

Developing a Countrywide Virtual Facility Center for Opto-Mechatronics Engineering Education in Taiwan

An-Bang WANG; Long-Sun HUANG; Chi-Kung LEE; I-Ping CHEN; Ming-Chang HSU; Yu-Sin Chen
Institute of Applied Mechanics, National Taiwan University, No1, Roosevelt Rd., Sec 4, Taipei 106,
Taiwan, abwang@mems.iam.ntu.edu.tw

Jeng-Ywan JENG

Department of Mechanical Engineering, National Taiwan University of Science and Technology, Taipei
106, Taiwan, jeng@mail.ntust.edu.tw

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ABSTRACT: *The virtual facility center program has been newly started under the Opto-mechatronics Education Resource Center (abbreviated as OERC) to concentrate limited resources with highly efficient use of countrywide equipment, instruments and facilities, and thus to facilitate the progress through partnership. The OERC, funded by the Ministry of Education of Taiwan government in 2001, which has been constituted by over seventy professors joined across from universities, has conducted the program since April 2003. As equipment, instruments, and facilities are crucial for lecturing, training, and hands-on practice as well as research, the purpose of the virtual facility center program is to gather and share as many equipment pieces as possible for common use within the OERC's members. All the members through the partnership of the OERC are encouraged to share laboratory resources, thus enabling any member to gain access to instruments. The OERC achieved significant results in which the total value of accumulated instrumentations exceeds NTD 60 million (1 NTD ~ 1/33USD) for 94 equipment pieces within 4 months. All equipment and instruments were categorized into five levels according to the value in purchases. Meanwhile, among those categories is the level 1 that includes 16 pieces in value beyond NTD 2 million each. Such a significant amount accounts for the sum of accumulated twenty-year annual instrumentation budgets of the OERC. In addition, there are 12 newly common laboratories that are physically distributed over entire the country for strong interaction between members. The associated mechanism for distributed common laboratories to promote interaction and education has also come to be activated in which the annual budget for instrument or equipment purchase is ranking-based allocated. The ranking in this mechanism for distributed laboratories is based on several indexes such as constitution, organization, administration system, laboratory collaboration, new course development, and the digital exchange platform. With such a new mechanism inserted into newly established, distributed common laboratories under the frame work of the virtual facility center, the OERC are facing new challenges, but toward a promising development.*

1 INTRODUCTION

The vision of Taiwan government to "Two Trillion and Twin Star Industries Development Plan" points to its challenges in future for this country. The Ministry of Economic Affairs aims at the target that the total production revenue for the semiconductor and TFT-LCD (Thin Film Transistor liquid crystal Display) industries is expected to both surpass NT\$1 trillion by 2008. The total manufacturing revenue in TFT LCD industry is anticipated to win the global No. 1 among all worldwide by the end of this year (2004) in which there has been an unprecedented record of fourteen global No. 1 electronics products in Taiwan. One of the essential requirements to meet this high production yield is the manpower supply for the optoelectronic industry. However, the total manpower from normal optoelectronic education program is far below the demand of optoelectronic industry. Owing to the urgent manpower demands to meet such a fast growing need, leverage and integration from resourceful, well-educated mechatronics-based manpower are a new strategy to link established resources across many disciplines. Integration, resource sharing, collaboration and inter-discipline in opto-mechatronics industry are becoming a crucial role in the next strength in Taiwan. Due to higher complexity and far beyond disciplines, the quality of human resource is the core to move the industry forward and thus to win over the future. Reviewing current

educational systems, curriculums and resources, the OERC is intended to construct a new frame of work, and to create a new mechanism that is compatible to current educational systems. The OERC expects to multiply its potential to increase its marginal benefit. A new program of the virtual facility center under the OERC is established to integrate present resources as well as to share equipment, instruments, and facilities, thus maximizing its utilization. "Sharing and Management" is the core of the virtual facility center. The detailed will be described in the following sections.

