Towards A Nationwide Web-Based E-Education Network on Precision Machine and Mechatronic Technologies in Taiwan

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Abstract — Engineering Education on Precision Machine and Mechatronic Technologies (EEPM) is one of the focuses in Taiwan. The EEPM project, supported by the Ministry of Education, is an effort with stress on building up curricula for fundamental field technologies as well as industry-oriented applications. The project is promoted in a university-industry strategic alliance model that each alliance emphasizes on a specific industry. Ten alliances are formed in the project with more than 45 institution and universities participated in the past two years. Multimedia course material and e-education technologies are developed, both among an alliance and across alliances. It turns that a web-based e-education cluster within each alliance is formed to provide distant and off-site leaning as well as an efficient communication channel. These e-education clusters are connected through a network via the program office to form a nation-wide e-education community for EEPM. This paper describes the planning, implementation, and current status of the web-based e-education community. With the growing community network, future development and challenges for integrating the distributed community is also discussed.

Index Terms — web-based e-education network, precision machine, mechatronics, academic-industry alliance

INTRODUCTION

Mechanical engineering is the foundation of industry. Precision machine technology and mechatronics, however, is one of the most recently developed technologies for industry in Taiwan. It was therefore listed as a strategic technology in the national science and technology whitepaper since 1997. While science-based and technology-based industry is the main target to develop in Taiwan, there is a strong need of manpower in this technology field.

It has been widely recognized that talent is one of the key roles for the industry. Based on the need for high-technology manpower on precision machinery and mechatronics, the Ministry of Education (MOE) has established a mission-oriented project “Educational Improvement on Mechatronics” to meet the requirements since 1994. The other project “Educational Improvement on Precision Machinery” is also established in 1997 for this purpose. The goal of these projects at the early stage is to set up the fundamental curricula, laboratory facilities, and multimedia courseware. When these projects are reviewed at the end of the second year, the question is raised “what is the next step of these projects when the foundation is established?” It is challenged that many laboratory facilities are set at different institutions but not much interactions between them. It is concluded at the advisory meeting that these facilities should be integrated and shared among these institutions. While many other institutions are lacking of laboratory facilities, it is suggested that institutions must be close to industry and thus institutions must be grouped to develop industry-oriented educational programs and curricula. Two strategic teams on precision machine technology and on mechatronics are formed in 1999 to plan action items to meet the above-mentioned goal. It took the teams one year to come out the strategy and action items for both education improvement projects on precision machine and on mechatronics. The project on precision machine focused on the integration and sharing of programs, including curricula and laboratory facilities, as some institutions already set up fundamental facilities. The project on mechatronics, on the other hand, stressed on developing teaching materials, including both international and localized textbooks, and competition of hands-on projects because mechatronics is a technology in action. The plans are then sent for discussion and approval at the advisory board at the MOE. Both projects started on 2001 after detailed items of action are finalized based on year-long discussions around the island. The two projects, however, were merged in 2002 due to their similarity and overlap on mechanical and mechatronic technologies and were renamed as Education Improvement Project on Precision Machine and Mechatronic Technologies (EIPPM).

While engineering education is an important issue in the past two decades, as many articles discussed in the America and
in the Europe, many scheme and plans, such as educational research centers, are proposed [1]-[7]. Among many discussed proposals, industry-oriented academic-industry strategic alliance is proposed, discussed and approved for the following four-year at the strategic plans [8]. This strategic alliance model is also used in the Educational Improvement Project on Aerospace Technologies as reported in [9]. One of the goals of these alliances is to integrate and to share teaching facilities, including laboratory equipments, faculties, as well as multimedia course material, to establish the nationwide education infrastructure.

**THE ACADEMIC-INDUSTRY ALLIANCES ON PRECISION MACHINE AND MECHATRONIC TECHNOLOGIES**

As the academic-industrial alliance model is decided for the educational projects, five alliances on precision machine technologies are formed in 2001 with a university, except for the precision components alliance, selected as the educational resource center for each alliance. They are alliances on machine tools, precision measurement, industrial machinery, precision components (two centers), and micro electro-mechanical systems (MEMS). Another six alliances on mechatronics are also formed in the same model. The six alliances are mechatronic servo systems, medical mechatronics, mold automation, optomechatronics, semiconductor, 3C (computer, communication, and consumer products). As the semiconductor alliance and 3C alliance are somewhat overlapped with another educational program on electronic engineering, they are merged with other alliances when the two educational projects are merged in 2002.

The nine academic-industry alliances are listed in Table 1. Educational resource centers of these alliances are located around the island, from northern Taiwan to central and southern Taiwan. Each educational resource center is steered by its steering committee with committee members from both academic and industry. Other institutions can join the alliance to share facilities with the obligation to open its laboratory facilities and to develop curricula together. The nine alliances are briefly described as follows.

- **The Precision Measurement Alliance** focused on precision measurement technologies, either contact or non-contact type. The alliance is formed by nine institutions leaded by the Department of Mechanical Engineering (ME) of National Taiwan University in northern Taiwan. The resource center also shares laboratory facilities on MEMS as it is also the Northern Taiwan MEMS Center sponsored by the National Science Council.

- **The Precision Machine Tools Alliance** emphasizes on the technologies for machine tools with the resource center located at the Department of ME at the National Chung-Chen University. The alliance is formed as machine tool is one of the major industries in central Taiwan. Seven other institutions, focused on either machining process or on spindle technologies, joined this alliance as this industry is related to process and sub-assemblies for machine tools.

- **The Optomechatronics Alliance** is intended for the integration of mechanical, electrical and electronic, as well as optical and software/control engineering. It consists of nine institutions and leaded by the Department of Applied Mechanics of the National Taiwan University. The Alliance shared many facilities with the Precision Measurement Alliance as the two educational resource centers located at the same campus.

