

Proceedings
Enhancement of the Global Perspective for
Engineering Students by Providing an
International Experience

Engineering Conferences International

Year 2003

Global Engineering Education Through
Joint Degree Programs

Ali Asghar Mirarefi
University of Illinois at Urbana-Champaign

GLOBAL ENGINEERING EDUCATION THROUGH JOINT DEGREE PROGRAMS

**Ali Asghar Mirarefi
Chemical Engineering Department
University of Illinois at Urbana-Champaign
Urbana, Illinois 61801**

ABSTRACT

The increasingly pervasive nature of the global economy makes it essential to provide opportunities for students to integrate an international dimension into their educational experiences and to prepare them to function in the world economy. The University of Illinois has invested heavily in International Programs and Studies and defines the mission of this office as having a leading role in the nation by coordinating, promoting, and supporting international activities on campus. The College of Engineering through its Study Abroad Office administers numerous exchange programs with many countries around the world. This college is the only U.S. institution to offer an international minor in engineering as part of the regular degree program. This program allows a student to concentrate course work in the social sciences and humanities on a particular country or geographical region. This course work is combined with work or study overseas. To expand these activities, in 1998, the University of Illinois at Urbana-Champaign (UIUC) and the National University of Singapore (NUS) initiated a joint Master of Science program in Chemical Engineering. This joint program integrates study and work experience in both Singapore and the United States. The program's goal was to provide a multicultural and multinational experience added to the graduate education in chemical engineering. Being the first multi-institutional joint program on this campus, official signing ceremony of the Memorandum of Agreement took about four years before it was celebrated on July 23, 2002. Beyond the joint MS, the program aims to provide UIUC and NUS faculty with possibilities for cooperative research; and to enhance the visibility of both institutions as leaders in global education and research. The program is based on pairing Singaporean and US students to ease cultural transitions and to foster collaboration. Students spend nine months in Singapore and nine months in the US. During each nine months, students take advanced courses and participate in an internship.

INTRODUCTION

The rapid advancement in technology and accessibility to internet has introduced a lot of changes in the world and has brought so many countries and cultures closer to each other. Technology has made time and space separation almost irrelevant. Engineers will work in a global economy where businesses operate around the world and around the clock. Most practicing engineers can count on working with foreign nationals or on international projects at sometime in their career. As a result of these changes and globalization, universities in general and engineering disciplines specifically feel a lot of pressure acting on them. To respond to these pressures engineering profession and education are undergoing a lot of re-evaluation and changes.

In an article entitled “Education for the Profession Formerly Known as Engineering” published in The Chronicle of Higher Education, Rosalind Williams, director of the Massachusetts Institute of Technology's program in science, technology, and society states that Engineering is undergoing an identity crisis. The author further states: “The mission of engineering changes when its dominant problems no longer involve the conquest of nature but the creation and management of a self-made habitat. To adapt to this new habitat, engineers have to retool, starting with their understanding of engineering education. Today, technological change is something that happens to engineers as much as to anyone else”.