2 STRUCTURE OF THE OERC

The Opto-Mechatronics Education Resource Center (abbreviated as OERC) was established in 2001, funded by the Ministry of Education (abbreviated as MOE). It is a four-year program constructed with an objective on the Education Reform Program in Precise Machine Technology especially focused on the area of Opto Mechatronics because of urgent demand of professional enterprises. The OERC has been constantly striving for three years to improve the interdisciplinary technology education in Opto Mechatronics design integration and promote the quality and innovation in education [1]. Through strategic alliance, OERC consists of 4 parts. (1) Executive team: One director who is a professor in Institute of Applied Mechanics of National Taiwan University, Taipei, Taiwan and three associate directors, and both of them take the responsibility to take the whole situation into account and make overall plan accordingly, meanwhile the Institute of Applied Mechanics serves as the executive institute. (2) Alliance partner part: Beginning with 11 professors from 8 universities in 2001, there are 73 professors from 32 universities in all over the country and more than 20 different industrial institutes in the group and serve themselves as alliance partners in 2003. All the alliance partners devote every effort to encompass the platform-driven teaching mechanism initiated by the OERC. (3) Industrial and academic circle: Members from eminent companies and institutes provide their experience and professional knowledge to propel OERC a full-integrated team. (4) Advisory board: Members distinguished and prestigious from industrial, academic and research circles take part in the group and serve as consultants, giving evaluation and advise which are useful guidelines for next plan and directions of improvement. Taking advantage of rapid Internet facilities, OERC communicates with its partners with e-facilities to plan the blueprint together. In addition to integrating and converting many of the results at the leading institute as the teaching tool, the Internet is heavily relied to link all the e-courses and teaching resources on the website.

The OERC is featured to establish a virtual facility center for opto-mechatronics (VFCO) for the precise machines and instruments exchanged and develop it by collecting all hardware and software resources, which are supplied from all alliance partners including industrial institutes (figure.1). With this mechanism, alliance partners may overturn a barrier by browsing the web pages to interchange their instruments. Throughout the program, the OERC has been commissioned to construct the following three major works. (1) Internationalization Education. In this item, it includes 3 parts such as (a) collect Opto Mechanics lecture-notes. The lecture-notes are contracted with the alliance partner professor and published as textbooks for the basic and advanced Opto Mechatronics courses. (b) The special "lab-LEGO" concept, which is to develop five different kinds of opto-mechanical and OE systems, was developed to foster system integration training platform. (c) Magnify and expand the cultivation for talents by holding activities, international workshops, seminar and invited presentation for experts or NANO-/BIO-/MEMS-technology summer camps for college students (2) countrywide student project competitions. Students can be rapidly trained to work in the competitive world, and their innovation and intelligence can be stimulated through this project competition. (3) E-learning program. The teaching texts or lecture notes are contracted and made into multimedia file. They are also available on the web site for all interesting program members. These three objectives are envisioned and established to cultivate and educate the next generation.

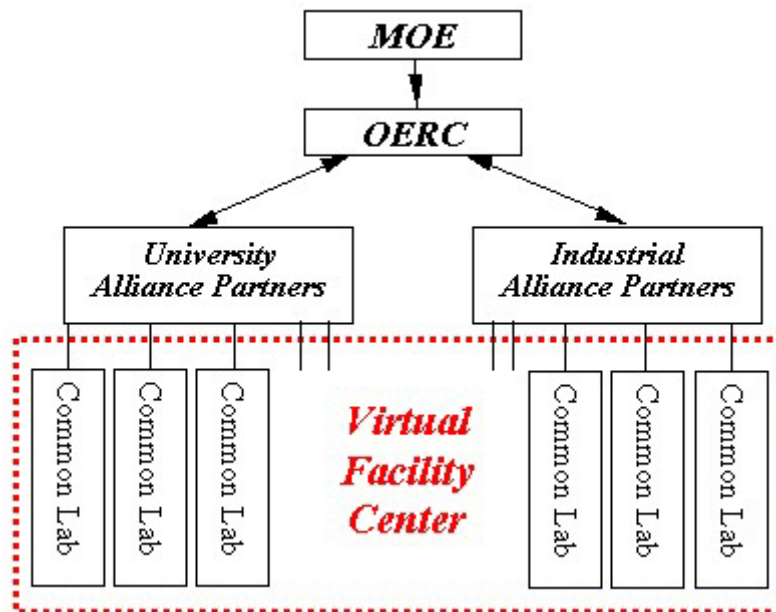


Figure1 Structure of Virtual Facility Center (VFC)

3 MISSION OF THE VIRTUAL FACILITY CENTER

The virtual facility center (VFC in short) is a strategic program within the OERC, a virtual organization for exchange of precious machines, equipment, and instruments. The virtual facility center enables any one of the members to gain access to interested equipment, machines and instruments. All those equipment and instruments are being gathered under a sharing mechanism and appropriate management. By use of networking and information integration, the virtual facility center is able to link all the machines that exist in laboratories and universities. One of the driving forces for the virtual facility center is due to limited grants in government support, but focal strength of available resources.

