Leonardo da Vinci Programme

Engineering Education in the Non-university Sector

Austria, Denmark, Germany, Netherlands, Portugal and United Kingdom

ARTHUR SCHNEEBERGER (ED.)

With contributions of

RUUD VAN DER AA, BIRGIT BAUER, ERIC JENSEN, BERND KASTENHUBER, AUGUSTO G. MEDINA, FERNANDA OLIVEIRA, WOLFRAM PFEIFFER, MARCUS POWELL AND OTHERS

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A-1050 Wien, Rainergasse 38/2. Stock
Tel.: (+431) 545 16 71 - 0
Fax.: (+431) 545 16 71 - 22
E-mail: info@ibw.at
http://www.ibw.at/

Foreword

This research paper was produced within the ENGENUS-Project in the framework of the Leonardo da Vinci programme of the European Union. The Main Contractor of the ENGENUS-project was the Institute for Research on Qualification and Training of the Austrian Economy. The co-ordinating function has been at Arthur Schneeberger and Bernd Kastenhuber.

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The working period lasted from December 1997 to April of the year 2000. Four workshops were held, interim reports were written and empirical investigations were carried out. The report in hand is one of the main results of the work. Additionally six comprehensive papers about the participating countries were produced and are available.

The synthesis paper of the six country reports has been written and compiled by Arthur Schneeberger. On the one hand it is broadly based on the country reports, on the other hand it contains additional information and research work.

All partners wrote country reports. These papers include information concerning the educational pathways for engineering and their connections to the economies and the labour markets. The authorship of the country reports is at the experts of the contributing institutes (see "Participating institutions and experts").

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INTRODUCTION

Better understanding of engineering education as a prerequisite of student and graduate mobility in Europe

The main purpose of this project and the main motive of its participants in the six countries was to make a *contribution to a better understanding of engineering education in the non-university sector (NUS)* in Europe. The context of European engineering education is characterised by very different cultural traditions on the one hand, and, on the other, common challenges of a coming technology- and knowledge-based society and economy in a growing global competition, which requires a high degree of mobility from students and graduates.

The work has involved complex analyses, discussions and reflections of the different routes and pathways, diplomas and certificates for engineering education in the non-university sector in the six member countries of the European project. The countries participating in the project in many respects have significantly varying types of educational systems and developments shaped by different cultures. From Portugal to Denmark, from Germany to the United Kingdom, from Austria to the Netherlands there exists a wide range of institutional arrangements for engineering education outside traditional university-education routes.

The six countries are examples of typical institutional solutions of engineering education and the variety of educational systems in the European Union. The work invested in the project by the experts involved has produced not only extensive country reports but also a Synthesis Report, which demonstrates that – in spite of cultural differences – common results and far-reaching understanding have been acquired by exchanging and discussing previously prepared working papers at four workshops.

In the first phase of the project, existing publications and systematic approaches for comparing educational systems in general and engineering education in particular were used. Especially the respective European guidelines (the first and second general guideline, and the architectural guideline) were discussed in great detail with transparency of qualifications in mind. The International Standard Classification of Education (ISCED) from the UNESCO (1976, 1997) has been reflected and used in papers and discussed in the workshops.

This general and formal information can be a helpful first clue for persons intending mobility as students or graduates in Europe, but there remain needs for substantial information about the specific systems of engineering education. A deeper insight into the systems is necessary because the existing informational sources rely mainly on formal definitions.

A recent European study indicates that in Europe mobility is significantly higher among technicians and engineering professionals than in other fields.[1] Due to different labour market situations there is a considerable mobility in occupations related to technology and its applications; this will strengthen the wealth of the European Union as a whole. Mobility of highly skilled people (of some months or even some years) during the professional career could become quite common if the intercultural language skills required for mobility are acquired early enough.

Why did we choose the non-university sector of engineering education?

Whereas in most countries the old university-based education routes have a long tradition of international scholars' or students' exchange, the alternatives to old university education in higher education institutions which have emerged over the last two or three decades are not as well-known and transparent to interested management responsible for recruiting foreign young persons in mul-

[1] Melanie Kiehl / Heinz Werner: Die Arbeitsmarktsituation von EU-Bürgern und Angehörigen von Drittstaaten in der EU, September 1997.

tinational active enterprises. When we speak about alternatives to old universities we are thinking for instance of the British Higher Education Colleges, the Portuguese Polytechnics, the Dutch Higher Professional Education, the German Fachhochschulen, or the Danish Short or Medium Cycle Higher Education.

The above-mentioned lack of the NUS of being known internationally may be noticed also in the various fields of engineering education. This is true although a major part of the new qualifications is actually obtained at Fachhochschulen, Polytechnics or similar institutions. The basic purpose of this survey and the main motivation for the analysis is to make this more visible in Europe.

Diversification of higher education is one of the most effective institutional means of improving wide social access to advanced-level qualifications and professions. The alternatives to old university-education routes are usually far better accessible to young people with vocational education and training backgrounds. To strengthen this advantage of both the society and the economy at the European level and to include far more than traditional academic students and scholars in mobility programmes we need better information regarding the non-university sector of tertiary education (NUS) in the first place.

In most countries employment of higher education graduates cannot be absorbed by the publicly financed employment sectors as it was done in the past. There exists broad empirical evidence[2] that engineering education – more than many other subject categories of studies – opens up growing chances of employment in the private sector. That is why we have focussed on engineering education.

Social inclusion into higher education is going on. Skill needs of technology-based manufacturing and service industries cannot be met just by multiplication of traditional higher education. Alternatives to old university-education at post-

[2] See: OECD: From Higher Education to Employment. Synthesis Report, Paris, 1993, p. 112ff.

secondary level are powerful instruments of social cohesion and economic forces as well. Underemployment and skill inflation on the one hand and a shortage of skills in business and technology-related fields on the other would be the consequence.

The ongoing extension of post-secondary educational system means that they will have absorb an "even wider range of students and much greater diversification must be envisaged”[3]. Questions of institutional delivery arise. Most European mainland countries provide state-run higher education in all routes. In the United Kingdom the market forces have much more weight for institutional performance. But anyway: questions of quality assurance and funding are of growing importance everywhere, as we shall see in the country reports.

Education-industry links are another relevant issue in engineering education. Not surprisingly nearly all teaching staff at non-university establishments of advanced level engineering education usually claim for themselves the right to carry out applied research work, mostly as joint venture with regional industries, and to fulfil various consulting functions. And that is why strict demarcation lines between Polytechnics and Universities can get more or less blurred.

Especially in the field of engineering studies there is a strong need for educational institutions at a higher level to keep in touch with the economy and relevant technology in various forms. These contacts range from part-time employment or experience of students and teaching staff to consulting functions in joint applied research projects. There are also various ways of, and tendencies towards, project-oriented co-operations with enterprises and even between Polytechnics or Fachhochschulen and (old) universities in technological fields. The country reports provide good examples of education-industry links as models for an international pool of ideas for engineering education.

[3] OECD: From Higher Education to Employment. Synthesis Report, Paris, 1993, p. 144.

What do the results worked out by the experts of the participating institutes contain and offer?

In the two years of the project work the first year was devoted to the use of official statistical data, research documents and published studies to analyse the situation of engineering education in the NUS in each country. In the second year own investigations by means of questionnaires or interviews were carried out to round up the picture and to collect further information. Workshops were held in *Vienna* (start-up), *Porto* (first drafts and discussions), *Rotterdam* (presentations of investigations) and *Leicester* (discussion of reports and of conclusions).

The reports for the six European countries provide far-reaching information about the national systems of engineering education in the NUS (or outside old universities as we have to say regarding the United Kingdom). The country reports which were prepared for and discussed at the workshops contain not only structural information about study programmes based on existing publications and sources, but also a lot of information produced by original explorative research work. Thus, the country reports should work as important information sources and contributions to educational information, guidance and research at national and at international levels.

The country reports contain the following sections adjusted to the special situations of the countries:

- Introduction and brief summary
- Social construction of the non-university sector: historical review
- Educational pathways in the field of engineering
- Institutions and programmes in higher professional education
- Mechanisms of delivery and quality assurance
- Employment and labour market of graduates
- References
- Appendices

The country reports provide detailed background information. Traditional roots as well as significant changes and improvements in the systems in the nineties are described. The acceptance of engineering education courses and programmes in the labour markets as well as examples of education-industry links are among the main topics.

The country reports have been produced in a multi-step procedure. Drafts, intermediate reports and final reports have circulated among the co-operating experts and have been presented in the workshops. Additional research has been carried out on the basis of these discussions and was integrated in the final reports. The authors from the various countries aimed at a thorough description of the engineering education routes in each country, detailed analyses on the basis of available data and own research. As a result of these efforts, volumes of 40 pages or more have been produced in each case.

All country reports contain not only common English translations of educational institutions but also their original terms in the respective countries' languages.

The final reports are available via the partners by postal delivery (for contact addresses see the Annex at the end of the Synthesis Report).

Comprehensive information about engineering education in the six countries is provided by the present *Synthesis Report* of the project, written and compiled by the main contractor. This paper is based mainly on contributions by the authors of the country reports, partly some additional research work had to be done. The Synthesis Report contains the project's objectives and purposes, condensed descriptions of engineering education in each county, the main results and conclusions. The paper at hand is intended to function as a first guide to engineering education in the participating European countries, whereas the country reports provide more detailed background information, broader empirical evidence and references, and some discussions on future issues for the countries.