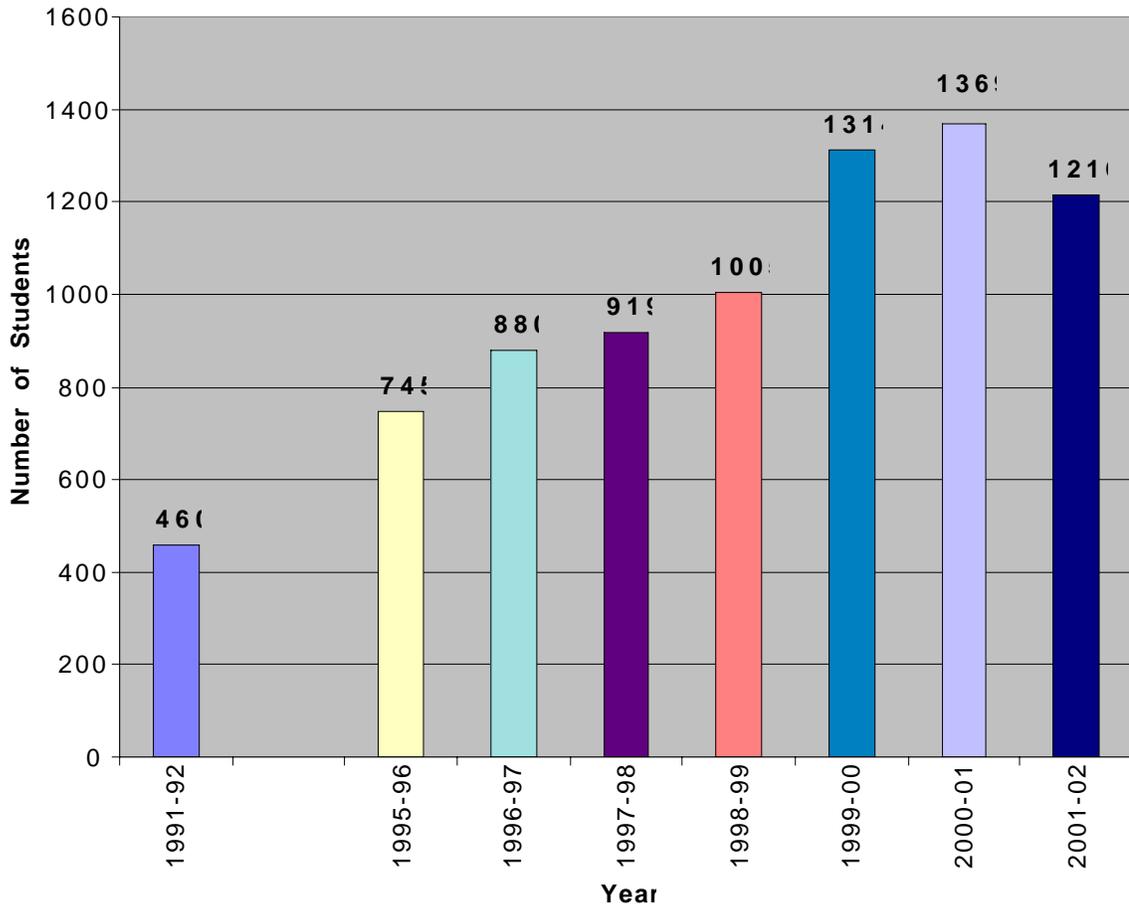
In addition to curricula changes in engineering, new degrees and programs are created which would cover more interdisciplinary fields of studies, add more diversity, and possibly integrating an international dimension into the curriculum. In the following sections different programs at UIUC are discussed and some statistical information is provided and then the joint program based on equal partnership between UIUC and the National University of Singapore is introduced in more detail.