- **The Mold Automation Alliance** is formed by 12 institutions with the educational resource center located at the ME department of Chung Yuan Christian University. The alliance is aimed on the process and automation technologies of precision and fine molding.

- **The Micro Electro-Mechanical System Alliance** consists of seven institutions leaded by the Department of ME of National Chia-Tong University. The alliance is divided into three groups. The Northern Taiwan group focuses on silicon-based MEMS technology; the Central Taiwan group stresses on non-silicon MEMS process; and the Southern Taiwan group emphasizes on fine fabrication technologies.

- **The Medical Mechatronics Alliance** is a special group aimed on developing programs on medical mechatronics. It consists of seven institutional members with the educational resource center allocated at the ME Department of Chang Gung University as there is a need on related technologies at the university-owned medical center and hospitals.

- **The Precision Industrial Machinery Alliance** includes nine institutions with the resource center located at the ME department of the Southern Taiwan University of Technology. The alliance focuses on two areas: the semiconductor equipments and rapid prototyping process equipments.

- **The Precision Components Alliance** allocates two educational resource centers as it consists of fundamental technologies. The National Tsing-Hua University in northern Taiwan and the National Cheng-Kong University in southern Taiwan are selected as the resource centers and consists of seven and five institutional members respectively. The northern center focuses on the components and integration of media storage systems while the southern center stresses on the application of fine fabrication on mechanical and mechatronics of computer systems.
The Mechatronic Servo Systems Alliance is leaded by the ME department of the National Chung-Kong University with six institutional members. The Alliance is aimed on the integration of servo and control systems, including pneumatic, hydraulic, and electrical servo systems. Although each alliance is formed based on the same interest and industrial technologies among resource centers and partners, it has educational missions including the development of domain-specific programs, such as curricula and laboratory practice. Among many items in this educational improvement project, digital education is one of the action items to be promoted. The digital education program, a sub-project, is intended to set up a test bed for digital education for a large community and distributed group. To achieve this goal, a digital information network must be established among the strategic alliances and among the partners. This is achieved automatically as it is required for each educational resource center to set up its web site that further links to homepages of their partners.

THE NATIONWIDE E-EDUCATION NETWORK AND DIGITAL EDUCATION

The goal of the digital education program is to construct a networked digital environment for e-training, e-education, and e-sharing. Items in action include, but not limited to, constructing community network and clusters, publishing e-newsletter, developing domain-specific multimedia course material, establishing digital laboratories and virtual experiments [10, 11], developing domain knowledge bases, and distributed training. Figure 1 shows the concept of the digital education that provides educational material, lectures as well as discussions through the constructed network, either real-time interaction or off-line access and discussion.

While each alliance is requested to set up a web site as a platform for news posting, communication, discussion, and technology sharing, the web site provides a base for constructing the nationwide educational infrastructure specifically for the community on precision machine and mechatronic technologies. Figure 2 is a sketch of the established network. The program office provides the community an entrance site that links to all educational resource centers and is hyperlinked to the homepage of MOE, as shown at the central circle in the figure. Partners and resource centers are networked via mutual hyperlinks among them. An electronic newsletter is issued monthly to provide a communication platform of activities, forum discussion, and achievement showplace. Figure 3 shows snapshots of the homepage of the program office and the monthly electronic newsletter of February 2003.

In addition to hardware construction for the network and the electronic newsletter, contents of the digital education program are also on going. For example, several multimedia course material, including “Introduction to Precision Mechanical Engineering,” “Precision Measurement,” and “Mechanism Design”, have been completed while three others are under development. Many action items are currently conducted and performed including the development of e-laboratory, virtual experiment, distributed training, e-education and evaluation [12], interactive e-learning as well as the development of dynamic multimedia course material.

CONCLUSIONS AND DISCUSSIONS

This paper describes an effort to construct a nationwide educational network for the community on precision machine and mechatronic technologies. It is a test bed for digital education for a large community and distributed group. The network is established based on the nationwide strategic academic-industry alliances that consist of educational resource centers and institutional partners. The environment provides platforms for e-training, e-learning and e-sharing. Many web-based educational programs are under development based on the community network. Both technical and social challenges, such as the effect on learning models via e-laboratory and virtual experiment, based on such an e-educational network will be faced in the near future and need further investigation.

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REFERENCES
TABLE I
EDUCATIONAL RESOURCE CENTERS OF THE ACADEMIC-INDUSTRY ALLIANCES.

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<tr>
<th>Academic-Industry Alliance</th>
<th>Educational Resource Center</th>
<th>Location</th>
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<tr>
<td>The Precision Machine Tools Alliance</td>
<td>National Chung-Cheng University</td>
<td>Central/Southern Taiwan</td>
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<tr>
<td>The Precision Measurement Alliance</td>
<td>National Taiwan University</td>
<td>Northern Taiwan</td>
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<td>The Optomechatronics Alliance</td>
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<tr>
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<td>Southern Taiwan</td>
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<tr>
<td>The Precision Components Alliance</td>
<td>National Cheng-Kung University</td>
<td>Southern Taiwan</td>
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<tr>
<td>The Mechatronic Servo Systems Alliance</td>
<td>National Tsing-Hua University</td>
<td>Central/Northern Taiwan</td>
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FIGURE 1
PLATFORMS AND CONTENTS OF THE NATIONAL E-EDUCATION NETWORK.
FIGURE 2
SKETCH OF THE NATIONAL E-EDUCATION NETWORK VIA ACADEMY-INDUSTRY ALLIANCE.

FIGURE 3