A Pioneer Program to Develop Human Resources for Interdisciplinary Green Technology by Ministry of Education in Taiwan

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In response to immense challenges on the national energy and environmental issues in Taiwan, the Advisory Office of Ministry of Education urged the need for the organized national efforts to nurture engineering students with modern interdisciplinary education that aims to elevate the national capabilities on various green technologies and enhance the participation in the international activities of global need. Green technology (GT) is a technology that is friendly to the environment and the ecology attempting to unravel the dilemma of balancing economical development and environmental sustainability. Hence, GT is a key step towards the success of sustainable development that is crucial for the future development of humankind. Since resources are the backbone of the economy, our society, especially younger generations, must learn not only to cherish clean environment but also to preserve the limited precious resources for the survival of mankind. It is now getting more acceptable that by improving our usage efficiency of resources and making our production and consumption patterns more sustainable will deliver environmental benefits and do less harms to the ecology while gradually improving our economic performance and competitiveness. In Taiwan, the plan for the establishment of a pioneer program to develop human resources for interdisciplinary GT (IGT) was contemplated in January 2006 and such program office was established in March 2007. The IGT education program in Taiwan is a four-year project starting from 2007 to 2010. It aims to develop core courses for IGT by integrating interdepartmental knowledge from chemical, civil, energy, environmental, material, and mechanical engineering including five independent but relevant fields: (1) Green accounting, (2) green building, (3) green chemistry, (4) green design and product, and (5) green energy. Approved by the MOE in Taiwan, there are currently 26 on-going projects run by 22 different universities aiming to develop core courses for these five fields using each university's strength and specialty. In additional to the green course development, there are more key working items, such as (1) supporting activities and conferences for IGT, (2) establishing an on-line learning and teaching platform for IGT, and (3) promoting cooperative projects between industry and academia sectors. Finally, the experiences, the progresses, and the difficulties encountering by the IGT program office as well as various executing universities will be shared and discussed

Introduction

Keeping pace with a rapid increase in population, prosperity, and the desire for improving the quality of life, mankind has used up tremendous resources for the past two centuries as if natural resources were unlimited. Human activities, such as the excessive consumption of energy and natural resources, deforestation, land use and land cover changes, and air, land and water pollutions, had put tremendous impact on the Earth. Nowadays, we are facing serious problems on the energy shortage, global warming due to green house effects, acid rain deposition, diminished water and land resources, and species extinction. How to reduce the global climate change and how to avoid the irreversible damage to the ecosystem's carrying capacity are the top two problems of humanity for next 50 years. Delay of action will jeopardize the ability of future generations to meet their needs.

On the international level, two important declarations on the education of sustainable development deserve to comment. The first is the "Tallories Declaration" signed by the presidents, rectors, and vice chancellors of universities from almost all regions of the world in 1990 [1]. In it ten actions were proclaimed to take: (1) Increasing awareness of environmentally sustainable development; (2) creating an institutional culture of sustainability; (3) educating for environmentally responsible citizenship; (4) fostering environmental literacy for all; (5) practicing institutional ecology; (6) involving all stakeholders; (7) collaborating for interdisciplinary approaches; (8) enhancing capacity

of primary and secondary schools; (9) broadening service and outreaching nationally and internationally; and (10) maintaining the movement. The second but even more important is the program of the United Nations Decade of Education for Sustainable Development (DESD) from 2005 to 2014 [2]. The DESD objectives include: (1) Facilitating networking, linkages, exchange and interaction among stakeholders in education for sustainable development (ESD); (2) fostering an increased quality of teaching and learning in ESD; (3) helping countries make progress towards and attain the millennium development goals through ESD efforts; (4) providing countries with new opportunities to incorporate ESD into the education reform efforts. Both declarations attempted to implement the concept of sustainable development to the education system, especially for higher education, and thus facilitate nations worldwide to put efforts and concerns on various environmental and ecology issues in general.