STUDY ABROAD

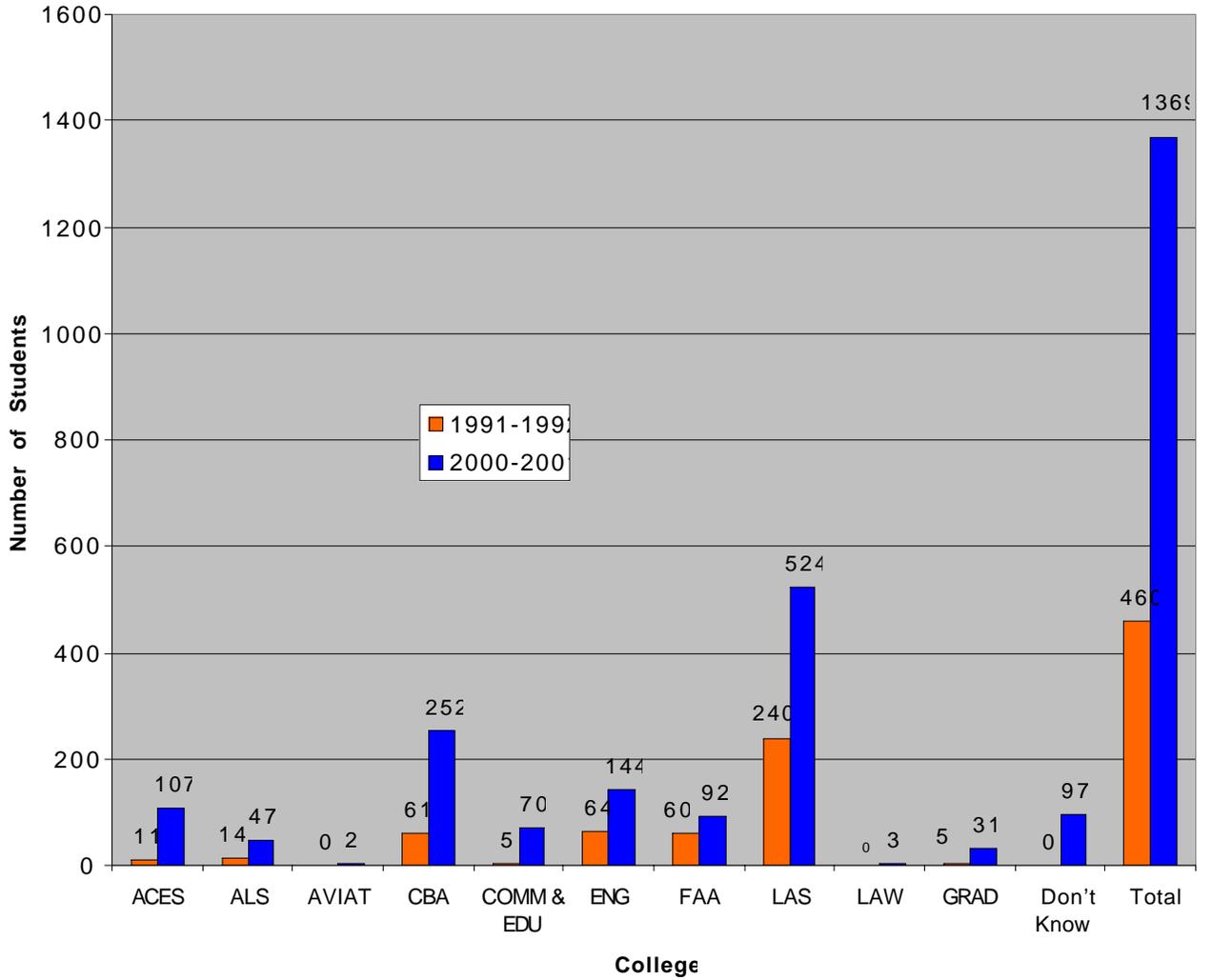
It is not the goal of this presentation to focus on the curricular contents and possible changes in engineering education rather to concentrate more on the globalization aspects of the engineering education. At the University of Illinois at Urbana Champaign (UIUC), the Office of International Programs and Studies (<http://www.ips.uiuc.edu/ipshome.shtml>) organizes numerous study abroad fairs, open houses, and workshops to promote its programs, attract students and increase enrollment. Due to their efforts UIUC ranked fifth in the nation in number of students studying abroad in 2000-01. Following graph shows number of UIUC students who studied abroad extracted from Open Doors Surveys. As seen, this number has almost tripled (from 460 to 1216) over a period of one decade.

The distributions by college are given in the next two graphs. The first graph indicates that UIUC engineering students who enrolled in the study abroad doubled during the period of 1991 to 2001 (an increase from 64 to 144). Though second graph shows a slight decline in study abroad enrollment from year 2001 to 2002 for most colleges and the university as a whole (1369 vs 1216), but the engineering enrolment increased slightly over this period (from 144 students to 158) due to considerable efforts and resources this college devoted to study abroad program.

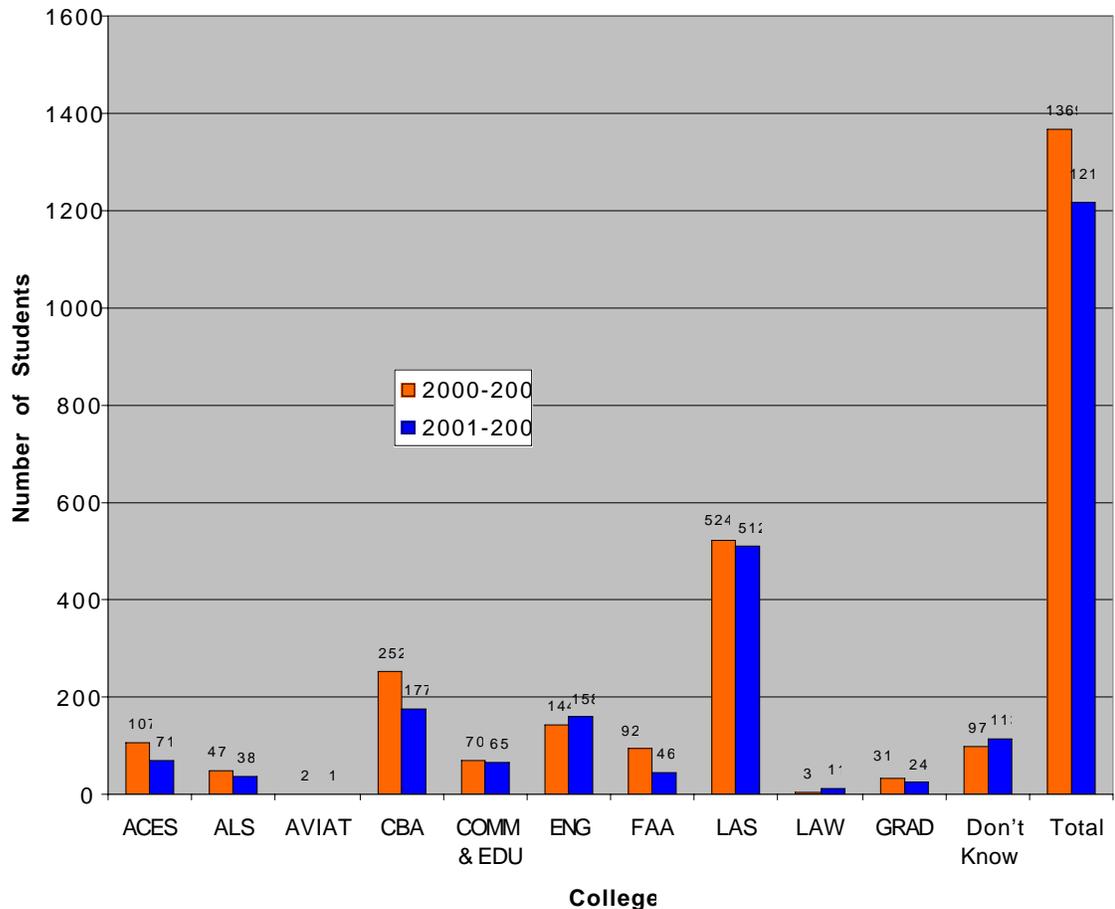
**Total Students who Studied Abroad according to Open Doors Surveys
AY95-96 through AY01-02**



