### PREPARING STUDENTS FOR ENGINEERING IN THE 21ST CENTURY THE OREGON INTERNATIONAL INTERNSHIP PROGRAM

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#### BACKGROUND

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The traditional education of engineers and engineering technologists includes classroom training and hands-on '. experience in the form of laboratory exercises and simple design exercises. There is considerable pressure from industry to increase meaningful experience through internships during the college training period. The experience gained during such industrial employment has been shown to have a positive influence in a number of areas. This paper anticipates the extension of internships into a formalized program, where industrial experience is an integral part of the education of the student.

In industry, the environment is changing. Design teams of the future will, because of improved electronic communications networks, be comprised of members from different countries working at a variety of locations on the same design problem. There is a trend toward the multinational company model, with design and fabrication facilities world-wide. Mobility has improved, even to the most remote areas, through improvements in both communications and transportation networks. Global competition and cooperation is, even today, a reality.

In the communications area, the Internet has become the conduit for a wealth of information, both within a company and, more importantly, with colleagues from different companies. With the widespread acceptance of the Internet, it is common to have "virtual" conversations with colleagues around the world as easily as with those in the same office complex. Beyond the simple act of "keeping up" with colleagues, it has become feasible to share projects and research in the same manner. This capability will have a profound effect on professional life in the future.

This paper describes a program initiated by the higher education system of Oregon, to foster changes in the education paradigm which will embrace the coming global design arena. This new program - *Global Graduates:* the Oregon International Internship Program - is designed to improve the educational preparation for the "borderless" careers that present students will encounter upon graduation.



### THE COMPANIES ARE CHANGING

In a traditional company, the role of engineer and engineering technologist is strictly limited in scope to within the company, often even within a department. The time pressures associated with many projects discourage casual contact with other designers, even sometimes within the same company. This lends a certain insular quality to a design team; it is effective in keeping trade secrets within company bounds, but stifles implementation of new ideas and design methods.

Global competition is forcing the breakdown of these traditional barriers for a number of reasons. For instance, as the market for products from a company becomes worldwide, there is a need for designers to have wider experience so they can better adapt the products to the new applications. As products designed using a global design team reach the marketplace and are successful, the benefits of such an approach become evident. There is a growing awareness on the part of companies that design talent may be found worldwide. In one such example, the team for Intel's N 10 (now the 80860 chip) was comprised of approximately twenty engineers drawn from the various Intel divisions. A photo on the cover of *Spectrum* illustrates the diversity and internationalization of the team [1].

The availability of improved communications channels has had, and will continue to have, a profound influence on both companies and individuals. Electronic mail (e-mail) and Internet access within a company is commonplace. Extending these trends to the future, *teleconferencing*' and *meetings from the desktop*<sup>2</sup> will also become commonplace. Documents and drawings are likewise expected to be highly mobile. In addition to improving productivity, improved communications mitigates or eliminates the penalty for operating from different sites.

Another forcing influence is the increased mobility of the work force. In many cases, designers have found that their skills were highly desired by other companies, and have thus found it in their best interests to be aware of the outside world. Similarly, with recent corporate "downsizing", the attitudes of the workers toward their companies have changed, as it seems unlikely that a given worker will spend their career with one company. Keeping in touch with one's friends has become a survival trait, including information on technical topics; this has the effect of spreading knowledge beyond company borders.

Given these trends, it becomes possible to speculate on the:

#### **COMPOSITION OF A DESIGN TEAM, CIRCA 2010**

The typical design team of the near future will have important differences from the team of today. Company boundaries will be world-wide, with networked communications and teleconferencing routine. In such a company, it becomes possible to assemble a meeting in a "virtual meeting room" using linked computers; small cameras mounted on each computer and wide-band communications networks enable real time interactions, without the need for all persons to physically assemble in one area.

 $<sup>^{2}</sup>$  meetings from the desktop involves two or more workstations, with local (often attached to the monitor) video cameras, in joint communication. Video and text are simultaneous, and appear on each others' monitor.