The Synthesis Report describes the main features of engineering education mainly besides the (old) universities at the tertiary level of the educational systems (partly also below tertiary level at upper secondary level of the educational systems). Most of the conclusions and recommendations were acquired at the workshops of the LEONARDO-Project. All the partners have written short or condensed papers in addition to the long versions of the country reports. These papers have been integrated into the Synthesis Report as much as possible.

The potential users of the project products

The produced reports contain information that is useful for the various actors and organisations, especially the below mentioned ones:

- mobile students and employees,
- co-operating educational institutions,
- exchange agencies,
- educational policy makers,
- employers (personnel or human resources departments),
- human resources consultants,
- labour market services,
- educational guidance organisations,
- researchers.

Defining the subject of the project in various national systemic contexts as an approach to the project's main topic

When starting this project on engineering education in the non-university sector (NUS) there seemed to be a very clear conception of the NUS. But this is only true from a continental point of view. As the binary system was abandoned in the United Kingdom at the beginning of the nineties things look differently from the British point of view.

Already at the first workshop (Vienna 1998) the definition of the project's subject had to be adjusted to a more complex concept, especially due to the participation of the United Kingdom with its *formally unified system of higher education*. The binary system and with it the Polytechnics were abandoned in 1992.[4] This does not mean at all that there have not remained substantial institutional differences of higher education provision, but not in the institutionalised sense of

[4] See: John Pratt: The Polytechnic Experiment: 1965 – 1992, Open University Press, Buckingham, 1997.

the older, clear-cut binary system.[5] At the end of the first workshop the topic of the project was redefined as, i.e. extended to, *Engineering education in the non-university sector or outside old university-education routes* to include all relevant routes and pathways in the participating countries.

The United Kingdom is characterised by a formally unified system of higher education whereas all the other five countries participating in the ENGENUS-Project have institutionalised technical and vocationally-oriented educational institutions as alternatives to the (old) universities and have maintained them. The United Kingdom have reformed their Polytechnics to (new) universities. In addition the United Kingdom has a very unique tradition of engineering education regarding the role of the respective professional associations, which are in control of standards and the access to the process of becoming a registered engineer. And it is only by means of this registration that a professional status comparable to a German Diplomingenieur or similar graduations is obtained, which on the European continent are awarded by universities, Fachhochschulen or similar institutions.

From the six countries participating in the ENGENUS-project, five have established more or less clear-cut "binary systems” of engineering education consisting of (old) universities on the one hand and younger higher education institutions (Fachhochschulen, etc.) on the other. These new forms of higher education where established for the purpose of either easing the burden of traditional universities caused by the rapid expansion of higher education enrolment since the sixties or seventies or of extending the occupational possibilities of graduates by horizontal and vertical diversification of post-secondary courses.

[5] To the new informal differentiation see: Patrick Ainley: ‘The end of expansion and the consolidation of differentiation in English higher education’, in: Teaching in Higher Education, Vol. 3, No. 2.

TABLE I-1.

Main subjects of the ENGENUS-Project in the participating countries

COUNTRY	Institution (degree, title)	Institution (degree, title)
AUSTRIA	*Fachhochschule (Diplomingenieur, FH)*	*5-years Secondary College for Engineering (Ingenieur*, Diplom-HTL-Ingenieur*)*
DENMARK	*Medium Cycle higher education (ingenie∅r hojsk∅le)*	*Short Cycle higher education (technisk skole)*
GERMANY	*Fachhochschule (Diplomingenier [FH])* *Berufsakademie (Diplomingenier, BA)*	Technikerschule (Staatlich geprüfter Techniker)
NETHER-LANDS	*HBO (Hogescholen, Higher Professional Education / HPO)* *(Ingenieur, ing.)*	MBO, Secondary vocational education
PORTUGAL	*Polytechnics (Bacharelato)*	Technical Programmes
UNITED KINGDOM	*Universities; HE College (I.Eng.**)*	*Higher Education College (I.Eng.**; I.Tech.)*

*These professional titles are awarded by the Federal Ministry of Economic Affairs.

**This title is awarded by the respective professional associations and not by colleges or universities; the UK differs from continental European countries in this respect.

Source: EU-Project/Leonardo da Vinci: ENGENUS

The German Fachhochschulen, the Dutch professional Hogescholen outside universities, the Danish Short and Medium Cycle Post-secondary Programmes, the Portuguese Polytechnic Education and the newly established Austrian Fachhochschulen (since 1994) can be seen as examples of a horizontal diversification of higher education. They all play an important role in the provision of engineering education in each country. In contrast to the old university-education routes all these institutions are more oriented towards the private economy and vocational and technical concepts of higher education which broaden the range of skills and occupational opportunities for higher education students as a whole.

The forces of the so-called "academic drift” are not only effective in the United Kingdom. When we look at post-secondary engineering education, we notice that the claim for applied research by the teaching staff is very common in most countries. Another example for the limits of the strict demarcation between Polytechnics and old universities at international level can be seen in the recommendation of the German Standing Conference of Rectors and Presidents of Universities and other Higher Education Institutions given to Fachhochschulen in 1998 to call themselves "Universities of Applied Sciences” in international communications[6]. This recommendation should make communications easier and give the right institutional level to Fachhochschulen; it is based on comparison to 4-year colleges in the United States.

The Austrian partner took the role of the main contractor. Austria’s engineering education provision has – or, at least, had until the 90s – an exceptional structure in comparison to most European countries: Until 1994 the main alternative to the outstanding long-term studies at universities (7 to 8 years on average for engineering subjects) had been the Secondary College for Engineering (Höhere Technische Lehranstalt, HTL). In the employment system its graduates have been fulfilling specialist functions or functions in the middle management which,

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[6] See: Deutsche Hochschulrektorenkonferenz: 83. Sitzung des Senats am 20.1. 1998; Top 9 "Name der Fachhochschule im Ausland".

in other countries, are fulfilled by graduates from short tertiary programmes. The colleges have a duration of 5 years at upper secondary educational level and are quite challenging and selective.

With the setting up of Fachhochschulen in 1994, which was based on a broad political consensus, the institutional configuration has changed. One of the motivations of the project's main contractor was to explore non-university engineering education programmes in other European countries, some of which have already considerable experience with this institutional process of diversification.

In spite of common structural problems and challenges due to the growing influx of students and changing employment structures for graduates, quite different institutional "solutions" evolved. The country reports will be able to demonstrate this by enhancing transparency of educational routes and pathways and engineering qualifications and the respective professional titles or status. The Synthesis Report as well as the six comprehensive country reports are contributions to a better understanding of engineering education and to improving educational mobility outside traditional academic educational routes as well.

Routes of Engineering Education in the United Kingdom

Marcus Powell

The routes to becoming an engineer in the United Kingdom are structured in a different way to those in other European countries. In part this reflects the educational reforms that have occurred to the country's education and training system over the past decade. The structure of these routes is also heavily influenced by the country's professional engineering bodies.

Pathways to professional engineering status

As in other European countries, the process of becoming a professional engineer in the UK involves not only academic qualifications, but also appropriate work-based experience. Within this section we look at the specific process involved in registering for *professional engineering status*. In the UK there are *three separate types of professional engineers*: Chartered Engineers (CEng), the Incorporate Engineer (IEng) and the Engineering Technician (EngTech). However, in order to follow the remit of the Leonard project the present chapter will focus on the processes involved in becoming an Incorporated Engineer.

However, prior to discussing the processes to becoming an engineer it is important to provide some background information about the *Engineering Council*, the body responsible for establishing and awarding these qualifications. This organisation was established by a Royal Charter to promote advances in education, particularly in relation to engineering and applied technology. Under this Charter, provided individuals have achieved the desired standards, they can be awarded the following: Chartered Engineer (CEng), Incorporated Engineer (IEng) and Engineering Technician (EngTech). However, in doing so the Engineering Council has to ensure that those who achieve this status have acquired a certain academic standard, as well as the necessary competencies and commitment required for registration. In this respect the Engineering Council also sets out the Standards and Routes for Registration (SARTOR).

Table UK-1.

Number of engineering graduates who achieved registration by the Engineering Council by professional status, 1997,

Professional Status	1985		1995	
(registered)	Absolute	in %	Absolute	in %
Chartered Engineer	200000	73	200000	75
Incorporated Engineer	60000	22	51000	19
Engineer Technician	15000	5	15000	6
Total	275000	100	266000	100

Source: Engineering Council; Marcus Powell, Country report, p. 30; own calculations

The highest level of accreditation offered by the Engineering Council is that of Chartered Engineer. Table UK-1 indicates that ¾ of all registered Engineers fall to this type. According to one of the Council's (1997) official documents a Chartered Engineer is primarily concerned with innovation, creativity and change. Indeed, in contrast to the other professional engineers, the Chartered Engineers are primarily concerned with the design aspects of engineering.

