PROMOTING UNIVERSITY-INDUSTRY AND INTERNATIONAL COLLABORATIONS IN AEROSPACE ENGINEERING EDUCATION IN TAIWAN

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Abstract *– This paper describes an infrastructure built in a national program to promote university-industry collaboration and international cooperation in aerospace engineering education in Taiwan. The infrastructure comprises three levels, namely, the program office, resources centers and partner schools. In the paper, firstly it points out the importance of university-industry and international collaborations to revitalization of aerospace education in the four areas emphasized, namely, aviation maintenance, aircraft components manufacturing, avionics and aerospace quality assurance, which all are featured with multi-disciplinary characteristics. Secondly, the methods to coordinate the efforts of program office, resources centers and partners are described and discussed. Finally, this paper points out that the success of university-industry collaboration rests upon the enthusiasm of individual educators, whereas international cooperation needs support and endorsement of school administration.*

Key words: university-industry collaboration, international cooperation, aerospace engineering education.

INTRODUCTION

University aerospace engineering education in Taiwan has been established for more than three decades. The traditional curriculum of undergraduate academic program places emphasis on the fundamental subjects of aerospace engineering, which are mainly directed toward disciplines relevant to aircraft design. However, during the last decade the aerospace industry in Taiwan has developed into a diversified trend. The demand of manpower in the defense industry was decreased sharply on one hand, whereas the civil aviation industry was selected by the government as one of ten key industries to be promoted on the other hand. The universities and technical colleges that offer academic programs in aerospace engineering are keen to this change and striving to curriculum revitalization. Some observations concerning this change were reported by Miau [1] in the conference ICEE2000. Miau [1] pointed out a trend that currently the aerospace engineering departments in the universities in Taiwan are offering more applied and multi-disciplinary courses in undergraduate curriculum, which plausibly was driven by the recent needs of manpower in the aerospace industry. Miau [1] also pointed out that establishing these multi-disciplinary orientated courses needs university-industry collaboration and international cooperation. The observations in this respect can be summarized as follows. Firstly, since much of the knowledge in these disciplinary areas is accumulated from practical experiences, which can be best learned from industry, teaching these courses would need a lot of help from local industry. Thus, it would be a good idea to have experienced experts from industry to help teaching as well as provide consultations. Secondly, so far some schools in Taiwan have already established cooperation to a certain extent with overseas institutions, in order to seek for the assistance in establishing new academic programs. Such activities were noticed very effective for setting up the new teaching laboratories. On the other hand, these activities were found rather fragmented, which critically depended on the support of the individual schools. Despite of the observations described above, this paper did not carry out further discussion on the methods how to promote the university-industry collaboration and international collaboration.

Apparently, integrating the multi-disciplinary courses mentioned above into the existing curriculum of an aerospace engineering department poses an issue which can not be overlooked.[2] Along with this concern, the relevancy of multi-disciplinary course contents to the university undergraduate academic program is being questioned among university educators. According to these observations, Miau [2] pointed out that restructuring the undergraduate academic curriculum would be necessary, which had to be based upon a consensus among the departmental faculty members such that the scope and mission of the departmental program would be clearly defined beforehand. The restructured curriculum should bear a feature of flexibility that allows students to pursue their academic interests with a large degree of freedom and,

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on the other hand, the completeness and in-depth of the academic program should be maintained. Miau [2] also pointed out that seeking opinions and consultations from experienced experts in industry would be very useful in the process of restructuring.

In this paragraph, a brief description on the recent development of aerospace activities in Taiwan is given, from which one might gain some ideas regarding the specialties of manpower of need at present and in the near future. Speaking of the development of civil aeronautical technology and industry, a number of key areas are being promoted by Ministry of Economic Affairs, including components manufacturing of airframe and engine, passenger-to-cargo conversion of aging aircraft, and avionics products such as the airborne flight information and entertainment system.[3] Apparently, these products are required to be manufactured in accordance with the international aviation regulations, subjected to certifications by original aircraft companies or engine manufacturers, or foreign civil aviation authorities. Hence, it is understandable that the manpower needs in industry range among the areas of aircraft design and manufacturing, aerospace quality assurance, aviation maintenance and management, and so on. On the other hand, speaking of space technology development, the National Space Program Office (NSPO), a governmental agency which is chartered to promote the space research and technology in Taiwan, is carrying out a series of ROCSAT satellite projects.[4] Since January of 1999, the ROCSAT-1 satellite has been orbiting around the earth to perform three scientific experiments, namely, mapping images of water around Taiwan island for oceanic environment study, in-situ measurement of ion particle density at the low earth orbit trajectory, and the Ka-band communication experiment at the uplink and downlink frequencies around 20 GHz. The ROCSAT-2 satellite will be launched in 2003, on which a high-resolution camera will perform the mission of earth remote sensing. At present, this satellite is being under detailed design. The ROCSAT-3 project, which was kicked off recently, is featured with a constellation of six micro-satellites, each of which has a GPS receiver as the payload. GPS data will be transmitted to the ground and analyzed for the purpose of meteorological study. Conceivably, university graduates major in aerospace engineering will have opportunities to join in the activities of research and development at NSPO.