Study Abroad Students by Co AY91-92 and 00-01



**Study Abroad Students by Col
AY00-01 and 01-02**



INTERNATIONAL MINOR

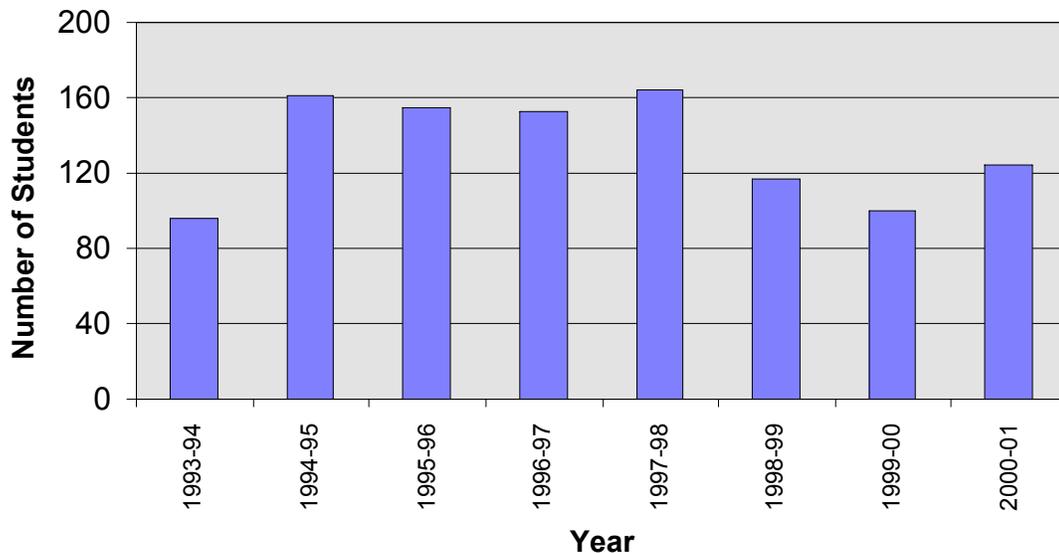
The UIUC College of Engineering is the only U.S. institution to offer an international minor in engineering as part of the regular degree program. This program allows a student to concentrate course work in the social sciences and humanities on a particular country or geographical region. This course work is combined with work or study overseas. The international minor allows a student to gain a level of expertise in a particular area while receiving academic certification for this knowledge. Enrollment data for this program is shown in the following graph indicating an average of 133 students per year for the period of 1994 to 2001.

Requirements for the International Minor

Completion of a minimum of 21 semester hours of courses that deal with the country or region that student has chosen to study. The courses may be in the culture, history, geography, economics, politics, sociology or a language or literature of the region. Selections are subject to the following rules.