Same as many countries in the world, Taiwan has encountered immense challenges on the national energy and environmental issues. This is why the Advisory Office of Ministry of Education urged the need for the organized national efforts to nurture engineering students with modern interdisciplinary green technology (IGT) education. The IGT education program aims to elevate the national capabilities on various green technologies (GT) and enhance the participation in the international activities of global need. To this end, we have established a pioneer program to develop human resources for IGT, a four-year program staring from March 2007 to December 2010.

What is the GT? In short, GT is a technology that is friendly to the environment and the ecology attempting to unravel the dilemma of balancing economical development and environmental sustainability. Thus, GT is a key step towards the success of sustainable development that is crucial for the future development of humankind. Since resources are the backbone of the economy, our society, especially younger generations, must learn not only to cherish clean environment but also to preserve the limited precious resources for the survival of mankind. It is now getting more acceptable that by improving our usage efficiency of resources and making our production and consumption patterns more sustainable will deliver environmental benefits and do less harm to the ecology while gradually improving our economic performance and competitiveness. In the future, the development of a self-reliant capability in selecting future energy sources and in assessing their impact on the environment is necessary. We must also establish a scientific and social knowledge base for assessing and addressing unavoidable damages frequently occurred along with the development of so-called new technologies. Obviously, these demands are the major driving force behind the IGT education program.

The Concept of IGT Program

The concept of IGT program is largely related to the concept of remarking the way we make things. The latter was written by Mcdonough and Braugart with the book title of “Cradle to Cradle” [3]. They mentioned that there are two metabolisms currently existing in our world: A biological metabolism and a technical metabolism. If our economic systems contaminate Earth’s biological mass and continue to throw away technical materials like metals or render them useless, as they currently stand, we will indeed live in a world of limits, where production and consumption are restrained, and the Earth’s will literally become a grave [3]. What is the right way of making things? Based on the concept of Mcdonough & Braugart, we plot a cartoon to indicate the two metabolism systems in the world and their coupling effects that must be monitored, as schematically shown on Fig. 1. As can be seen in the biological metabolism, each product should be able to be biodegraded to biological nutrients which are materials for the next products. On the other hand in the technical metabolism, each product should be able to be disassembled, so that it can be upcycled and reused. In order to maintain healthy and valuable of two metabolisms, things such as mutagens, carcinogens, and persistent toxins from the technical metabolism should be carefully monitored to avoid contaminating one with the other. Clearly, this concept is crucial for the survival of future generations. An important question arises. How can we implement such concept into our current education system? This is truly a challenge because there are just too many ingredients to be implemented. However, it is thought that the IGT education program should be a start. Therefore, we select fire independent but relevant subjects named by the order of alphabet starting from A to E for our IGT education program in Taiwan. Here A is for “Green Accounting”, B is for “Green Building”, C is for “Green Chemistry”, D is for “Green Design and Products”, and E is for “Green Energy”, respectively.

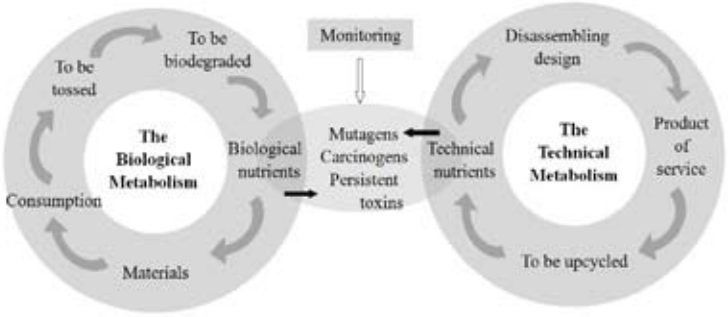

Fig. 1. Two metabolism systems in the world.