Under the base of the sharing information available in networking server, the platform of the virtual facility center for open use may integrate resources to lower the barrier of lecturing, training, and research among universities. As shared in information and facilities, the OERC is in charge of motivating all the alliances together toward this mission. Some results have been done to move this idea forward. Those are workable managing approach of sharing, investigation of existing resources, and establishment of virtual facility network.

First of all, the sharing of resources is truly embraced and anticipated by the grant agency of the Ministry of Education, which is to realize educational resources broadly to as most people as possible. On the other hand, the sharing is meant to be averaged by default, thus diluting resources and consequently lowering its strength. The virtual facility center is to create a potential in compromise of taking advantages of source sharing and retaining concentrated resources in a sense. Incentive of joint effort and buildup of the platform for common-use virtual laboratories is required to realize the sharing mechanism. The matching fund award is accompanied to encourage the joint center. The associated matching grant relies upon a ranking mechanism reviewed by the panel committee and all members. In other words, the ranking is based on accumulated credits that were awarded by review in previous year. By doing so of a fair mechanism, the virtual facility center has received so far recognition from all members. The awarded grant is allowed for new item purchase in feedback to add on equipment strength of the virtual facility center.

Second, the OERC is in charge of resource integration and managing system in which the new frame work may motivate all the members to move this mechanism forward. As categorized in five levels of all instruments in terms of value, the facilities contributed by joint laboratories under the virtual center are accredited. The crediting system is designed to allow the joint laboratories, with good performance in annual review, for equipment purchase in next fiscal year. Such an incentive is to motivate all participated members to share existing resources for all members. The virtual center is then to include all the associated information into the networking system such as equipment name, model number,

manufacturing company, photographs and standard operation procedure. Apart from those contributed, the credits are also counted on a basis of usage requested by members. With such an encouragement, the barrier between members, laboratories and the center is overturned to facilitate interaction.

Third, to link those virtual laboratories and to achieve sharing for all members, the web-based networking is essential to realize the virtual facility center. The OERC is also responsible for network establishment and maintenance. All the softwares are designed in line with those purposes described early. The evaluation of equipment usage, time, users, providers, and interaction are all quantified into the crediting system. Therefore, the on-line web-based data bank is crucial in the virtual center.

4 RESULTS

The virtual facility center program has been initiated since April 2003. All the reviewing mechanism are made in the panel committee formed in a fair basis of wide professional and expertises across from academies, industries, and government. At this moment, several milestones have been marked as follows.

4.1. Sharing mechanism and management

The sharing mechanism of the virtual facility center is to gather all interested members and link all the precious equipment, instruments and machines with an interaction-intense and healthy management. There are three crucial elements to execute the management as of a board committee, instrument circulation system, and evaluation.

Referring to the operation experience of the prestigious National Instrument Center under the National Science Council of Taiwan government, the OERC drafted a new regulation that was able to adapt to such a virtual organization and existing facilities at distributed sites. The board committee formed in a wide spectrum of professionals across academies, industries, and government is set to regularly review the progress and to provide comments. In the comments and conclusion of the general review, the OERC is obligated to abide by the concluding remarks.

Second, as to its circulation system, the sharing mechanism in the OERC is divided into two parts in aspect of existing resources and newly added pieces. The first one for existing resources is to encourage volunteering members to share laboratory resources. The owner is still in charge of equipment resources owned, maintained, and managed under the laboratories. The OERC includes those equipment items to be posted on the web for information exchange. The second for newly added pieces is to assist in educational purpose in terms of featured laboratories at distributed sites. The ownership of newly added pieces is still under the OERC, but to be retained, maintained, and managed by the laboratories. The keepers are required to submit the annual report, progress, and common-use achievement. With a three-year constant review in positive evaluation, the ownership of those equipment items is allowed to transfer to the laboratories and keepers. Moreover, the usage number of distributed facilities is counted into its crediting program.

In an evaluation system, the crediting program is made to be a basis for budget allocation of newly added equipment pieces. Several elements are taken into account of number of contributed instruments, usage, and sharing request and its associated service. All the members are allowed to request equipment pieces for circulation across laboratories and universities. To maintain and support the mechanism, an appropriate management is required to realize the virtual mechanism. As a result, a general statement of management and a corresponding operation procedure are proposed to insert the sharing mechanism spirit.