<sup>&</sup>lt;sup>1</sup> teleconferencing usually involves some form of audio/video link, often with a group of people in a special room so equipped.

In such a company, the typical design team will be selected from persons with the special skills needed by the proj-bout consideration of physical location. In such a work team, there is a need beyond technical skills. There is a need for *flexibility and cultural understanding*.

—... —... Foremost, individuals must show flexibility in the working relations that exist within a team. When the team is comprised of a variety of individuals from different backgrounds and cultures, the successful team members will be the ones who understand and can work with persons from different cultures.

Market needs and company responses to those needs will cause individuals to accept flexibility in their work assignment, as one project may need a certain skill, and another some other skill. One project team may be comprised mostly of on-site personnel where another is a "virtual team", with members at remote locations.

As some of the team members maybe physically remote, there is a need for flexibility in the work environment; i.e., members must be able to work under a variety of conditions and time schedules. For one project, it may be necessary that the team assemble at a time agreeable to all; it may be midnight in one location, 0700 at another. Or, it maybe necessary to conduct most business matters and meetings via e-mail, if no compatible schedule can be found. The team members must be willing to work out compromises and be able to work under conditions far different from those that exist today.

It should be noted that some companies are not waiting for the Millennium to incorporate many of these characteristics ! As discussed in a number of recent articles [2,3] there is a growing awareness of the need for internationalization and diversity in the workplace. Indeed, in a recent RAND corporation study, [4] some companies have found that when they recruit internationally, they get employees they can send anywhere in the world; when they recruit North Americans, they are to work in the U. S. only! The characteristics sought by several firms interviewed in the study included:

- Domain knowledge... the knowledge in a specific area; US graduates are strong in this area,
- Cognitive, social and personal skills...such as flexibility and adaptability, openness to new ideas; US graduates fare poorly here, as there is little focus during their education on these areas.
- Prior work experience and on-job experience (OJT).. this varies among institutions. Many international institutions incorporate work experience into their curricula.
- Cross-cultural competence. ..this is lacking in many US graduates, even those who have participated in study-abroad programs, due to lack of language competence and the tendency for short-term study abroad experiences that do not emphasize cultural integration.

In summary, the design team of the future requires skills that US degree programs are not producing.



## **ROLE OF EDUCATIONAL INSTITUTIONS**

The traditional educational paradigm is outmoded. In this methodology, students receive their education in discrete packets, in a strictly academic environment. Projects, if any, are quite limited in scope; this is a necessity with quarter or semester-based classes, where grades must be assessed at fixed intervals. Interaction between the campus and others is limited or non-existent. "People skills", e.g. group dynamics, speech, writing and adaptation to cultural variations may not have much emphasis in the conventional model. Graduates from traditional programs will struggle to fit into the AD2010 company design team model, as described above. The need for change is evident. What is lacking are new and creative ideas for providing students with the revised educational experiences that are relevant to their future careers.

To have their curricula remain relevant, change is needed by educational institutions. In one study, the *ASEE Project: Changes In Engineering Education [5]*, included action items, especially Action Item 4, similar to those discussed in this paper. Change in major concepts include:

- an appreciation of different cultures and business practices
- the understanding that the practice of engineering is now global
- the need for an increased focus on projects, and
- a formal inclusion of internships as a part of the curriculum.

Students are also aware of the changes, and a growing number are finding foreign opportunities for study. For instance, in a recent article in ASEE Prism [5], the numbers of students studying abroad has increased 50% from 1985/6 to 1991/2. Some of these are in engineering and engineering related areas; most are still liberal arts majors.

■ To prepare the next generation of Oregon's leaders to cope with economic competition and cooperation on a global scale by combining the study of other countries and cultures with the practical knowledge gained from an experience in an overseas work environment.

To improve Oregon's competitiveness in an increasingly global economy by providing internationally skilled job candidates.

■ To build mutually beneficial partnerships among OSSHE institutions and internationally-oriented businesses, agencies and organizations in Oregon and abroad.

■ To further the understanding between Oregonians and their international counterparts on global issues such as economic development, the environment, public health, energy, democratic government, science and technology.

