"In Japanese laboratories during my studies abroad, I learned the importance of the development of the next generation."

(Professor Professor Lucia Demirovic, University of Sabah, Malaysia University, Indonesia)

**Benefits of Japanese-style research-based education** ( Results of a survey conducted by JICA to Japanese professors in engineering field)

- Effective as a method to cultivate high level of expertise: 81.5%
- Effective as a method to cultivate high research capacity and agenda setting/analytical skills: more than 90%
- Effective to introduce Japanese-style LBE in developing countries: 75%

**Educational Impact of Team Activities**

- Communication Skill
- Cooperativeness
- Leadership
- Teamwork

**Image of Laboratory Based Education (LBE)**

- Researchers having completed a PhD (Post Doc)
- Graduates (Master/Doctor)
- 4th-Year Undergraduate Students
- Faculty member

**Student Support to research activities of authorized LBE laboratories**

- Paper application, paper submission to international journal, application to external funds and others

**Improvement of education capacity of authorized LBE laboratories**

- Improvement of education capacity of authorized LBE laboratories: 89% of the students were satisfied with LBE, and the average period to complete the Master’s program was shortened (LBE student: 4.03 semesters vs. General student: 4.4 semesters).