The scope of this paper is to present a four-years national program of Ministry of Education for 2001 to 2004, with emphasis on university-industry collaboration and international cooperation to promote aerospace education in the areas of aviation maintenance, aircraft components manufacturing, avionics and aerospace quality assurance. This program aims to assist universities and colleges to revitalize aerospace engineering education, in order to meet the manpower needs of the local aerospace industry.

THE NATIONAL PROGRAM FOR REVITALIZATION OF AEROSPACE ENGINEERING EDUCATION

This program was initiated by Ministry of Education in 1996, to comply with a governmental policy in effect in 1990 [5] for promoting aerospace industry in Taiwan. A strategic planning for this program of 1997-2000 was conducted in the year of 1996, which was based on a survey over the opinions and comments from governmental agencies, industrial organizations and academia. In the strategic planning report, a summary concerning the academic areas of need to be emphasized in aerospace education was stated.[6] In the years of 1997 to 2000, this program placed emphasis on the areas of aircraft maintenance and aircraft components manufacturing technology, which basically reflected the immediate need of manpower in the industry. Funding support was given to universities and colleges for upgrading educational equipment and developing lecturing materials using multi-media software tools. The approval of funding support was actually based on the evaluation comments on each of the proposals submitted by academic institutions to Ministry of Education directly. Merits were given to those proposals emphasizing university-industry collaboration to revitalize their education programs.

The effectiveness of university-industry collaboration in the program of 1997-2000 was reviewed and commented by Miau *et al.*[7]. In this report, it was pointed out that despite of the efforts having been made by the universities and colleges, a number of difficulties were identified which were yet to be overcome. To name a few, firstly, lack of communication between university and industry could easily deter from further progress of collaboration. Apparently, communication would require the initiatives of university departments or, more specifically, the educators themselves. Secondly, due to lack of coordination, several schools could make negotiation for collaboration to the same company repeatedly. This was rather ineffective, and even caused confusion. Nevertheless, the first four-years program of 1997-2000 did receive wide attention from universities and colleges in Taiwan. Its outcome results can be appraised from recent development of a number of academic programs in aviation maintenance and manufacturing among universities and colleges, and the appreciative comments given by industry.

Having learned the experiences of university-industry collaboration in the first four-years program, the program of 2001 to 2004 takes another initiative to establish an infrastructure, so-called university-industry strategic alliance, aiming to promote the

university-industry collaboration in a more effective manner.[7] This infrastructure consists of three levels shown in Fig. 1, which can be briefly described below. The first level is the program office, which is under the Advisory Committee of Manufacturing Technology Education, Ministry of Education. Besides the program office for aerospace engineering education, two more program offices are established in parallel, which are for the programs of precision machinery and engineering education and mechatronics education, respectively. Each of the program offices is functioned to promote and monitor the progress of the respective program. The second level is the resources centers so-called, each of which plays the role of coordinating the educational resources in the academic schools and industry. For the aerospace engineering program, there are three resources centers established corresponding to the areas of aircraft manufacturing technology, avionics and aerospace quality assurance, respectively; in addition, two resources centers of aircraft maintenance are located in the north and south of Taiwan, due to geographical consideration. The third level is referred to the partner schools so-called, coordinated by the resources centers. The partner schools actually play the role as the building blocks of the program. The schools can gain benefits from the program, in terms of equipment funding, inviting experienced experts from industry to give lectures or provide consultations with regard to curriculum development, and student summer practice. On the other hand, the partner schools have to show their strong willingness and interests in participating in the program.