Figure One: Goals of Global Graduates: The Oregon International Internship Program

# THE OIIP INITIATIVE-A POSSIBLE SOLUTION

Global Graduates: the Oregon International Internship Program (OIIP) [6], is a new program being implemented by the Oregon State System of Higher Education (OSSHE). The primary OIIP goals are shown in Figure 1. This program will form partnerships between Oregon educational institutions and companies and organizations that operate on a global scale. These partnerships will enable students to integrate an internship opportunity into their degree programs.

This new program will follow different formats for the various college curricula and company environments. In general, a student will study the language and culture first; have an in-country orientation program; participate in an internship experience of 3-6 months; and, return to the home campus to complete studies and report on

 Oregon State University University of Oregon Portland State University Oregon Institute of Technology Southern Oregon State College Eastern Oregon State College Western Oregon State College

Figure 2: Participating Universities

experiences to other students. The preferred model will connect the students to an Oregon-based company involved overseas before they depart and involve them with that company after they return. It is expected that many internship students, upon graduation, will continue employment with the companies involved as partners in the internships.

Through a federal grant, the OIIP will provide the initial students with need-based grants and/or loans to assist with the additional internship costs. Also, many of the partner companies will compensate the students for their work. The companies with which partnerships are being formed include all the major international and global enterprises in Oregon and several in other states. Initial responses from engineering related firms have been positive because these prospective employers have been forced to import talent

due to a supply and demand imbalance within the state. The educational institutions involved with implementing the OIIP include all seven campuses of the Oregon State System of Higher Education, see Figure 2. The policies and procedures for the OIIP are being developed through inter-institutional committees within OSSHE and through a statewide Advisory Board with representation from all major constituencies. Each interested student will apply for an internship and related funding support through a system-wide process. The application will be matched to an internship opportunity from a central data bank compiled by pooling knowledge and contacts from throughout the State System and from its internship partners, here and abroad. Some internships will have language pre-requisites to apply; others will require intensive language study after acceptance; and others will operate in an English language environment. Each internship application will be reviewed in advance at the departmental level in regard to appropriate academic credit. The process of creating the data bank of internships will include collecting sufficient information to estimate the quality of the experience as well as the skill level required, and the language and cultural sophistication needed. This, combined with the scope and type of project planned and completed, will allow evaluation and then credit to be awarded in both the design component and the cultural studies component. For most students, a presentation will be scheduled upon return to the home campus, both to pass along the knowledge acquired and to assist in evaluation of the results. The goal is to provide a worthwhile experience from the student, university and prospective employer perspective.



Key to the program's success is development of internship sites. Initially, personal contacts between alumni, faculty and students will account for most of the opportunities. As time progresses, (particularly if the program : succeeds,) publicity will create additional opportunities. Also, as experience with the OIIP grows, some of the procedures for application may become streamlined. Companies may have continued participation in the program, with pre-conceived ideas for projects they are willing to support. This facilitate finding an appropriate project for a given student's abilities. The OIIP staff will be actively involved in developing as well as coordinating internships. They will promote contacts wherever possible and will gain experience with the different companies and settings, allowing better placements to be made.

## BENEFITS ALL AROUND...STUDENTS, COMPANIES AND EDUCATIONAL INSTITUTIONS

The OIIP appears to be that rarest of ideas, one which benefits all involved.

Among the principal benefits to students is a relevant design experience with a commercial enterprise. This experience allows the student to put their studies in perspective, and provides a basis for the final year of studies at the home institution. It is very important that this experience be actual company experience, not just an academic one, in order for it to be truly relevant. Finally, key to the goal of the OIIP, is that the experience be international in scope. Becoming comfortable in another culture and with the people of that culture is key to being able to work on a mixed culture team, likely to be the norm in the future.

There are benefits from the company point of view as well. Aside from the obvious fact that the students will accomplish meaningful work on a project for the company during their internships, there is the less obvious benefit from having firsthand experience with the potential employee, leading to a possible long-term employment relationship. Also, they will benefit from the new ideas the students come with, and will have increased access to research areas of colleges. Finally, due to the international flavor of the exchange, there will be in increased push toward unified standards, for instance in the electrical arena.

