Conclusion

It has been said that the greatest teachers always point beyond themselves. This is what separates teaching from other professions—the hope and expectation that our students will surpass our own achievements. This standard might be best exemplified by J. J. Thomson, the Nobel Prize–winning physicist credited with discovering the electron. Eighty years ago, the model of the atom he developed (commonly known as the "plum pudding" model) was displaced by the nuclear model developed by his former student, Ernest Rutherford. (In total, seven of Thomson's students, including Rutherford, received the Nobel Prize—an amazing legacy by any criterion.)

Today's science and engineering graduates face a challenge of a different dimension—pursuing intellectual and professional horizons that surpass the conventions known for generations. For the individuals, institutions, and government agencies that shape policies for graduate education and research, this requires changing and updating many long-standing practices. The three points we outlined—reinvigorating the teaching and learning mission of higher education, fostering a more strategic link between research funding and graduate education, and recognizing the changed career paths awaiting future scientists and engineers—provide touchstones for progress in this time of change. By embracing these new directions while preserving its fundamental strengths, the academic enterprise, working in partnership with government and industry, should have no trouble producing the finest scientists and engineers for the 21st century.

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European Union: Fresh Tracks for Academic Exchanges

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Cooperation in higher education and training among the member countries of the European Union (EU) (*1*) is to be restructured. Since the mid-1980s, it has been typified by several international mobility programs. These are now to be consolidated in two new programs, SOCRATES and LEONARDO DA VINCI, corresponding broadly to education and vocational training, respectively. The move seeks to rationalize and develop EU activity in both areas. SOCRATES, additionally, will put education at all levels onto the Community map with, for the first time, substantial scope for cooperation among schools. Both programs are currently scheduled for adoption by early 1995 and will cover the European Economic Area (EEA) including Austria, Finland, Iceland, Norway, and Sweden, in addition to the present 12 EU member countries.

The various current programs are administered by the European Commission in Brussels. But their real visibility and impact are at the grass-roots where EU money is used by many thousands across the Community to breathe life into the notion of European union through cooperation within multilateral transnational networks. Three of the programs, ERASMUS (the European Community Action Scheme for the Mobility of University Students), COMETT (the Community Action Programme for Education and Training for Technology) and LINGUA [the European Community (EC) program to promote knowledge of foreign languages in the Community] all involve higher education, and ERASMUS exclusively so (*2*). Several others address different aspects of vocational training.

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Roots of Exchange

Historically, the present programs are the by-product of a perceptible shift in the bearings of the European Economic Community set up by the 1957 Treaty of Rome. From within its economic focus has grown a political awareness that a closer union among the peoples of Europe can be interpreted broadly. However, this interpretation is circumscribed, not least of all in education and training, where cooperation, not harmonization or uniformity, has been the keynote. The present cooperation programs have only a modest budget, which has never reached 1% of overall EC spending.

It was recognized that if the EC were to consolidate its credibility as an international trading partner, it needed to be competitive and display cohesion, generating the benefits of healthy economic peformance across all regions and sectors. This policy vision pointed to the need for advanced training of Community students in more than one EC country, together with the transnational pooling of the intellectual resources in higher education and the skills of business and industry. Cohesion called for balanced cooperation, sectorally as well as geographically. Above all, mobility had to be on a scale sufficient for its effects to have an impact.

Launched in 1987 to pursue cooperation within higher education, ERASMUS was (retrospectively) the culmination of many years of discussion, political negotiation, and testing. It was built initially on a small Community-wide network of almost 600 university student and staff exchanges as part of a program initiated by member country education ministers in 1976.

Current Levels of Exchange

Estimates of student mobility in Europe are still far from standardized, with several countries including part-time students. In 1986 the European Commission concluded that fewer than 1 Community student in 100 was enrolled at a university in another EC member state (*3*). Often these included the children of EC citizens living abroad, or students on nationally funded exchange schemes. The Commission sought to boost this small proportion to around 10% of the total EC student population from 1992 onward. In 1987, this amounted to 150,000 students annually, out of a total EC student population of some 6 million for whom university studies lasted around 4 years on average. But in adopting ERASMUS, the Council of Ministers cut the Commission's

3-year budget proposal by more than half and excluded any reference to the 10% mobility target.