For purposes of comparison it is useful to comment on the process involved in achieving Chartered Status. First you must have obtained qualifications, such as M.Eng. or B.Eng. (Hons.), at an accredited institution. Having obtained this qualification a person has to register with the Engineering Council. This stage is called the *interim stage*. If, however, a person has only a B.Eng. (Hons.) they would be required to do another years studying. The purpose of this extra year is to enable a person with a BEng (Hons) qualification to achieve equivalence with M.Eng. graduates (referred as the Matching section).

The next stage of registration is called the *initial professional development*. During this process the candidate will be expected to obtain structured training within a particular industry, as well as a number of years experience and responsibility within that industry. This initial professional development bridges the gap between the educational base and the final registration. The period of training should begin with an initial induction and then the candidate should learn about the full cycle of the engineering process in relation to whatever industry they are working in.

These processes of initial professional development should last for about 2 to 3 years and where possible the training should occur within an accredited scheme. However, the Engineering Council recognises that some people will not have access to such a scheme and instead will gain their skills and knowledge through self-managed learning. Under such circumstances an individual mentor will have to ensure that a candidate is achieving the same standards as those on a comparable training scheme. During this period all trainees will have to record their training on a form developed by their chosen institution. Furthermore, the subsequent record will be monitored and varied by the candidate's mentor. This mentor or supervisor will also produce a report to provide documentary evidence that the candidate has achieved certain requirements.

When a person has completed their initial professional development they will now be in a position to achieve Chartered status. However, this will depend on a person's professional review. The *professional review* is an assessment of a candidate's competence and involves a written report from the candidate themselves and an in-depth interview by two suitably qualified engineers. The report basically outlines the structured training and development a candidate received during their initial professional development. During the interview a candidate will present his report and this is be followed by a question and answer session. Only then can a decision be made on whether the candidate can achieve professional status.

Incorporate Engineers and the respective two routes

In contrast to a Chartered Engineer, an Incorporate Engineer manages applications of current and developing technology. In this respect the Incorporate Engineer requires a detailed understanding of the use and management of technology. Normally the route or pathway to becoming an Incorporated Engineer (I.Eng.) will involve a young person achieving certain academic qualifications and obtaining appropriate work experience. The qualifications can be obtained though a vocational oriented route or by studying for a degree at university.

a) The vocational route

The more vocational oriented route to becoming an Incorporated Engineer (I.Eng.) can begin with a young person studying for a General National Vocational Qualification in engineering. These qualifications are work-related and aim to provide 16 to 19 year olds with the general skills and knowledge associated with working in the engineering sector.

The advantage of the GNVQs are that those with minimal qualifications are provided with the opportunity to study engineering. The foundation and intermediate level GNVQs each last for one year and are assessed using a combination of practical work, multiple choice examinations and portfolio evidence. Following the successful completion of an intermediate level GNVQ a student can study for an advance level GNVQ. In contrast to the other GNVQs, the advance one lasts for two years and is assessed by a portfolio and external examinations. All GNVQs programmes contain a number of core compulsory subjects which a person is required to study, and also a number of optional ones.

Those students who successfully complete their GNVQ Advance in engineering are now eligible to enter higher education and study for a BTEC Higher National Diploma (HND) or a degree in engineering. The newer universities are more inclined to accept students with GNVQs onto their engineering courses than the older universities[7]. The purpose of HNDs is to provide students with a balance between knowledge and skills. According to official literature, these qualifications enable students to develop work-based skills, such as problem-solving, planning and scheduling, team working, research and report writing. The qualification also provides flexibility as successful candidates can continue at their institution and study for a degree in engineering.

The HND is primarily intended for those studying full-time at college and also takes two years. Nevertheless, under the HND there are opportunities for a year of industrial experience (extending the course to a period of three years). These higher level qualifications will normally consist of the following:

Core subjects	Optional subjects
Business management techniques	Aerospace engineering
Engineering design	Electrical & electronic engineering
Engineering science	Manufacturing
Mathematics engineering principles	Plant process and instrumentation
A project	Telecommunication

The HNDs are assessed by a combination of course assignments and end of year examinations.

[7] Note '*newer universities*' refers to those institutions which received degree awarding powers following the 1992 Education Act. The majority of these '*newer universities*' used to be Polytechnics.

TABLE UK-2.

National qualification routes within engineering education/training in the UK

		National Award: Capability level
Post graduate level	GNVQ level 5	NVQ level 5
National Award: Capability level		
Degree level in engineering	GNVQ level 4 (BTEC HND in engineering)	NVQ level 4 (BTEC HNC in engineering)
National Award: Advanced level		
Traditional A-levels in maths and science subjects	GNVQ level 3 , advanced level, in engineering (BTEC OND in engineering)	NVQ level 3 in engineering in a specific occupation (BET ONC in engineering)
National Award: Intermediate level		
Traditional GCSE (grades A to C) in science and maths	GNVQ level 2 in engineering (intermediate level)	NVQ level 2 in engineering
National Award: Foundation level (normally obtained on leaving school)		
Traditional GCSE	GNVQ foundation level	NVQ level 1

Source: M. Powell, 2000

b) The degree route

The vast majority of young people who wish to become an Incorporated Engineer (IEng) opt for the academic route. This involves a young person staying on at school, beyond the compulsory age level, for a further two years and studying at least two or three Advanced level GCSEs in science base subjects, such as Maths, Physics or Chemistry. The grades which students have to achieve will depend on the entry requirement of the individual college or university.

Given the vast number of institutions that award degrees in the United Kingdom it is almost impossible to say what the composition of a typical engineering course looks like. Not only are there vast differences in the way in which institutions deliver their courses, in terms of whether they are full-time, part-time or by distance learning, there are also an equally diverse range of subjects taught at UK institutions.

Nevertheless, there are a number of important characteristics of engineering degree courses in the UK. First, there are differences in the type of qualifications that graduates can receive from universities. For example, if an engineering department has been accredited by a professional body, such as the Institute for Incorporated Engineers, students can be awarded an IEng (Hons) or a BEng. (Hons) on the successful completion of their course. However, if a department has not been accredited by a professional body than a graduate will be awarded with a B.Sc. (Hons). Understandably, the labour market acceptance of graduates with a BEng (Hons) is greater than that for those with just a B.Sc. (Hons).

Second, within the more traditional universities there is a tendency for engineering departments to focus on single honour subjects, such as engineering, chemical engineering and civil engineering. However, at the newer universities, departments provide students with the opportunity to study other subjects such as business studies as well as engineering. On successful completion of these courses, students are awarded a joint honours degree. Understandably, joint honours courses are proving popular with students since they are able to study for another vocational oriented subject besides engineering. Another development, particularly at the newer universities, is the increased emphasis being given towards developing key skills. Often the development of such skills can be supported through work experience schemes, the length of which will vary from university to university.

Degree courses are assessed through a combination of course work, examinations and project based assignments. Normally, during the first year students will be primarily assessed by examinations and in the final year they are more likely to be assessed on their project work.

TABLE UK-3.

Home acceptances to degree courses in engineering and technology

1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
14422	13846	13641	15008	16535	19153	21315	21535	19156	17645

Source Engineering Council, 1997; E. Powell, country report

The process of registration for the I.Eng.

An Incorporated Engineer (I.Eng.) requires a detailed understanding of the use and management of modern technology. This will involve a young person demonstrating that they have achieved specified competencies and commitment to the engineering profession, all of which are outlined in the Engineering Council's document entitled "Standards and Routes for Registration'' (SARTOR).

During the first stage to registration a candidate must successfully complete their educational base. This will involve a student obtaining a qualification, such as B.Eng. or an I.Eng., from an Engineering Department that has been accredited by one of the professional engineering bodies. If, however, a candidate only has an HND or an HNC they will be required to do another year of academic studying at an appropriate institution. The purpose of this extra year is to enable a person with an HND qualification to achieve equivalence with B.Eng. graduates (referred to as the matching section).

After a candidate has obtained the appropriate education qualification for initial registration they can start on the next stage of registration, namely their initial professional development. During this process the candidate will be expected to obtain structured training within a specific industry, as well as a number of years of experience and responsibility in that industry.

This initial professional development bridges the gap between the educational base and the final registration. The period of training should begin with an initial induction and then the candidate should learn about the full cycle of the engineering process in relation to what ever industry they are working in.

These processes of initial professional development should last for about 2 to 3 years and where possible the training should occur within an accredited scheme. However, the Engineering Council recognises that some candidates will not have access to such a scheme and instead will gain their skills and knowledge through self-managed learning. Under such circumstances an individual mentor will have to ensure that a candidate is achieving the same standards as those on a comparable training scheme. During this period all trainees will have to record their training on a form developed by their chosen institution. Furthermore, the subsequent record will be monitored and verified by the candidate's mentor. This mentor or supervisor will also produce a report to provide documentary evidence that the candidate has achieved certain requirements.

When a person has completed their initial professional development they will now be in a position to achieve Incorporated status. However, this will depend on a person's professional review. The professional review is an assessment of a candidate's competence and involves a written report from the candidate themselves and an in-depth interview by two suitably qualified engineers. The report outlines the structured training and development a candidate received during their initial professional development. During the interview a candidate will present their report and this will be followed by a question and answer session. Only then can a decision be made on whether the candidate can achieve professional status.