Educational institutions stand to benefit the most of all. As described above, a pressing problem they all face is keeping programs relevant to industrial practice. The feedback of OIIP participants will, if considered and selectively adopted, result in changes to the curriculum, placing it more in line with the needs and practices of industry. When accomplished, this upgrading of curriculum will result in improved placement of graduates, with all the benefits that implies.

From the faculty point of view, there are opportunities for exchanges and joint research projects. Another possible benefit involves the Americanization of the curriculum and language. In many developing countries, the lack of a internationally-recognized language hinders growth. Most turn to English (really American) as a common language. Exchanges between institutions, both student and faculty, encourage this trend. Benefits are the increased mobility and increased opportunity for shared curriculum ideas and methods.



#### BUT, THERE ARE POTENTIAL PROBLEMS

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As with any new concept or program, it is anticipated that there will be problems. Careful selection of students to participate in this program, especially at the outset, will minimize these problems. First and foremost, there are the problems associated with the language of the international country. Also, there is the adjustment to cultural differences. As with learning experiences of most types, overcoming the problem will be beneficial for all concerned. Also, after several students have returned, passing along information and experiences, the process will be improved and the problems better understood.

There will be the predictable administrative problems, including how to assess fees and tuition, what sort of credit to give for the foreign studies aspect of the program, and what sort of credit for work experience. The nature of the OIIP is to be flexible in these areas, allowing the different colleges and schools to set their own standards. As time moves along, there will be guidelines established to help others join the program. Another difficult area will be visas and work permissions. These requirements vary greatly around the world and are often complex, just as they are in the U. S. for any international interns.

One area of possible conflict lies in the overall schedule of classes. Ordinarily, students take classes in a certain sequence, with some prerequisites for following classes. For efficiency's sake, classes are often taught only one term per year. In the environment of the 90's, becoming "out of phase" makes a student's life difficult from many aspects. This conflicts with some internship programs if they are only a part of the academic year. With students spending part of their educational experience with another institution, there is a need for classes taught in a variety of sequences. One innovative approach is Worcester Polytechnic Institute, whose curriculum was restructured to five seven-week terms in the 1970's to better accommodate project work. This restructuring has proven to be helpful to overseas projects as well. Other colleges may need to innovate to allow internship-based education to proceed.

## SUMMARY

As we look to the 21st century, it is becoming obvious that our traditional programs for preparing engineers are increasingly out of touch with the realities of the global marketplace. Throughout the U. S., fundamental changes in degree requirements are being debated and many innovative programs are being implemented. This article is based on the assumption that these changes must reflect the global environment that is becoming the standard framework within which the engineer of the future will function. Unless present programs are modified to include an international dimension, graduates will not have the preparation required to work with colleagues from diverse cultural backgrounds and to benefit from the opportunities available to those who have included an international internship in their degree studies.

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## **BIOGRAPHICAL INFORMATION**

## **RICHARD A. KING--**

Richard King is a Professor in the Computer Systems Engineering Technology Department at Oregon Institute of Technology. He joined OIT in 1982, following a twenty-five year career in industry, where he worked as a design and project engineer for Hughes Aircraft Company, Litton Mellonics, and Pro-Log Corporation. His formal education includes degrees from UCLA (BS Engineering, 1958) and USC (MSEE, 1968). He is married, with three grown sons. His hobbies include tennis and restoration of elderly British sports cars.

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Jack Van de Water is Associate Vice Chancellor for International Education in the Oregon State System of Higher Education, and Dean of International Programs at Oregon State University. In addition to overseeing foreign study programs, his responsibilities currently include administrating a \$4,000,000 federal grant to develop overseas internships for Oregon students. Before coming to Oregon in 1976 to work with the Oregon State System and with OSU, he completed a master's degree in International Relations and a Ph.D. in Comparative Education at Syracuse University, and then worked in international programs at Syracuse for eight years. Jack is married with three grown children.