The key instrument in pursuing the significant increase in student mobility requested by the Council has been a European university network of multilateral inter-university cooperation programs (ICPs) voluntarily negotiated by faculty. Support goes, first, to universities and colleges to develop the infrastructure needed to send large numbers of students abroad regularly for up to a year. In the 1994–1995 academic year, this amounted to ECU (European Community Unit) 20.45 million (just under 20%) of the total budget of around ECU 105.1 million ($128.3 million). Well over half of the budget since 1990–1991 (ECU 77.3 million in 1994–1995) has been in the form of nationally administered grants to students to help them meet travel costs and the additional costs of foreign study.

The student mobility achieved must take account of the geopolitical expansion of ERASMUS to cover (in addition to the 12 EU member states) the five new Länder (states) of reunified Germany from 1991–1992, and the seven countries of the European Free Trade Association (EFTA) from 1992–1993. Since 1990–1991, identical administrative structures have also been the basis for ICPs supported under LINGUA. In 1994–1995, over 137,000 students are eligible for ICP exchanges, as compared with around 3000 in 1987–1988. If all were to benefit from foreign study over the course of a 4-year degree, 5.3% of the entire EU plus EFTA student population of some 10,417,000 would experience some time abroad. In reality, the actual rate of exchange in the years up to 1991–1992 (the latest period for which accurate mobility figures are available) stood at around two-thirds on average of the eligible students. In all, over 200,000 students are estimated to have benefited from the exchanges.

Figures on graduate participation helpful for comparative purposes are elusive because of the different structures of postgraduate study across the Community. Taking four years as a rough undergraduate-graduate dividing line, a large minority (44%) in a 3200-strong sample of 1988–1989 ERASMUS students had completed at least 3 years of study when they began their courses abroad (*4*). Academic research unrelated to degree study is excluded from ERASMUS, reflecting a distinction, in EU funding mechanisms, between research and the higher education and training programs. Since 1984, the Community has nevertheless supported exchanges of thousands of postdoctoral and predoctoral researchers under its framework programs for research and technological development. In a human capital and mobility program within this framework, 1755 research fellows, around 75% of them postdoctoral, were exchanged from 1992 to 1994. Less easy to estimate is the amount of intra-EU funding for postgraduates supported by major national student exchange agencies in the EU member countries, which do not necessarily distinguish EC grantholders from others, or between undergraduates and postgraduates in their statistical records.

ERASMUS has also provided for the transnational exchange of university professors and lecturers for teaching purposes. In 1994–1995, up to 10,600 staff are expected to contribute to the teaching activities of partner establishments in EU countries, and around 15,000 are estimated to have done so altogether.

For ERASMUS students, the free movement of persons of the 1987 Single European Act, implying the right to live and work, rather than simply travel elsewhere, has been reinforced by the systematic recognition of study abroad. Patterns of recognition freely negotiated among the universities involved have included joint degree programs, or double or multiple degrees or diplomas. In the search for a more comprehensive yet voluntarily based mechanism, ERASMUS has also supported an experiment for an EC credit transfer system, in five subjects (business administration, chemistry, history, medicine, and mechanical engineering) involving 145 higher education institutions.

A related program, COMETT, launched in 1987, is aimed at bringing together higher education and industry in training partnerships to help them identify needs, improve the quality of training, and perfect the practical applications of technology. There is special emphasis on new or advanced technologies and on small and medium-sized firms (less than 500 employees) to facilitate technology transfer for their benefit. In 1993–1994, there were 205 partnerships involving 3500 firms (70% of them small or medium-sized) and 1500 higher education institutions. Since 1990, these networks have resulted in 24,000 in-company training courses for students, and approximately 800 exchanges of university and industrial staff. One example is the Euskal-Herria partnership in the Basque country. This network has updated training and facilitated retraining for hundreds of underskilled people, giving many of them new jobs and improving the economic and social prospects of a threatened community.

Cooperation has had to contend with the wide variety of languages spoken in Europe and the concern that European integration should not be achieved at the expense of the cultural identity of the EC member countries. Communication in the lesser used Community languages sometimes associated with peripheral or poorer regions is actively sustained and encouraged by the LINGUA program. And in ERASMUS, preparatory tuition in the appropriate foreign language is widespread as a mandatory element alongside the principal specialization of students going abroad. Host universities have also laid on regular, intensive, or follow-up courses for these students, or arranged for them to do subject-related practical placements in business or industry.

Restructuring

As far as higher education is concerned, the practical upshot of the proposed restructuring of the cooperation programs is the consolidation of the best of ERASMUS and most of LINGUA in SOCRATES, alongside a whole new range of transnational projects for schools. The benefits of COMETT are to be further developed in LEONARDO, as are those of vocational training programs. Exchanges partially involving university research will continue within a fourth framework program (1994–1998) with a budget of ECU 12 billion.