Quality assurance

The process of quality assurance involves a number of organisations. The *Higher Education Funding Council* requires that educational institutions achieve a base line standard in the following areas if they are to maintain core funding for their students: (i) curriculum design, (ii) teaching, learning and assessment, (iii) student support and guidance, (iv) learning resources and (v) quality assurance and enhancement. When assessing each of these areas engineering departments will be awarded points, ranging from one to four. One being unsatisfactory, two satisfactory, three highly satisfactory and four excellent.

Professional bodies play an equally important role in regulating quality. Indeed, in order for an engineering department to award an I.Eng. or B.Eng. degree programme they must be accredited by the *Institute of Incorporated Engineers (IIE)*. This is a thorough process in which engineering departments have to send copies of their syllabuses and examination scripts to the Institute of Incorporated Engineers (IIE), for accreditation. In addition, IEE accreditors will visit departments and undertake a quality audit. All of this information is then evaluated by a panel at the IIE. This is a continual process and will normally occur every three to four years.

Quantitative and qualitative shortages of engineering qualifications

In the UK an estimated 1.87 million people are employed in the field of engineering. The supply of engineering and technology graduates has grown by over 51 per cent during the 1988 to 1996 period. Although this rise appears large in relative terms it is small when compared to the numbers studying Biological science and mathematics/computing, which have grown by 87 per cent and 85 per cent respectively over the same period. A large proportion of these graduates (56 per cent) are employed in manufacturing. Other sectors which also employ a significant proportion of the country's engineering graduates include business services and research/development.

Despite the large increase in the number of engineering graduates entering the labour market over the past 10 years, evidence suggests that there are both quantitative and qualitative shortages. In certain sectors, such as electronic engineering, over one third of enterprises experience severe difficulties in recruiting graduates. Whilst employers in pharmaceuticals and mechanical engineering also experience recruitment difficulties, although not to the same degree as those in electronic engineering.

Besides labour market shortages, a number of studies have began to question the quality of engineering graduates that our university system is producing. One area of concern is whether engineering graduates have the communication and team working skills of the type that modern competitive industries require.

Clearly, there are severe mismatches between what the country's education system produces and what is demanded by the labour market. A combination of factors account for these circumstances. Evidence would suggest that students have a preference for studying subjects other than engineering at university. It is difficult to fully understand why engineering is so unattractive. Part of the reason may be historic, in that student's parents may have negative perceptions towards the industry following its rapid decline in the 1970s. Thus, it is possible that parents could deter young people from entering the profession. At the same time, subjects such as computing or business studies appear much more attractive than engineering.

Another reason for shortages of engineering graduates is that a large number opt for a career in financial services rather than manufacturing. This reflects the fact that financial services can offer graduates much higher salaries than they would receive in the manufacturing sector. Figures from the Institute of Chartered Accountants, the professional body responsible for accountants, revealed that about a quarter of its entrants have a degree in engineering or a science based subject.

TABLE UK-4.

Extent and nature of difficulties in recruiting technical graduates in selected industries

QUESTION: How have you found it to meet your recruitment targets or needs for graduates in the past three years ?

Sector	Graduate recruitment			No graduate recruit-ment	Total	Number
	Very difficult	Quite diffi-cult	Very easy			
	%	%	%	%	%	
Electronics	12	23	27	38	100	87
Machinery	5	21	38	35	100	79
R&D services	8	18	34	40	100	50
Computer services	7	18	43	32	100	88
Financial services	3	16	42	39	100	71

Source: Mason 1999, Skills Task Force Research Papers No.7

The quality of provision by engineering departments is also influenced by a number of other structural factors. Given the emphasis towards ‘bums on seats’, departments are having to attract non-traditional entrants onto engineering courses, including mature students and those with more vocational orientated qualifications, all of which can lead to variability in quality of graduate output. However, the professional engineering bodies have attempted to rectify this situation by requiring that accredited departments only accept students if they have achieved certain A-level grades. The situation at universities is made worse by the fact that many experience severe staffing shortages as those with post graduate engineering qualifications are much more likely to opt for a career in industry than academia.

The circumstances in the UK’s labour market for engineers will probably become worse in the near future, particularly if we enter a period of high growth and the supply of graduates is unable to keep pace with demand. Furthermore, this will also exacerbate what many academics call '*latent or concealed labour market shortages*'.

TABLE UK-5.

Entry qualifications held by UK-domiciled students admitted to first degree courses in UK higher education institutions, analysed by sector
Row per cents

SUBJECT	Total No. of admissions	A-levels or Scottish Highers	BTEC/ SCO-TVEC	GNVQ	Access / Foundation	Other	None	% A-level entrants with 26 or more points
	%	%	%	%	%	%	%	
Engineering / technology	17001	66.4	12.6	3.3	2.3	6.5	8.9	25.6
Biological Science	16840	81.7	3	1.9	6.1	4.2	3	24.9
Physical Science	14732	85.4	2.5	1.2	3.1	3.6	4.1	25.4
Mathematical Sciences	5621	87.3	2.2	0.9	1.9	4.1	3.7	44.1
Social studies	35198	72.6	4.1	3.5	9.1	5.5	5.2	25.2
Business / Administration	28180	62.3	10.7	14.2	2.4	3.9	6.5	11.7
Languages	17837	86.8	0.9	0.4	4.5	4.6	2.8	37.1
Humanities	10645	81.9	1.6	0.5	7.3	5	3.7	31.9
All subjects	276503	70.2	7.9	5	6.4	5.3	5.3	23.5

Source: Mason,1999, Skills Task Force Research Papers No.7.

TABLE UK-6.
Changes in application for degree/HND courses over the 1997 to 1998 period

Subject	Degree 1988		HND 1998	
	Applicants	Change	Applicants	Change
Computer Science	70,093	+15.8%	11,899	-7.7%
Mechanical Engineering	28,090	+1.3%	1,025	-18.4%
Electronic Engineering	17,237	-3.8%	1,419	+21.4%
Civil Engineering	16,761	-6.3%	660	-36.9%
Engineering & Technology combinations	14,819	-15.0%	1,346	-31.6%
Software Engineering	10,844	+22.1%	2,097	-1.7%

Source: UCAS, 1988

Results of a recent survey on education-industry links

Education-industry links can take a variety of forms ranging from the traditional work experience programmes, lasting a year, to the forming of innovative partnerships for purposes of delivering courses. These links help improve employability amongst engineering graduates, make engineering departments more sustainable and also support wider economic development within the local economy.

At the further education level the research identified two departments that had established successful links. However, these departments were a minority and probably do not represent what is happening nationally. In the first case an engineering department came together with 20 local employers to form a non-profit making company. The mandate of this company is to help define a course of study for HND students which offers them the opportunity to gain work experience and at the same time prepare the calibre of engineers required by local industry. The advantages of this scheme were that it helps provide industry with students who have developed employability skills and at the same acts as an incentive to encourage students onto the course, since they are provided with paid work experience during their vacations.

Another case study from an FE college involved an engineering department that had forged links with local companies for the purpose of delivering its courses. Under this partnership the department operated as a full cost centre and delivered courses according to the defined needs of local industries, including: the subject content of their courses, the proportion of time spent on project based assignments, as well as how long the students spent at the college and how long they spent within the company during their initial training. This partnership proved very successful.

The final case study outside of the university system was a short work placement scheme targeted at young people who have just successfully completed their A-levels and are in the process of starting university. The duration of the scheme is five weeks and it provides young people with the opportunity to study for a supervisory management certificate. One of the purposes of the scheme is to provide young people with key skills and to enable them to see if they want to work in engineering. This is a national scheme and approximately 775 young people participate in it each year.

At the higher education level the study identified three types of work experience programme, ranging from those lasting a year to some that did not have a fixed time period. These programmes varied in flexibility with regard to their tasks. Some were concerned with a specific task or project, and in others the emphasis was on a variety of tasks or functions.

Despite their differences it is not possible to speculate which work experience programme was most effective. However, it is possible to suggest that certain schemes are more suitable for certain contexts. For example, large companies are more likely to benefit from, and be capable of supporting, a work placement lasting a year than smaller companies. Similarly, larger companies are also more likely to be able to benefit from a scheme which focuses on a specific task or project. In contrast a smaller company is much more likely to prefer a work placement that is flexible and responsive to a variety of tasks rather than just one task or project.

Table UK-7.

Key data and information concerning Engineering Education and Training in the Non-University Sector in the UK[8]

1.	Engineering education outside traditional university	Technical Colleges, Colleges of Further Education, Colleges of Higher Education and the Newer Universities (formerly polytechnics).
2.	Formal degrees, professional status	Bachelor of Science in Engineering (B.Sc.); Bachelor of Engineering (B.Eng.); Institute of Incorporated Engineers (IEng); Higher National Diploma (HND); C.Eng., I.Eng. and Eng.Tech.
3.	Duration	Normal degree – 3 years; HND – 2 years; however, with an industrial placement add an extra year.
4.	ISCED – classification (1976)	B.Sc and B.Eng. – ISCED – Level 6; HND – ISCED – Level 5.
5.	Classification in the EU-Directives	Incorporated Engineers (IEng) are included in the European First General Directive (89/48/EEC).
6.	Quantitative relations in labour force	Approximately 1.87 million people are employed in the field of engineering; 266.000 are registered Engineers (1995), of these 77% C.Eng., 19% I.Eng., 6% Eng.Tech.
7.	Number of Students	Intake for 1998 (Degree): Computer science – 70,093; Mechanical engineering – 28,090; Electronic engineering – 17,237; Civil engineering – 16,761; Engineering technology – 14,819; Software engineering – 10,844;Intake for 1998 (HND): Computer science – 11,899; Mechanical engineering – 1,025; Electronic engineering – 1,419; Civil engineering – 660; Engineering technology – 1,346; Software engineering – 2,097
8.	Co-operation with industry	The majority of students can take a year's placement in industry, although there are a number of other voluntary schemes which are shorter.
9.	Labour force acceptance	Very low unemployment
10.	Entitlements	Registration as IEng is irrelevant as far as actual licence to practice is concerned; it is relevant for the professional status.