The Structure of IGT Program

Since 2007, the IGT program office (IGTPO) financially supported by Ministry of Education in Taiwan was established and currently located at the Center for Energy Research, College of Engineering, National Central University. The role of IGTPO is quite similar to the PO of national education program of image display in Taiwan [4], which is responsible to the evaluation of various projects, executing the directions required by Advisory Office of Ministry of Education, and organizing relevant meetings to promote mutual interactions among funded projects. Figure 2 highlights the structure of the IGT program, which aims to nurture creative talents with an emphasis on engineering education as the first step. The program includes the development of core courses for various green technologies along with integrating resources from government, industry and universities and promoting cooperative projects between companies and universities. Furthermore, we are currently establishing an on-line learning and teaching platform for various green technologies.

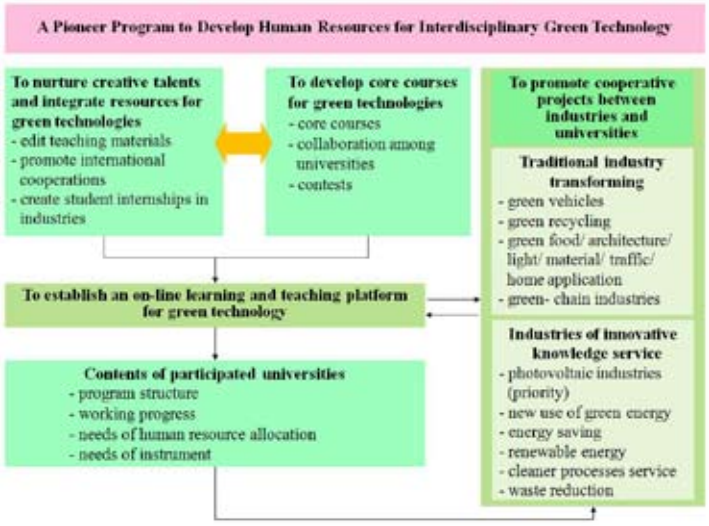

Fig. 2. The structure of the IGT program.

As illustrated in Fig. 3, there are four key working items in the IGT program. First of all, the program aims to develop core courses for the IGT education by integrating interdepartmental knowledge among chemical, civil, energy, environmental, material, and mechanical engineering, so that creative talents with the problem solving capability may be nurtured. Secondly, an on-line learning and teaching platform is currently establishing to integrate and share teaching materials from all participated universities and to provide common information for public. Thirdly, efforts are made to reduce the discrepancy between industries and universities via the promotion of mutual cooperation by inviting experts from industries to teach in universities as well as edit teaching materials together with professors and sharing instrumental resources. During this first phase of the IGT program, the photovoltaic industry is selected as the priority industry to be promoted. Fourthly, a series of IGT activities, contests, and international conferences

are constantly held to increase hands-on experiences and thus facilitate interactions among students, faculties, and engineers for outreaching the green concept.

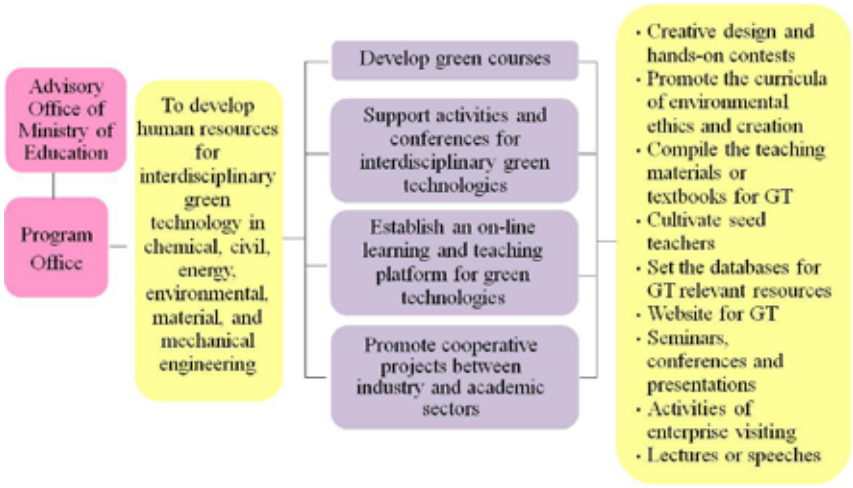

Fig. 3. The key working items by the IGT program office.