First of all, a general statement of management applicable to all laboratories is as follows:

1. The virtual facility center program under the OERC is set to share resources and to promote common resource effectiveness. In the alliance of the virtual facility center, all the equipment and laboratories are obligated to provide service in support of the project in Ministry of Education.
2. The board committee is formed to review a fair evaluation and accessibility among joint laboratories. The evaluation is made in a credited- and ranked- basis.
3. The circulation is required to gain approval under the permission of the previous or original keepers.

4. The resources in the virtual facility center are mostly contributed from volunteering members (marked in B-instrument) and newly added pieces particularly granted in this program (marked in A-instrument). Those are in a list of sharing resources.
5. In A-instrument, several regulations are made to be abided by
 - a. The applicants under the circulation system are required in two months by the end of the year to submit a proposal for use in a next-year term.
 - b. The ranking is made in terms of public use and donated equipment. The keeper is obligated to provide service of circulation, maintenance, and reservation.
 - c. A regular report under the virtual facility center program is required for submission to the OERC. With a constant positive review in three-year term, the ownership is allowed to transfer to individual laboratories and universities.
 - d. The virtual facility center reserves the right to revoke equipment usage if any violation or immoral use occurs.
6. B-instrument contributed by volunteering members is able to provide service under the described sharing mechanism for members.
 - a. The ownership still belongs to the volunteering members in B-instrument. The credits are given in sharing mechanism to create interaction between members.
 - b. Higher credits win the priority in the virtual facility center.
 - c. Circulation is made under approval between keepers and applicants.
 - d. The crediting system is renewed every year.

Secondly, the corresponding operation management is described as follows:

1. All the service and circulation are required to process in the web-based database system. The credit points are automatically generated in a one-year basis.
2. The equipment-shared volunteering members gain credits when registering pieces.
3. The equipment-shared volunteering members gain credits in successful deal requested by other members. The associated crediting table is listed in Table 1.
4. The annual report is counted by 1/5 of its accumulated points.
5. The relation between OERC and partnership is illustrated in figure.2.

Table.1 The crediting table for different category of facilities and Instruments

Category	Value of facilities and Instrument (in NTD)	Gained credit point(s) by registration	Credit point by lending (per 8 hr)	Lending hour	Accumulated credit point(s) by lending
Level 5	>2 million	20	0.5	A	$P = A/8 \times 0.5$
Level 4	>1~2 million	10	0.4	A	$P = A/8 \times 0.4$
Level 3	>0.5~1 million	5	0.3	A	$P = A/8 \times 0.3$
Level 2	>0.1~0.5 million	2.5	0.2	A	$P = A/8 \times 0.2$
Level 1	<0.1 million	1	0.1	A	$P = A/8 \times 0.1$

4.2. Instrument category and investigation

The virtual facility center aims to provide access service of facility sharing to all members. The first thing to be done is to investigate a list of A-typed instrument and B-typed instrument. At this moment, there have been 93 pieces available for public use. Those items are categorized into five levels in terms of their purchase prices. There are 16 items designated in level 1 that exceeds 2 millions each as seen in Table 2.

Table 2. The number of B-typed facilities and instruments in VFC (status: 2003.12.31)

Category	Value of facilities and Instrument (in NTD)	Number of facilities and Instruments
Level 5	>2 million	16
Level 4	>1~2million	7
Level 3	>0.5~1million	12
Level 2	>0.1~0.5million	29
Level 1	<0.1 million	37

4.3. Web-based information exchange of virtual facility center

The web-based platform was established by the OERC for the virtual facility center to increase equipment effectiveness and to promote the integration of educational resources. The center virtually integrates 93 equipment and instruments from three distributed facility centers or twelve laboratories (figure.2). By using the web-based data input, all the related information is timely posted for users, which is especially helpful for remote users. Besides, the circulation system and crediting system are also released in this system. The interaction between the OERC, members, and joint laboratories are established in this system. The web-based achieves its work as follows:

1. On-line enrollment and reservation
2. Database for instruments and equipment
3. Distinctive access regulations for distributed laboratories
4. Application of use for instruments
5. Authorization of instruments
6. Timely information update in approved application
7. Credit gain after return.