[8] This table attempts to focus specifically on data relating to the pathway to becoming an Incorporated engineer.

Secondary Colleges for Engineering and new Fachhochschulen in Austria

Arthur Schneeberger / Bernd Kastenhuber

Any information about engineering education outside the old universities at an advanced level in Austria has to take two quite different pathways into consideration:

a) the SCE with a long tradition and
b) the newly established Fachhochschulen (since 1994).

Till the nineties the SCE was the only alternative to the long term university studies. Based on the last census (1991) there were about 112.000 graduates of secondary colleges for engineering (SCE) and 24.800 university graduates ("Diplomingenieure") in the Austrian labour force.

Secondary Colleges for Engineering (SCE)

For a long time the main route for engineering education in Austria outside the long term university studies (which take about 7 years for a first degree on average) have been the Secondary Colleges for Engineering (SCE). Graduates of these highly demanding and selective colleges finish with 19 years (main route) or 20 to 21 or later (special routes) and can apply for the status of "Ingenieur" at the Ministry of Economic Affairs after three years of professional work experience in a related field or branch.

This type of long upper secondary education with early professional experience and a high degree continuous education was in connection with the apprenticeship system part of the success story of many branches of Austrian manufacturing industry. In a rough description we can say: the graduates from apprenticeship training build the medium level of qualification, the graduates from the five years colleges the upper level of technologists and middle management.

TABLE A-1.
Occupational Distribution of the Labour Force by Educational Attainment, 1991, in per cent (columns)

Occupational major (or sub-major) group	Compulsory school	Apprenticeship training	Vocational school	Pre-academic school	5-years vocatinal college	NUS higher education	University	Total
Managers in administration, industry & finance	0.6	1.5	2.4	4.4	5.8	0.3	11.6	2.2
Engineering and natural science professionals / technicians	**1.0**	**2.8**	**4.3**	**6.4**	**26.7**	**0.4**	**13.3**	**4.5**
Teachers, non-teaching supervisory staff	0.6	0.5	4.6	6.3	7.8	81.8	22.0	4.3
Health professionals & technicians	0.2	0.2	7.7	5.1	0.9	4.5	16.6	2.4
Legal, social professionals	1.3	1.0	2.3	6.7	2.8	5.3	17.9	2.6
Clerical occupations	8.1	11.5	33.8	33.9	31.0	2.9	7.2	15.1
Wholesale & retail trade occupations	8.6	13.4	9.1	10.4	8.4	0.7	5.3	10.4
Service occupations, armed forces	23.8	14.9	13.2	13.5	6.5	3.1	2.6	15.9
Transport occupations, machine operators	13.4	11.8	4.4	6.5	3.2	0.3	1.0	9.8
Basic industry workers	6.5	4.7	1.4	0.8	0.6	0.1	0.2	4.1
Construction and related trades workers	7.1	7.1	1.3	0.6	0.6	0.0	0.2	5.2
Product manufacturing workers and others	19.6	25.6	7.0	4.2	4.0	0.3	1.3	17.5
Agricultural and forestry occup.	9.2	5.0	8.5	1.1	1.7	0.3	0.8	6.0
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Numbers: 1000	1,084	1,493	480	158	207	65	198	3,684

Source: Austrian Statistical Office, Census 1991

The table below gives us clear evidence, above all, of the central role of the TVE sector for professional occupations in general and engineering occupations in particular until the present (see table A-1). As the data refering to the category " Engineering science and natural science professionals; technicians" indicate there has not been a strict vertical differentiation between SCE and university graduates. While the public sector in Austria protects a vertical occupational differentiation by formal educational attainments this was never true in a strict sense in the private sector. Very successful careers of graduates from SCE-colleges has been are still possible.

The success of the graduates in the employment system is one of the reasons of the high attractiveness of this educational route and at the same of the resistance to structural change which astonishes sometimes international observers.[9] With Austria's joining the European Union some surprises arouse about the educational structures in other countries in general and especially in the engineering education. The 5-years Secondary Colleges for Engineering (SCE) as the pride of the Austrian educational system was threatened to be seen as "mere" upper secondary schools in the European area. In reality they are much more, but they are quite unique kinds of advanced level engineering education. Thus there is always much need of explanations and footnotes in communication with international educationalists.

The Secondary Colleges for Engineering are mainly intended as colleges at secondary level II (i.e. the upper secondary level); *these courses run for five years* and have already for a long time been offering essential qualifications for industry in the fields of the middle management and technical specialisation. Whereas universities and related institutions mainly have prepared for work in the public service, the liberal professions, and the management of large enterprises, SCEs have focussed on employment in the private sector primarily. The SCE experienced a strong growth in the wake of the educational expansion.

[9] Which was the case in the workshops of this project.

This is reflected not only in student and graduate numbers, but can be clearly noted also in their share among people under employment.

The *educational concept* of SCE is based on a combination of *three areas* of study: specialist practical training in workshops and laboratories - basic and advanced specialist theoretical knowledge and general education. These areas are complemented by practical hands-on training during vacations. Each area of study is weighted with approximately one-third of the total course length including practical training periods, with a concentration of workshop training at the beginning of the course and priority given to laboratory work at higher levels.

Leaving qualifications from SCE comprise – in brief – a number of elements and accreditations, including:

a) a vocational certificate in accordance with the Second European Directive on certificate recognition (92/51/EEC) with reference to long vocational training or short study courses, owing to the recognition and inclusion of the SCE in Appendices C[10] and D[11] of the directive;
b) a general matriculation (entrance standard) for universities and colleges;
c) privileges in industrial law concerning self-employment in trades and craft industries requiring specialist technical qualifications;
d) possibility of gaining the professional title of "Ingenieur" after three years' experience in a specialist position. This title is awarded to SCE graduates by the Federal Ministry for Economic Affairs on submission of an application.
e) Since 1994 there has been the additional possibility of being awarded the title "Diplom-HTL-Ingenieur"[12].

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[10] Appendix C covers conventional professions regarded as certified under the terms of European Directive 92/51/ EEC which also provide access to careers for which the host state demands university qualifications on principle, e.g. engineering office management or planning engineer.

[11] Appendix D covers training courses corresponding to certificates under the terms of European Directive 92/51/EEC. Training courses for these must enable graduates to carry out a wide range of complex specialist and profession-specific activities in a variety of areas. Within these activities graduates are expected to show a high degree of individual responsibility and independence in decision-making and implementation of the planning, organisation and use of equipment, machines and staff.

[12] See: BGBl. [Federal Law Gazette] No. 512/1994, Section 16, Subsection 1, BGBl. No. 776/1994.

Apart from the above-mentioned main form, various *special forms* have been established at the SCEs, which also show a significant output. The special forms are set up at post-secondary level of the educational system and have been established for graduates of pre-academic secondary education (“Gymnasium”) or of graduates from full time vocational schools or the Apprenticeship training tracks.

Project learning at SCE in co-operation with Business

Training courses at the SCEs are based on close contacts between the specialist teaching staff, all of whom must satisfy employment requirements of several years' experience in their field, and business specialists. Representatives from the world of business sit on academic boards in advisory capacities, and close permanent contact is maintained with companies located near the colleges. This co-operation with companies is demonstrated particularly clearly in project work. Projects have a long tradition within the SCEs, forming one of the main columns of teaching as a fundamental principle of imparting and receiving knowledge, in which students and teaching staff undertake technical and engineering assignments involving frequent consultation with external specialists. The consolidation and improvement of specialist theoretical knowledge by co-operating on relevant projects is furthered by the key objectives of the training courses: creative problem-solving, flexibility, team-work, pragmatism, time management, and the combination of technical and business viewpoints.

In the academic year 1996/97, around 50 per cent of the projects were initiated or contracted by external institutions.[13] Some of these external partners are from the field of industry, ranging from large enterprises to small and medium-

[13] See: Bundesministerium für Unterricht und kulturelle Angelegenheiten, Abteilung II/2, technisch-gewerbliche Schulen [Federal Ministry of Education and Cultural Affairs, General Directorate II/2, Secondary Schools for Engineering, Industry and Trade] (ed.): Ingenieur/Technikerprojekte an technischen und gewerblichen Schulen im Schuljahr 1996/97, February 1998, p.1.

sized businesses; partners can also be found in public administration (e.g. regional or municipal authorities); also social institutions (e.g. organisations for persons with special needs or for development aid) also co-operate with the SCEs. It is not the objective of the project work to be able to present theoretical results, but to achieve concrete practical solutions. In the academic year 1996/97, two thirds of the projects completed with an external partner produced concrete achievements, i.e. commercial or social benefits.[14]

In the 1997/98 school year, a nation-wide school-based pilot project was carried out in the framework of which the realisation of so-called *Ingenieur-projects*[15] – as an *alternative* to the 40-hour project work in the framework of the "Reifeprüfung"- and TVE Diploma Examination – was tested at about 30 school locations. Thus, this modified form of project learning has been established at already about half of all the existing SCE-locations, a fact that safeguards a strengthening and broadening of the co-operations which have so far been carried out with enterprises.