Course Development and Activities/Contests

The student competence is a key issue in the field of engineering education which has long been discussed by many nations, such as the engineering knowledge, the transferable skills, and the ability to be creative and innovative [5]. In order to develop the interdisciplinary ability for engineering students and meet the needs of sustainable development and green concept, efforts are made by each involved university to integrate interdepartmental knowledge from chemical, civil, energy, environmental, material, and mechanical engineering. In 2007 and 2008, there were 13 projects run by 13 different universities to develop core courses for green building, green chemistry, green design and product, and various green energies using each university's strength and specialty. Each project has developed a curricula including at least 6 ~ 8 courses covering from fundamentals to practical applications with a breadth of training related to these specialized subjects. More than 3,200 students had taken these courses in 2007 and the number increased to 7,316 in 2008. At the present (2009), there are 13 on-going projects including a green accounting curriculum and various curricula in green building, green design and product, and green energies such as fuel cell and hydrogen energy, biomass energy, and ocean energy to be implemented by 13 different universities in Taiwan. There are also four on-going projects to develop the solar photovoltaic curricula in 2009.

Various activities and contests for the IGT program have been held since 2007. The purpose of holding activities or contests is to promote the green concept to the society. Conferences and creative contests focusing on various subjects, such as creative products, wind energy, environmental materials, and energy-saving in buildings have attracted many attendees from universities and industry. Several students from the IGT projects have won excellent awards from international contests, such as "Taipei International Invention Show & Technomart" and "i'NOV".

Collaboration between Universities and Industries

Collaborations between universities and industries are an important part in engineering education [4]. Due to the limited budget, we select the solar photovoltaic industry which is the available green industry in Taiwan to be the priority industry for our IGT program. Currently, there are eight on-going projects involving 10 solar companies collaborated with 8 different universities. Each project must satisfy four criteria: (1) Sharing instruments between both sides; (2) providing on-site practices in collaborated companies for graduate students; (3) training graduate students to bring the problems, if any, back to their advisors in universities and building up the student's problem solving skill; and (4) inviting experts from companies to deliver speeches and edit practical teaching materials

together with professors.

One project run by the National Chung Hsing University in Taiwan has set up a solar photovoltaic laboratory, which provides 25 instruments for manufacturing processes and analyses, such as the electron-gun thermal coater and the hall-effect measuring instrument. Such lab. not only provides the service to cooperative companies but also it acts as a platform to bridge and promote collaborations among different companies. Other projects have established practical teaching materials for solar cell curricula with the collaboration from various companies. Furthermore, a website to integrate all relevant information has been established by the project run by the National Changhua University.

Concluding Remarks

As a final remark, the interdisciplinary green technology education program aims to strengthen the partnerships among government, industry, and academia attempting to fulfill tomorrow's energy and environment requirements, so that in the long term our society may have a sustainable security of supply under environmentally acceptable conditions and at competitive cost.

References

01. Association of University Leaders for a Sustainable Future. 1990. The Talloires Declaration (http://www.ulsf.org/programs_talloires_td.html).
02. W. Calder. 2005. The UN Decade of Education for Sustainable Development- A Progress Report. The Declaration 7(2): 1-8.
03. W. McDonough and M. Braungart. 2002. Cradle to Cradle: Remarking the Way We Make Things. North Point Press, New York.
04. L. S. Huang, Y. Y. Liu, S. L. Lee, N. C. Hu, Y. S. Tarng, H. P. Yueh, and An-Bang Wang. 2007. Establishing A Country-wide Image Display Program For Engineering Education. In Proceeding of the International Conference on Engineering and Education. Coimbra, Portugal.
05. J. Lucena, D. Gary, J. Brent, and S. Elber. 2008. Competencies Beyond Countries: The Re-Organization of Engineering Education in the United States, Europe, and Latin America. Journal of Engineering Education 97(4): 433-47.