- a. At least 9 semester hours must be in courses other than language and must include one 300 level course.
- b. One course must be from the political science/economics list.
- c. Spend at least 6 weeks in residence for work or study in chosen country or region.
- d. If a student doesn't already know the language of the chosen region, he/she must learn it. This can be at the beginning level, or can build on previous courses. Summer intensive language programs are available for several languages. Foreign language study included as part of International Minor can be used to satisfy the campus humanities requirement.
- e. All of the normal degree requirements, as outlined in the Courses of Study catalog must be met.

Enrollment of International Minor in Engineering



Joint Degree Program:

In 1998, the University of Illinois at Urbana-Champaign (UIUC) and the National University of Singapore (NUS) initiated a joint Master of Science program in Chemical Engineering. This joint program integrates study and work experience in both Singapore and the United States. The program's goal was to provide a multicultural

and multinational experience added to the graduate education in chemical engineering. Being the first multi-institutional joint program on this campus, official signing ceremony of the Memorandum of Agreement took about four years before it was celebrated on July 23, 2002. Beyond the joint MS, the program aims to provide UIUC and NUS faculty with possibilities for cooperative research; and to enhance the visibility of both institutions as leaders in global education and research. The program is based on pairing Singaporean and US students to ease cultural transitions and to foster collaboration. Students spend nine months in Singapore and nine months in the US. During each half, the students take advanced courses and participate in an internship.

The need for a greater international dimension in a student's education was brought forth to both departments through their corporate partners who emphasized opportunities available at multinational corporations for those with experiences in the US and Singapore. In particular, our corporate partners discussed with us their needs for students with multicultural, industrial experiences as part of a postgraduate program.

Participating students receive the MS degree from their home universities together with a certificate of participation jointly awarded by both institutions. This MS program provides the impetus for both institutions to extend the collaboration to joint research and PhD programs. In this paper, the MS program with details of the structure, curriculum and projects carried out, as well as the planned extensions of this program will be presented.

THE PROGRAM

Duration and Schedule

The MS program is based on pairing Singaporean and US students to ease cultural transitions and to foster collaboration. Students spend nine months in Singapore and nine months in the US. During each half, the students take advanced courses and participate in an internship. This program started in 1998 with 4 students (2 from each institution) and has been well received. The number of participating students in each year has increased since then. From 2000 onwards, the target enrolment is 10 students (5 from each institution) for each academic year.

The program schedule is summarized in Table 1.

Table 1. Program Schedule

July	December	April	September	December
Coursework in NUS	Internship Project in Singapore	Internship Project in US	Coursework in UIUC	Graduation

US students who apply to UIUC and are admitted into this program join the NUS students in the first semester of the academic year at NUS from July to November. Participating students at the host institution are expected to help the visiting students with the settling-in, and orientation at the host institution. During this first semester, the students take courses and prepare for their internship project. The internship in Singapore starts in December and lasts till April of the following year. The students relocate to the United States and work on the second internship project from May to August. They then enroll for the Fall Semester in UIUC to complete the coursework requirement. Thus, the students spend equal proportions of their time in Singapore and in the United States. Between the coursework semester and the internship period, and also between the two internship periods, are short breaks of a couple of weeks. These breaks, as well as the periods before and after the formal program, are well appreciated by the students who often utilize the time traveling to places of interest.

Coursework and Project Requirement

Students are required to take at least six graduate level subjects (at least three modules at each institution) and achieve an average grade of “B” or better at both institutions. In addition, the internship projects must be completed in a satisfactory manner with final reports and oral presentations required.

While the students are at NUS and UIUC, they are also appointed as Teaching Assistants or Laboratory Demonstrators. The internship period may involve a single project or a number of smaller projects. The UIUC and NUS students are usually paired up during the internship period and are assigned to work on the same or related projects. The projects are intended to be of a practical nature that are relevant to current technology. Examples of the industrial projects carried out are given in Table 2. The examples are chosen from projects undertaken in the petroleum refining, microelectronics processing, chemicals/petrochemicals and pharmaceuticals areas. The projects are jointly supervised by the company’s staff and staff members from NUS and UIUC who act as liaison officers. The liaison officers are also responsible for coordinating with the company to ensure suitability of the projects, and for grading the reports of the students. As can be seen from Table 2, the projects are a mix of modeling, simulation and optimization studies on existing plant units as well as developmental studies on alternative processes.