An Ingenieur-project is defined as a separate, independent work that has to be carried out by a *team of two to five students* under the supervision of a *project coach* who must be a teacher with a subject-related know-how and who bears the main responsibility. The project must be carried out during the last (i.e. fifth) school year and must have a duration of *at least six months*; it is possible, however, to carry out preparatory projects or to start the project already in year four. Wherever possible, the Ingenieur-project should be carried out in *co-operation with a non-school partner* and the tasks should have a *branch- or sector-specific or a trade-related character*.

[14] BMUkA, Ingenieur/Technikerprojekte, op. cit., p. 1.

[15] Upon successful completion of their final examinations, students at secondary colleges for engineering receive a "Reifeprüfung" Certificate and TVE Diploma. After having worked in their respective fields for a period of three years, graduates are entitled to the occupational title "Ingenieur". "Ingenieur" is therefore an occupational title for people working in the field of engineering, it does not, however, correspond to "engineer".

Fachhochschulen since 1994

Since 1994 Austria is setting up Fachhochschulen. A very demanding new sector which challenges the old universities in the field business administration and engineering education. Within a four years the share of new entrances in engineering fields (including IT-studies) reached a shore of 29 per cent for the Fachhochschul-sector of all engineering new entrants (University and Fachhochschulen together are the base).[16]

The development of the *Fachhochschulen* has been a novelty that has been supported by a great part of the political spectrum in the Austrian educational landscape. The aims are always: a closer connection to practical applications; shorter study duration (4 years mostly); and a relation to economic practice, especially to the regional development. In contrast to the universities, which are legitimised to a large extent by the independent dynamics of the development and differentiation of systematic knowledge – and offer occupation-oriented educational preparation only in the second place –, Fachhochschulen are legitimised primarily by their optimum preparation of students for their future work in the economy. Indeed, the Fachhochschulcourses look compared to university studies both, more specialised and and wider spread regionally, as table A-2 shows for the engineering programmes (set up within the first three years of the sector in existence).

The high degree of vocational specialisation and reference to regional economic development is the reason why needs-assessing expert opinions and studies are necessary prerequisites for the foundation of these establishments, with the social acceptance being taken into consideration as well. A very important consequence of this barrier to setting up these highly specialised type university-level colleges is that they (together with higher techno-medical courses) act as the *closed sector* of the Austrian higher education where the university act as

[16] ÖSTAT: Österreichische Hochschulstatistik – Studienjahr 1997/98, Vienna, 1999, p. 156, 343.

the *open sector* (they have accept each person who has a “Matura-Certificate”. Thus it happens that unsuccessful applicants to the closed sector enrol at universities as a second choice.

TABLE A-2.

Students in Fachhochschulen in the Technological Field, Winter Semester 1996/97

Study field / Location	Students
Electronic Engineering, Spittal an der Drau	88
Electronic Engineering, Vienna	237
Industrial Electronic Engineering, Kapfenberg	71
Precision, System and Information Technology, Wiener Neustadt	166
Software Engineering, Hagenberg	143
Automotive Engineering, Graz	54
Industrial Economics, Kapfenberg	103
Automation Engineering, Graz	40
Automated Plants/Process Technology, Wels	305
Manufacturing Automation Engineering, Dornbirn	79
Production/Management Technology, Steyr	102
Production/Automation Engineering, Vienna	28
Engineering of Building, Pinkafeld	96
Civil Engineering/Project Management, Spittal an der Drau	76
Planning/Management of Building, Graz	98
Civil Engineering /Management of Building, Vienna	66
Timber Industry, Kuchl	59
Industrial Design, Graz	32
Total	1,843

Source: ÖSTAT, Österreichische Hochschulstatistik (Austrian Statistical Office, Austrian University Statistics) 1996/97

Till now the Fachhochschulen have restricted numbers on new entrants based on need and demand assessments and public funding per study-place. Beside this the permission to enter post-secondary higher education in Austria is in all pathways the same generally. The criteria is having attained a "Matura" or "Reifeprüfung" Certificate regularly, which is a Certificate of pre-academic secondary schools or of a five-years TVE-colleges. From the new entrants in 1997/98 exactly 89 per cent were Matura-holders (about 48 per cent from a VOTEC-college, about 41 per cent from a pre-academic Gymnasium), about 11 per cent fell to the category of non-traditional access to university. [17] In Austria, about one third of each age group obtains such a qualification with growing frequency. It provides access to all universities and limited places to Fachhochschulen. There is open access without any tuition fee. It is quite possible that with the fast growing offer of Fachhochschulen and the growing competition for students between different Fachhochschul-deliverer and old Universities will reduce the selectivity of the first years.

Till now engineering or technological studies (especially information technology) and business administration and various combinations of these dominate the study subjects of the FH sector. The regional diversification is considerably higher than in the case of the universities, thus fulfilling the requirements and aims of the Fachhochschulen *to promote regional economic innovation* by means of qualification development as well as to meet the social need for higher education by means of an economy-oriented and occupation-related offer.

The Fachhochschule courses usually run for four years and include a practical part; there are both full-time offers and part-time offers for persons under employment. The technological courses all end with the awarding of the degree "Diplom-Ingenieur (FH)" and correspond to the First Council Directive on the General System of Recognition of Higher Education Diplomas. Currently (November 1999) there are 48 Fachhochschule (FH)[18] study programmes in Austria; in their majority, they are run as day variants (full-time study courses),

[17] ÖSTAT: Österreichische Hochschulstatistik – Studienjahr 1997/98, Vienna, 1999, p. 343.

[18] The Austrian and German Fachhochschule institutions are now commonly translated as Universities of Applied Sciences.

some can be attended both as day variants and as work-accompanying (half-time) variants for employed students, whereas some exist only in a half-time form.

Practical training of Fachhochschul-students

All of the *full-time forms of Fachhochschul-programmes*, which were introduced in Austria in 1994 and whose number currently totals 40, include *one semester of practical training*. As a rule, the length of the study courses is 8 semesters. In those FH-programmes which are organised as *part-time forms* (currently 14), the common (and useful) practice is that students who are working in the relevant field do not need to do the one-semester work-placement. The duration of these programmes is between 6 and 8 semesters. In some FH-programmes, students complete one semester of their *studies abroad* – a scheme conducted in co-operation with foreign partner universities.

A study carried out in March 1998 in the framework of which entrepreneurs were questioned about their experiences with FH-graduates active at their companies showed that the work-placement does play a role in making first contacts with a future employer-company. One of the results obtained was that slightly less than one third of the first Austrian FH-graduates (31 per cent) started a regular employment relationship at those enterprises where they had already completed their work-placement.

Employment and labour market

Current information from the labour market indicates that only 1.5 per cent of those unemployed at the end of April 1998 were SCE graduates, which is tantamount to an unemployment rate of 3.1 per cent, calculated on the basis of the labour force figures in the 1991 census (112.000). As a comparison, the same calculation methods show an unemployment rate of 6.5 per cent for the labour force as a whole (around 3.7 million). The employment prospect are for engineering graduates of all level are very positive due to the significant increase in the respective occupational fields (Micro-census data indicate an increase of about 60 per cent in the last decade).

The earning potential of graduates of TVE Colleges in general is considerably higher than that of all other qualified secondary school leavers and also of graduates from many field of university studies. While SCE graduates in the civil service – with the exception of the teaching professions in vocational schools, where differences in specialist teaching are slight – are not in direct competition with university graduates owing to the clear hierarchical structure of levels of employment status according to formal education, this type vertical differentiation does not apply to market-oriented sectors in the same degree, especially the small and medium sized business sector.

The number of employed SCE graduates rose between 1981 and 1991 – the dates of the last two national censuses – from around 57.000 to around 112.000, which is an increase of almost 100 per cent. Despite a drop in the employment level in the manufacturing sector (processing and finishing trades and industry), the employment rate of SCE graduates has actually increased in this sector, in absolute terms. The distribution of SCE graduates throughout the range of categories of business and industry, however, indicates a structural shift towards highly qualified service areas.
Unlike the expansion in higher education, which has led to an enormous increase of highly qualified staff in civil service occupations, the SCE focuses on the sectors of private manufacturing and services. At the time of the last census, 81 per cent of SCE graduates were employed in the private sector. The largest group represented among employed graduates from SCE is that of *technical and natural science specialists*; however, technical qualifications are also required for many other professional categories, for example teaching staff in technical branches, specialists in trade and commerce – since in many fields of study at the SCE technical and business qualifications are closely linked – and, not least, management.