Based on the above description, it is clear that the program of 2001-4 is intended to promote the mechanism of university-industry collaboration in aerospace engineering education in a more systematic manner. The functions of MOE, the program office and resources centers and partner schools in this concern are summarized in Fig. 2. Moreover, as seen in Fig. 2, the item of international cooperation activities is included as one of the working items in the program office, which was lacking in the first four-years program.

In the following, the methods concerning implementation of the mechanisms of university collaboration and international cooperation into the program are described. Emphasis will be placed on the coordination between the three levels of the infrastructure on the various activities to be carried out.

UNIVERSITY-INDUSTRY COLLABORATION

The program office is functioned to plan and organize the efforts of university-industry collaboration in an integrated manner. The program office is responsible for strategic planning on the priority items of university-industry collaboration and monitoring the progress of the working items carried out by the resources centers. In doing so, an advisory committee is formed by the program office, seen also in Fig. 1. In this committee, senior members from governmental agencies, industry and academia are invited to conduct meetings to review the performance of the program office and resources centers, as well as provide consultations to various aspects of the program.

There are a number of activities organized by the program office in the year of 2001. First, a workshop with exhibition of the results of university-industry collaboration in aerospace engineering education will be held in December. Members of the advisory committee, school instructors participating in the program, and representatives of the industrial organizations will be invited to attend the workshop. During the workshop, performance evaluation on each of the funded projects will also be conducted. The evaluation data will serve as a reference for funding approval next year. Second, a national contest of student design projects with emphasis on hands-on practice will also be held in December. The announcement of this activity has been posted to public. The due date of submitting proposals was 30th of June. It is required that each of the submitted proposals has to be originated from a departmental course, not from an academic research project or other sources, and has to show evidence of endorsement by the industrial partner. The topics of the proposals can be on any of the four areas mentioned, namely, aviation maintenance, aircraft components manufacturing, avionics, and aerospace quality assurance, as well as other subjects relevant to aerospace engineering. After reviewing, each of the accepted proposals will receive a cash award amounting to 1,500 USD for covering the expense of the project. Third, workshops or intensive courses for instructors training will be held in this summer, on selected topics of aircraft maintenance, aircraft manufacturing, avionics and aerospace quality assurance. The purpose of these workshops or intensive courses is to provide opportunities for school instructors to obtain up-to-date technology information from industry and get acquainted with the experienced experts in the respective areas. Speaking of the activities of instructors training, a couple of examples can be given below. Currently, the program office is contacting the Aeronautical and Astronautical Society of Republic of China (AASRC) to organize the intensive courses for school instructors in the areas of avionics, aircraft manufacturing, and aerospace quality assurance. The scope of the courses is to provide the instructors with comprehensive background and lecturing materials in the respective areas. Additionally, the program office is contacting Aviation Training Institute, Civil Aviation Administration (CAA), for a series of courses on various subjects of civil aviation at the introductory level. The

subjects are in the areas of aviation regulation, air transportation management, aviation safety, air traffic control, and aircraft flight-by-wire technology. The purpose of the intensive short courses is to have the instructors familiarize the up-to-date technology information in aviation, which is, as found, difficult to be obtained from open literature. Both cases illustrate that university-industry collaboration makes instructor training possible with local resources.

In establishing the linkage between schools and industry, each of the resources centers actually plays a pivotal role in coordination. Each of the resources centers, selected by the program office in the initial phase of the program, has reputable experiences of collaboration with industry in the respective area. Basically, a resources center is located in a university department, hence the departmental office can support the administrative work of the center. A large degree of freedom is given to a resources center in planning the activities relevant to the collaborations between schools and industry. MOE funding support is provided to each of the resources centers for hiring administrative staff, covering the expenses of meetings, workshops, and intensive short courses on specialized topics. The resources centers are entitled to invite experienced experts from industry to university or college to give lectures in regular classes on a part-time basis. Also, a resources center is responsible for coordinating a team of experts to develop course materials by using multi-media software tools, which can be of use to universities and colleges later-on. Nowadays, school instructors are facing a serious problem in common that few published textbooks are available on the subjects of the four areas emphasized in this program. Hence, it is urgent to organize a team of experienced experts in industry and school instructors to work together for developing course materials or textbooks with computer software tools. These lecture materials will be posted on the website, hence can be accessed by anyone through the internet.