Industry Participation

The participation from individual companies and foundations through their financial support and employment of the students as interns is a key factor in the success of this program. The internships also provide close collaboration between industry and academe. The industrial companies supporting the program provide training opportunities in a wide range of areas of great interest and importance to chemical engineers such as process engineering, petroleum/petrochemicals, pharmaceuticals, food, chemicals and microelectronics processing, as shown in Table 3. The student-pairs sponsored by multinational companies such as Schering-Plough, DuPont,

Table 2. Examples of Internship Projects

Participating Company's Focus	Project
• Petroleum Refining	(i) Modeling and optimization of lube hydrocracking and dewaxing units (ii) Simulation of hydrocracking unit and reactor sections for maximizing naphtha production
• Chemicals/Petrochemicals	(i) Simulation models of NO_x absorber to estimate temperature profile, release rate of NO_x during disturbance, and vent area required to prevent over-pressurization of tanks (ii) Developmental work on azeotropic distillation of Promotor X using a packed bed distillation column
• Pharmaceuticals	(i) Pilot scale studies on liquid-liquid extraction as an alternative to the double precipitation process for production of Z (ii) Feasibility studies of the recovery of vaporized liquid N₂ and the integration of the N₂ vaporization with the VOC condenser systems
• Microelectronics Processing	(i) Optimization and cost saving options for the ultrapure water facility (ii) Application of phase shift masking for sub-0.16μm contact hole imaging

Honeywell, and ExxonMobil, usually work in the companies' US and Singapore plants during their internship. Sponsoring companies without the necessary operations in either country can team up partners to provide complementary internship, e.g. Chartered Semiconductor Manufacturing in Singapore and Applied Materials in the US. Some companies may require the Singapore students to return to work for a specific period of time (2 years) in return for sponsoring student participation in the projects. However, in practice, many of the companies do not require such commitments, and the employment of graduates by the companies is mutually agreed upon.

Faculty members are encouraged to participate through financial incentives to visit the companies in order to discuss and formulate the projects, and to provide feedback on the project work. During these visits, faculty members establish contacts out of which may grow research connections. Companies may require the participating students and faculty members to sign a deed of confidentiality.

Table 3. List of Participating Companies in NUS-UIUC MS Program

Company	Year of Participation
1. Kraft	1998/99
2. TECH Semiconductor	1998/99
3. Shell/Seraya Chemicals	1998/99, 2000/01, 2002/03
4. Mobil/ExxonMobil	1998/99, 1999/00, 2000/01, 2001/02, 2002/03
5. DuPont	1999/00, 2000/01
6. Schering-Plough	1999/00, 2000/01, 2001/02, 2002/03
7. Glaxo-SmithKline	2001/02, 2002/03
8 Chartered Semiconductor Manufacturing	2000/01, 2001/02, 2002/03
9. Applied Materials	2000/01, 2001/02, 2002/03
10. Honeywell	2001/02
11. Merck	2001/02, 2002/03
12. Obiter Research	2002/03

CHALLENGES AND FUTURE PLANS

The MS program is now in its fifth year and has been positively received by the students, sponsoring companies and both institutions. Survey data and informal feedback from participating companies indicate that the program is of benefit to all stakeholders. Students from both countries learn a great deal about living and working in different cultures, and the application of skills learnt in the classroom to real plant problems. The corporate partners appreciate contacts with and the projects carried out by a group of highly motivated and unusually adventurous students. However, each institution also recognizes the amount of effort required to coordinate the academic activities and the planning and management of the projects with the industrial sponsors. A faculty member has been appointed by each department to serve as a coordinator for the program and to liaise with the students, university administrators and industrial sponsors. The coordinators also assist the students in the procurement of travel documents and housing arrangement. While the students are in Singapore or at UIUC, they are eligible for student housing. However, during the internship in various parts of the US, they have to make their own housing arrangements although some companies provide assistance in this respect. The “buddy system”, whereby the participating students from the host university play an active role in helping the visiting students settle in, certainly alleviates some of the difficulties.

The success of this program has set the stage for further collaboration in chemical engineering between the two institutions. In January 2001, the departments jointly organized a NUS-UIUC Joint Symposium on Globalization of Chemical Engineering Research, at which intensive discussions were conducted to design a Joint PhD

program. There is already collaborative research between NUS and UIUC chemical engineering faculty members. However, a Joint PhD program will formalize and further enhance this collaboration providing visibility for the quality research that can be done with the skills, resources and ideas of the combined effort of NUS and UIUC faculty. This program is being implemented with a shared commitment to excellence in education and research based on collaborative efforts where interest, capabilities and resources of each institution combine to offer unique and advantageous opportunities.