In the technology-oriented service society of the present and foreseeable future, the manufacturing sector is set to retain its significance for the economy's value added; however, its links are to company-related services, from research and development to training and further education, marketing and distribution support. Advance and subsequent input of these kinds are among the factors enabling high productivity levels in the secondary sector to be achieved.[19] Employment among SCE graduates has echoed this structural transformation, demonstrated by the increasing numbers of SCE graduates employed in business-related private services (from 26 per cent to 35 per cent between the last two censuses). The SCE has undergone the necessary structural changes and reacted by increasing the service-related components of its courses (project-oriented study to promote present-day requirements of key qualifications, aspects of trade and commerce, foreign languages).

There is no doubt that specialists in technical and natural science subjects play a key role in a technology-based service society or information society. Census data show that, despite expansions in the higher education sector, the proportion of SCE graduates in this occupational category has risen over the last decade examined (from 29 to 32 per cent).

Results of a recent company-survey

The development in the direction of a technology-based industry- and service-oriented society goes hand in hand with an increasing demand for technicians and engineers of the various specialised areas. A recent nation-wide company survey based on questionnaires provides detailed information about the job prospects and the in-company operational fields of graduates of all *three pathways of engineering education* in Austria (SCE, Fachhochschule, University). This survey was carried out at the end of 1998 by the authors of this report in co-operation with experts of the Educational Department of the Association of

[19] See: Werner Clement: Die Tertiärisierung der Industrie, Vienna, 1988, S. 16ff. und passim.

Austrian Industrialists among its member companies; 202 companies with more than 94.000 employees took part. A total of 8.7 per cent of the employees in the responding companies were technicians and engineers, comprising, by definition, SCE graduates (5.7 per cent), FH graduates (.5 per cent) and university graduates (2.5 per cent).

TABLE A-3.

Fields of Employment of Technicians and Engineers by Educational Pathway

Fields of Employment	SCE %	FH %	Univ. %
Project organisation / project management	51.5	18.3	33.2
Research and (software) development	31.7	14.9	48.0
Construction, calculation	61.4	10.4	14.4
Manufacturing	59.4	13.9	14.9
Marketing, sales, customer care	34.7	10.9	26.7
Human resources management, leadership	14.4	7.4	30.2

Source: Company Survey, November/December 1998, n = 202

The companies employ technicians and engineers *of all three* tracks in *all* major divisions / functional areas, however with certain *qualification-specific* priorities. In project organisation / project management as well as in marketing, sales and customer care all three types of technicians and engineers are employed frequently. The SCE graduates, in addition, find major employment opportunities in the areas of construction technology / calculation as well as in manufacturing; the FH graduates in the fields research and (software) development and in manufacturing. The university graduates of technological fields are most frequently employed in research and (software) development as well as in human resources management / leadership – in addition to the above-mentioned generally important areas.

TABLE A-4.

Knowledge and Skills of Technicians Seen as *Very Important* by Employers

Knowledge and Skills	*very important,* in %
Extra-disciplinary knowledge and skills	
Project management	41.1
Foreign language/s	41.1
Information management	14.4
Conducting conversations / rhetoric	14.4
Basics of marketing and sales	9.9
Supra-disciplinary (i.e. general) qualifications	
Ability to work in teams	68.8
Ability to communicate	53.0
Structural thinking	50.0
Personal characteristics and attitudes	
Willingness to perform / determination	84.7
Independence	57.9
Flexibility / mobility	54.5
Ability to achieve their objectives	38.1
Ability of integration	28.7

Source: Company Survey, November/December 1998, n = 202

For all qualification pathways of the training of technicians and engineers, specialist knowledge and skills are of key importance. Moreover, knowledge on – and also character traits from – other fields as well as of a more general nature are important for professional success. Essential aspects of the requirement profile of today's technicians and engineers are, apart from specialist knowledge and skills, extra-disciplinary and supra-disciplinary additional knowledge and skills as well as performance- and flexibility-related character traits.

As far as extra-disciplinary knowledge of technicians and engineers is concerned, employers mention as most important fields project management and foreign languages, coming clearly ahead of information management and communication / rhetoric. The ability to work in teams and to communicate are on top of the list of the supra-disciplinary qualifications that are considered most important.

Funding and quality insurance

In *Austria* there is open admission to all universities but not to the newly established “Fachhochschulen” which have limited number of study-places due to a different funding. The state refunds the educational institution per each study with about 100.000 ATS roughly. But this funding is based on previous acceptance of a restricted number of places by the public authorities. That means that the sector of Fachhochschulen became a kind of “closed educational sector” compared to the fully open old universities. That has consequences on funding, quality and the student-teacher ratios of the institutions.

The funding of engineering education and training in Austria is provided nearly totally by the federal government as long as it is part of the initial education and training sector. There are some courses in continuing education and training which involve considerable contributions by the participants. The SCE is part of the public upper secondary school system which is free of any tuition fees in all branches. Also the post-secondary forms of the SCE, which are very often attended by people under (at least part-time) employment, are free of private financial contributions. Companies contribute on a voluntary basis by funding special equipment, activities and joint projects of colleges and enterprises.

All curricula of the SCEs are based on ordinances of the Federal Ministry of Education. In the process of elaboration these ordinances, the teaching staff, the involved industries and the social partners have an important say. In case new developments are planned, studies on the occupational requirements are usually carried out by research institutes commissioned by the Federal Ministry of Education. The standards of the SCEs apply to the country as a whole.
The SCE colleges usually establish boards of advisors where the social partners and experts from the companies play an important role. This, together with a long tradition of carrying out joint projects with companies of the respective regions, is an important reason for the well-functioning adjustment of the colleges' and companies' requirements in the engineering sector.

The FHs were an innovation of the Austrian education system in many respects. The new sector is based on an *accreditation model*. This model allows different institutions to offer FH study courses and unified standards at the same time.[20] The Fachhochschulrat is the responsible authority concerning the establishment and prolongation of the courses in respect of the quality of the courses and their labour market and social acceptance. It is under the chairmanship of the Ministry of Science and Research and the Court of Auditors. Up to the present, the financing of the FH sector has come mainly from federal sources. It has not been possible so far to put into reality the original plan of a mix of sources. Only two per cent of the current financing programme come from companies or other private institutions.

[20] Cf. for the background of the new approach: OECD: Reviews of National Policies for Education - Austria, Paris, 1995, p. 31.

TABLE A-5.

Key data and information concerning Engineering Education and Training in the Non-University Sector in Austria

1.	Engineering education outside traditional university	SCE-Secondary Colleges for Engineering (main form and special post-secondary forms) and Fachhochschulen (FH) since 1994
2.	Formal degrees, titles	SCE: TVE Diploma, Ingenieur, Diplom-HTL-Ingenieur ("Standesbezeichnung", awarded by the Ministry of Economic Affairs); FH: Diplom-Ingenieur (FH) (Academic graduation)
3.	Duration	SCE-main form (5 years), specials forms (post-secondary): from 2 to 4 years; FH: mostly 4 years; universities: 5 years minimum, actually 7 – 8 years
4.	ISCED-classification	SCE = level 3; Fachhochschule = level 6
5.	European directives (first and second)	SCE: included in the Second European Directive (92/51/EEC); FH: included in the First European Directive (92/51/EEC); both types of diplomas are included in the Architects' Directive (85/384/EEC)
6.	Quantitative relations in the labour force (rough figures)	SCE: 112.000 (census 1991); university graduates/"Diplomingenieure*", census 1991): 24.800); FH (established in 1994)
7.	Number of students in relation to other routes	SCE: 34.226 (main form, 1997/98), 6.749 (special forms); FH in engineering fields: 2.533 (1997/98); University students in engineering fields* (1997/98): 47.697; but in 1997/98 about 29 % of all new entrants at tertiary level in engineering subjects fell to Fachhochschulen
8.	Co-operation with industry (what kind of co-operation, formalised or not)	SCE: mandatory work placement – eight weeks; joint technological projects of colleges and enterprises; FH: mandatory work placement; applied research co-operations with companies of the regions
9.	Labour market acceptance	Very low unemployment, strongly growing employment prospects of both types of qualification
10.	Entitlements and access to regulated professions	SCE: engineering office management or Planning Engineer; access to a course for the European Welding Engineers Diploma; FH: in the private sector same possibilities as university graduates, but not in the public sector

*excluding agricultural fields of technology
Source: ibw, 1999

Translation of German terms

GERMAN TERM	ENGLISH TRANSLATION
Höhere Technische Lehranstalt, HTL	Secondary College for Engineering, SCE
Technical and vocational Education, TVE	Berufliche Bildung
Post-secondary courses in TVE	Kolleg
Technical and Vocational Schools and Colleges for People under Employment, ... for Adults	Sonderformen für Berufstätige
Reifeprügung (BHS) Zeugnis	Reifeprüfung-Certificate and TVE Diploma
Berufsbildende höhere Schule / BHS	Secondary Technical and Vocational / TVE
Allgemeinbildende höhere Schule / AHS	Pre-academic upper secondary school
Fachschule / Berufsbildende mittlere Schule	Technical and vocational school
Fachhochschule	Fachhochschule or Vocational Colleges offering university-level education
Hochschulverwandte Lehranstalten	Non-university sector of higher education (NUS)
Fachhochschulrat	Fachhochschulrat is the responsible authority concerning the establishment of the courses
Diplomingenieur (FH)	Graduate of engineering studies at Fachhochschule
Diplomingenieur	Graduate of engineering studies at Technical University or University
Ing.	Title of SCE-graduates awarded by the Ministry of Economic Affairs
Diplom-HTL-Ing.	Title of SCE-graduates awarded by the Ministry of Economic Affairs

Short- and Medium-cycle Higher Education in Denmark

Eric Jensen

In Denmark there are basically two types of engineering education in the non-university sector (NUS):

- Medium-cycle engineering education at the Colleges of Engineering
- Short-cycle engineering education at the Technical Colleges

Both types of education are post-secondary/tertiary and together with the third type of engineering education at the Universities (Long-cycle engineering education) they constitute all the tertiary education in Denmark.