The planned changes follow substantial discussion in the Community-level institutions and in the member countries about the experience and evaluation of all the present initiatives. The conviction that EU cooperation in education and vocational training should be more sharply targeted has had its strongest formal endorsement in the 1993 Treaty of Maastricht on European Union. Provision in the Treaty of the consecutive Articles 126 and 127 devoted to each of these fields in turn suggests that cooperation in each requires its own self-contained program. In a January 1991 resolution, the European Parliament regretted the fragmentation of higher education programs and education and research programs with virtually identical target groups, citing as examples postgraduates in ERASMUS and young researchers in COMETT.

All the current programs have been subject to ongoing evaluation since they began, and the findings are reflected in the restructuring. An external evaluation of ERASMUS from 1991 to 1993 concluded that it had achieved its central aim of boosting student mobility within the EC, pointing out that its effect had been "additional," rather than substituting for the traditional mobility groups whose strength was also increasing (*5*). Development of study abroad with full academic recognition will thus remain a priority in SOCRATES and be linked, where appropriate, to the continued expansion on a voluntary basis of credit transfers. However, the review also found that ERASMUS had not sufficiently consolidated the potential for full institutional commitment to cooperation. Although it

has helped attune the internal administrative structures of many universities and colleges to a more international outlook, ERASMUS has arguably been over-dependent on the outstanding contribution of individual academics keen to develop their own faculty exchanges. A related inference is that a faculty-based network of now over 2500 partnerships may have become a cumbersome administrative basis for EU funding.

The SOCRATES proposal stipulates that universities and colleges will be able to conclude an institutional contract with the European Commission covering not just single projects (like specific partnerships), but a whole range of "European dimension" activities eligible for financial assistance. Among them are curricula that not only enhance awareness and understanding of other member states, as well as aspects of European integration, but maintain the thrust of LINGUA by boosting the learning of Community languages as an integral part of studies. Further assistance may also be granted to transnational groups of universities to develop jointly such activities in collaboration, where appropriate, with regional bodies and local representatives of the business and political community. The notion of a "European dimension" has already been the subject of several EC resolutions emphasizing the need to bring Europe closer to the classroom of the nonmobile majority of students in higher education.

Wide-ranging consultations were also initiated by the Commission in the EC member countries while the Maastricht Treaty was awaiting ratification. Their purpose was to gauge opinion on the future of higher education among all those with a professional interest. The principal vehicle for this initiative was the circulation in 1991 of a *Memorandum on Higher Education in the European Community*, a discussion document with no policy recommendations attached (6). Respondents said that open and distance education (7) should be extended to complement traditional teaching methods in most higher education institutions. The reaction is part of the increasing importance attached to this kind of provision to broaden access to higher education and upgrade the skill of an aging work force over the span of professional activity. SOCRATES envisages financial assistance to universities and colleges to develop curricula incorporating material delivered in this way.

In one key area, the impact of ERASMUS remains unknown. While the opinions, on the whole very favorable, of the students have been surveyed, there are no scientifically analyzed data from those who subsequently employed them to indicate whether they were an asset to business and European competitiveness in the pre-1992 period. The recent Commission verdict on that period is that the economic growth that occurred was unable to halt a longer term decline in the Community's relative position in international trading markets or create enough jobs (8). The effect of the priority emphasis in SOCRATES on quality education as a possible contribution to reversing this trend must remain a matter for future judgment.

European mobility schemes are also acquiring a wider international dimension, not only as a repercussion of the fall of the Berlin Wall. On 21 September 1994, at the initiative of Commissioner Antonio Ruberti, the European Commission decided to forward a draft negotiating brief to the Council of Ministers with the aim of reaching cooperation agreements between the EU, the United States, and Canada in higher education and vocational training. Activities would be geared to encouraging interaction between higher education establishments, training bodies, and the business world in the countries concerned. The agreements to be negotiated would be based on experience recently acquired during an exploratory phase of cooperation with the United States involving support to 23 consortia projects that have directly mobilized some 200 EU and U.S. universities and colleges, with a good regional spread on both sides of the Atlantic. The projects have covered areas like the environment, microbiology, international marketing for small and medium-sized firms, and development of a postgraduate program for the study of higher education, and have included student and teaching staff mobility, in-service training in firms, joint curriculum development, and the development of mechanisms for credit transfers. In tabling its latest proposals, the Commission is responding to the determination of the parties in the Trans-Atlantic Declaration of November 1990 to develop cooperation in this area. Trans-Atlantic cooperation in higher education may thus be on the threshold of a major breakthrough.

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