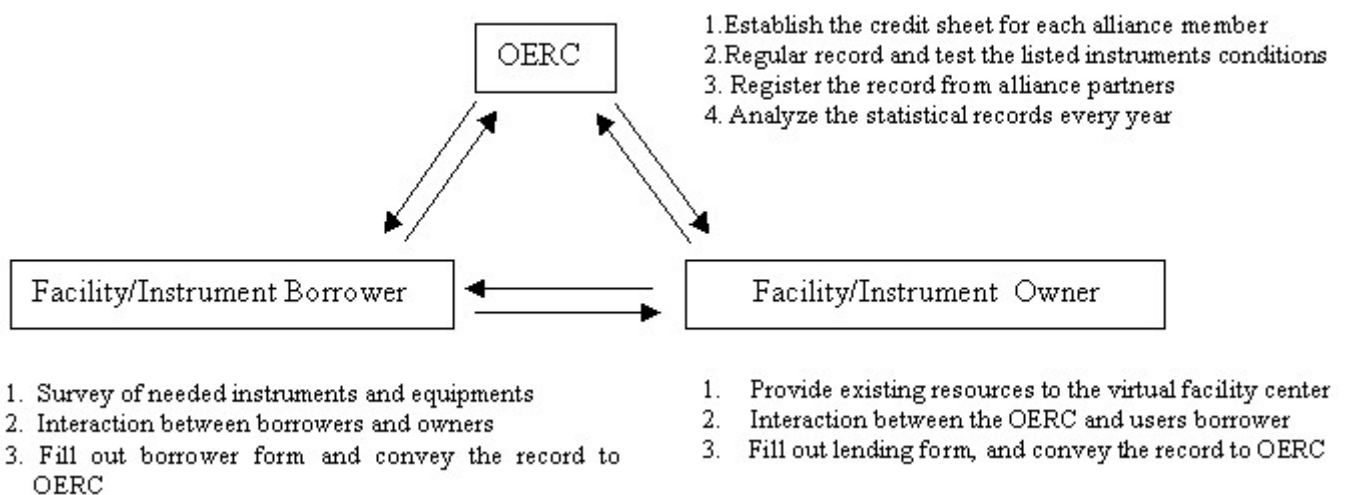


Figure2. The interaction flow chart of the OERC virtual facility center

5 CONCLUSIONS

The virtual facility center program has been executed under the Opto-mechatronics Education Resource Center (OERC) to focus limited resources with highly efficient usage of countrywide equipment, instruments and facilities. The members of the OERC include more than seventy professors from over 30 universities spreading in the whole country (see figure3). Three local facility centers (FC) have gradually formed. All the members within the OERC are encouraged to open laboratories, thus enabling other members to gain access to instruments and share their experience. The OERC achieves significant results in which the total value of accumulated instrumentations exceeds NTD 60 million for 94 equipment pieces. All equipment and instruments are categorized into five levels according to the

value in purchases. The sum of accumulated twenty-year annual instrumentation budgets of the OERC. It means, on the other words, that the faculties, especially the new ones, do not need to wait for longer to gather enough facilities for her/his experimental investigations. Moreover, there have been 12 common laboratories (see figure.3) opened over entire the country for strong interaction between members. The associated mechanism for distributed common laboratories to promote interaction and education has also come to be activated in which the annual budget for instrument or equipment purchase is ranking-based allocated. The ranking in this mechanism for distributed laboratories is based on several indexes such as constitution, organization, administration system, laboratory collaboration, new course development, and the digital exchange platform. Although the virtual facility center was just begun for less than one year, the OERC is continuing its good start to fortify its strength.

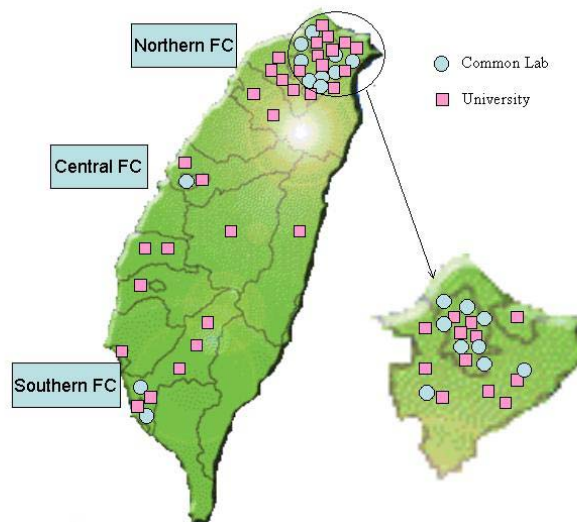


Figure.3. Distribution of alliance partners, common labs, and local facility centers (FC) of the OERC

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