It is worthwhile to mention that through the coordination by each of the resources centers not only the program funding can be utilized efficiently, but also the coordination can overcome some administrative constraints in individual schools. For instance, normally inviting an industrial expert to give lectures in a regular class in a department requires a formal process of application and review, which would take time of months. In the present program, through the coordination by a resources center it is possible for a university department to invite an industrial expert to give lecture in a timely manner. Moreover, it is also possible to have several experts giving a series of lectures for a course if necessary.

For a partner school, the school can receive equipment funding provided that its proposal is approved by Ministry of Education. A partner school may also obtain additional support from the resources centers and the program office, under the items of inviting industrial experts to give lectures, students summer practice and international cooperation. However, it should be stressed that it is the responsibility of a partner school to make his own requests for support and show his open mind to share the resources with other schools. As shown below, Table 1 provides a list of the schools that will receive equipment funding from the Ministry of Education this year. Evidently, the schools shown represent the major group in Taiwan, who are interested in promoting aerospace education.

In viewing that the efforts made by the program are aimed to improve the quality of aerospace education in each of the schools, the successfulness of the program should be measured by whether or not the quality of education in the schools has been improved since they joined in the program. It is realized that the key to success lies in the coordination and communication between the program office, the resources centers and the partner schools. It is important that each of the schools should have a good grasp of understanding on how to make good use of the resources offered by the program.

INTERNATIONAL COOPERATION

Compared to the program of 1997-2000, it is a new attempt in this program to provide funding support for the activities in international cooperation. Funding is allocated in the budget of the program office for inviting overseas experts to give intensive short courses, or provide consultations to the academic programs of schools. It should be mentioned that in Taiwan a university department normally does not have regular budget for inviting foreign visitors. Hence, funding of this item actually signifies an attraction to the participants in the program.

For the activities of this year, the program office is currently coordinating the resources centers to finalize the list of foreign experts whom will be invited and the workshops or intensive courses to be organized. As an example, an activity proposed by the avionics resources center, Department of Aeronautics and Astronautics, National Cheng Kung University, is planning to invite two overseas experts to give a series of lectures on the design of MEMS (Micro Electrical-Mechanical System) sensors and actuators. Conceivably, this activity represents an interest of the department in education and research, which will also benefit to other academic institutions as well.

Distance learning is one of the items promoted by the program office in international cooperation. Since internet networking is popular in campus, distance learning using internet is highly feasible in the universities in Taiwan. A distance learning network between the program office and the resources centers will be established

in the near future, through which the lecture materials can be stored at one of the resources centers or the program office and easily accessed by the others. In the future, this network will be extended to the academic institutions abroad as well.

The other possibility of international cooperation extends to the contest of student design projects. While this year the contest is confined to the teams of the domestic schools mentioned above, in the future it is desirable to offer this opportunity to teams abroad as well. The benefit is plausible that students from different countries will be able to share their learning experiences through this activity.

DISCUSSION

As described above, this program presents an effort by Ministry of Education to promote revitalization of aerospace education with emphases on university-industry collaboration and international cooperation. The authors would like to suggest further that the outcome results of the program be evaluated on a yearly basis with the considerations as follows.

1. Speaking of university-industry collaboration, the utmost importance is the enthusiasm of participation of the schools and industry. This will be reflected from the courses development in schools and the comments from the industry. To be more specific, the enthusiasm of participation has to rest upon the school instructors themselves. Hence, it is desirable to have the instructors who participate in this program get together frequently for exchanging ideas and sharing experiences with others.
2. Speaking of international cooperation, a major consideration would be the effectiveness and benefits of cooperation to the academic curriculum and students. In order to have long-term impact, support and endorsement by the school administrative are deemed necessary; hence the cooperation can be carried out on a solid ground. It is of no doubt that a formal agreement of international cooperation would require the countersigns of the school administrators.

CONCLUDING REMARKS

This paper describes a four-years national program (2001-4) by Ministry of Education in Taiwan, aiming to revitalize aerospace engineering education for meeting the manpower needs of local aerospace industry. In this program, four academic areas are emphasized, which are aircraft maintenance, aircraft components manufacturing, avionics and aerospace quality assurance. An important feature of this program is that an infrastructure is built in the program for the purpose to promote university-industry collaboration and international cooperation in a systematic manner. The infrastructure called university-industry strategic alliance consists of three levels, namely, the program office, resources centers and partner schools. The coordination of these three levels is vital in carrying out various activities in the program. It is suggested that evaluating the outcome results of the program be made on a yearly basis, therefore the strategies of execution can be modified and improved in a timely manner. In essence, the success of the program rests upon teamwork of the program office, resources centers and partner schools. More importantly are the enthusiasm of individual educators and the support of school administration.

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TABLE 1

List of schools sponsored by the MOE Program in the year of 2001.

Aviation maintenance (North center)	1.Chung-Hwa Institute of Technology 2.I-Lan Institute of Technology 3.Shin-Shing Technical and Commercial High School
Aviation maintenance (South center)	1.Yun-Tai Institute of Technology 2.National Huwei Institute of Technology 3.Kao-Yuan Institute of Technology
Aircraft component manufacturing	1.National Taipei University of Technology 2.National Cheng Kung University 3.National Taiwan Ocean University 4.Feng-Chia University
Avionics	1.National Cheng Kung University 2.National Huwei Institute of Technology 3.Tamkang University 4.Feng-Chia University 5.Shin-Shing Technical and Commercial High School
Aerospace quality assurance	1.National Taiwan Ocean University 2.Tamkang University 3.Saint John's and Saint Mary's Institute of Technology

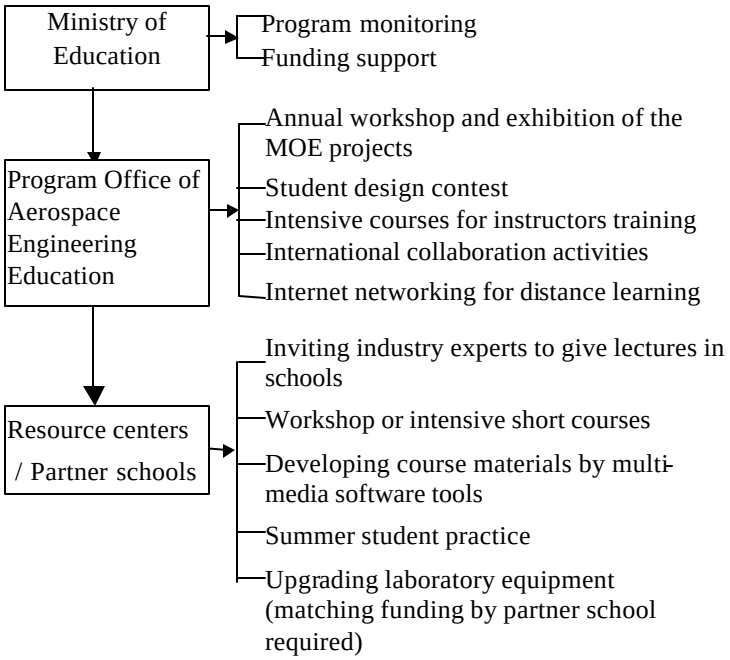

FIGURE 2

Mechanism of the MOE Aerospace Engineering Education Program

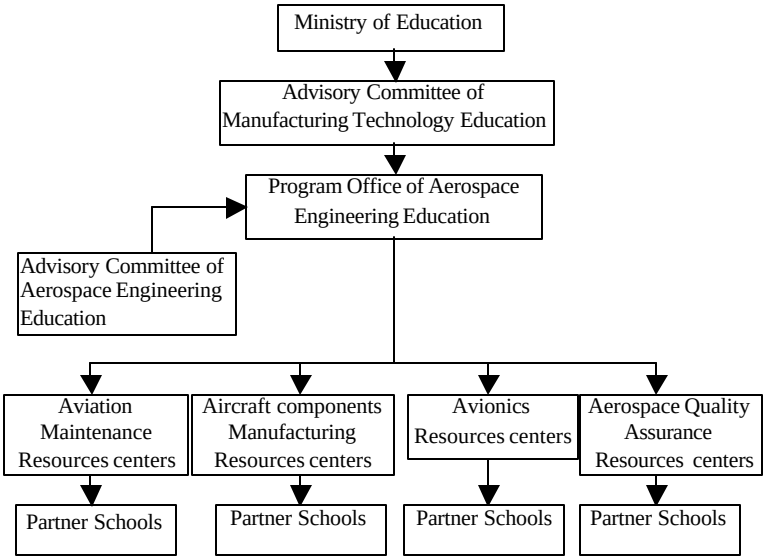

FIGURE 1

Infrastructure of the MOE Aerospace Engineering Education Program