Medium-cycle engineering education

The medium-cycle education takes place at the Colleges of Engineering as a principal rule. There are 5 colleges of engineering in Denmark with engineering programmes of 3½ years' duration.
Further it is possible to achieve an medium-cycle engineering education at 3 universities: Aalborg University, Syddansk University and Technical University of Denmark. The above mentioned education allows the students to continue to the long-cycle engineering educations.

The 3½ years duration are divided into 7 semesters of 20 weeks of duration each. One semester consists of 5 theoretical subjects and a 3-week practical training course. Within the first 4 semesters all courses are mandatory. The 5th semester consists of industrial placement which also is mandatory. The 6th and 7th semester consist of a mix between mandatory and optional courses, and the 7th semester includes a mandatory thesis project.
Medium-cycle engineering education is possible within the following main fields of study:

- Civil and constructional engineering
- Electronic engineering with computer science
- Electrical engineering
- Mechanical engineering
- Production engineering
- Chemical engineering
- Export engineering

Unlike former medium-cycle education, admission through the new educational system from 1993 does not require previous practical knowledge and experience. To be admitted to the course the applicants normally need to have attained upper secondary education: short-cycle engineering education, upper general or upper vocational secondary education.

However, the new educational system has the possibility of offering the students a 5-week course at the workshop in lecture free periods. Furthermore, a ½ year of paid trainee service/work experience is mandatory in the medium-cycle engineering education. The period of engineering work experience is integrated and placed at the end of the educational programmes, and the employer pays the students. For students, however, with a vocational education and training course or similar qualifications, the period of working experience is not mandatory. According to the International Standard Classification of Education (ISCED, 1976) the medium-cycle engineering education in Denmark is at ISCED 6-level.

Between 1994/95 and 1995/96 a decrease of approximately 1.000 full-time students has been recorded for Colleges of Engineering, i.e. from 7.000 to about 6.000, and since 1996 the number of the full-time students has still been falling.

Short-cycle engineering education

The short-cycle engineering education in Denmark corresponds to an English higher national diploma (HND) and is at ISCED 5-level and has duration of 1½ to 3½ years. The educational courses take place at the Technical Colleges which offer engineering programmes within the following fields of study.

- Civil Constructing and Installation
- Industrial Production
- Textile and Garment
- Agriculture and Gardening
- Industrial Process and Food Business
- Industrial Export

In short-cycle engineering education 15 per cent of the educational programme encompasses optional subjects, the intention of which is to meet locally defined needs of qualification. Within the single education there is a great variety and possibilities of specialisation - typically in the last semester of the education - either via the optional subjects or by choice of specially studied subjects.

The *admission requirements* to the short-cycle engineering education are a relevant vocational education and training course/apprenticeship or a course with a specialisation connected to the education subject and a relevant vocational supplement in the form of industrial employment or previous professional and academic education followed by industrial employment.

The picture of admission to the short-cycle engineering education in 1996 shows that *approximately half of the admitted persons have a vocational education and training course*, about 20 per cent have a school leaving certificate and 12 per cent hold an upper general secondary certificate. The rest have another kind of upper secondary certificate or short-cycle education. The student's admission varies extremely from one short-cycle educational programme to another.

A few educational programmes take place in continuation of a short-cycle engineering education. This concerns the Construction Architect with admission requirements as Building Engineer. The Constructing Architect is placed under ISCED 6 (ISCED 1976, UNESCO), but legislatively it belongs to the short-cycle education.

The education as a technologist within the environment, laboratory and chemical fields of study also takes place in continuation of a short-cycle education. Here the admitting educational course is laboratory technicians. A Diploma in Food Business and in Constructing Engineer in textile and garment are also educational programmes at medium-cycle level taking place in continuation of short-cycle engineering education.

The short-cycle engineering education focus both on theory and practise with an emphasis on technological and workshop-like subjects as well as a number of general/academic subjects.

As far as the short-cycle education concerns a number of councils and committees take part in the decision-making process with either decisive or recommending influence. These advisory bodies are composed with the labour market organisations - equally representation of the employers as well as employees. The educational programmes provided are subject to constant change in step with the general development of society. The principle that education is most effectively kept up to date and relevant through the active participation of the labor market organisations is widely supported. Their participation is also a guarantee that the content of the individual educational course fulfils the requirements of the labour market, and that the qualifications provided have been found acceptable and useful by employers and employees in the enterprises.

The labour market for the short-cycle engineers is concentrated within civil construction, energy, industrial production, agriculture and also industrial processes and food business. This is the reason why the technological/technical/professional content in the short-cycle engineering education is primarily aiming towards operation, maintenance, planning, designing, development, construction, computer science, technical documentation and quality assessment. Secondarily, the content focuses on sale and marketing.

To a large extent the content of the educational programmes are planned in continuation of the vocational education and training courses. In these courses the student have gained a professional and methodical knowledge and, therefore, the short-cycle educational programmes are able to aim at a high degree of theoretical specialisation.

In the years 1993-97 the number of students at the short-cycle engineering educational programmes decreases from 5548 to 4704, in corresponding to about 15 per cent. 1993, 3532 students were admitted to the short-cycle engineers educational programmes and 2822 students in 1997 representing a 24 per cent decrease. The intake to the single educational courses varies considerably and the picture shows some educational programmes with a large take in and some relatively small educational programmes with a take in below 50 students.

The decreasing applications to the short-cycle engineering educational programmes can not be looked upon as isolated phenomena. In general there is a decrease in the number of a youth cohort and also a decrease in the applications to further education within natural science and technological/engineering subject areas.

TABLE DK-1.
Number of intake of full-time students and of institutions concerning Colleges of Engineering (medium-cycle courses) and Technical Colleges (short-cycle courses)

Institution / students	1994/95	1995/96	1996/97	1997/98	94/95 – 95/96
Colleges of Engineering (medium-cycle courses)					
Students	7,000	6,000	-	-	-14 %
Institutions	5*	5*	5*	5*	-
Technical Colleges (short-cycle courses)					
Students	5,500	4,500	4,300	-	-18 %
Institutions	39	39	35	35	-

*The number is not including the 3 universities with medium-cycle engineering courses

Source: Statistical Yearbook 1997 and Statistical News, Ministry of Education, 1998

TABLE DK-2:
Number of students in higher education by institutions in Denmark, 1980, 1992 and 1995

Institution/year	1980	1992	1995	Relative growth 80-95	92-95
KVU	10,321	16,186	16,977	64 %	5 %
MVU	48,234	78,617	93,330	95 %	19 %
LVU	54,765	58,367	60,871	11 %	4 %
Total	113,320	153,170	171,178	51%	12 %

Source: Uddannelsesredegørelse 1997, Undervisningsministeriet (Educational Report 1997, Ministry of Education); own calculations

Teaching staff

At the short-cycle level (KVU) the demand for teacher's qualification is defined in the central educational legislation. As a principal rule the demand is that the teachers hold a graduate degree together with relevant work experience or have reached the equivalent level in another way. Connection to business and industry is a priority at the selection of teachers at the KVU-institutions. The teachers are thus hired more according to their educational background and work experience than to their teaching or educational experience.

On the other hand it is a demand for permanent occupation at the institutions that the teachers complete an educational programmes of approximately 500 hours' duration within the two first years of their engagement. This type of education is provided by Denmark's Erhvervspædagogisk Læreruddannelse (The Danish Institute for Educational Training of Vocational Teachers). This institution is a nation-wide institution undertaking pedagogic-psychological initial education, professional-pedagogic in-service and further training of teachers and managers at commercial colleges, technical colleges and other schools. The Institute is also undertaking vocational pedagogic research and development work, consultancy work etc. for central trade organisations and administrative authorities at national level.

Newly research show that an increasing number of teacher have no work experience. A situation probably caused by the fact that the persons with the demanded qualifications among other things would be able to earn more money in business or industry than being a teacher. Nevertheless it is considered of great importance that some of the teachers have extensive job experience in order to ensure maximum interaction between college-based courses and reality in trade and industry.

At the medium-cycle level (MVU) the teacher as a principal rule have a graduate degree or equivalent with work experience within their teaching subject. Unlike the KVU-education there are no explicit demands for teacher's qualification in the educational legislation. At the MVU-institutions, however, the condition for a permanent engagement is an assessment by a selection committee.

Employment prospects of medium- and long-cycle engineers

In 1993 the total number of employed medium- and long-cycle engineers was 53,599. Overall the main tendency is, that graduates with a medium- or long-cycle education in engineering are employed in the service industry, private or public, at the expense of the manufacturing industry.

There is also a change in the characteristics of jobs. More and more of the graduates are employed in new functions different from the traditional, meaning new and different demands in relation to the education and competencies of the graduates. There is also a profound change concerning the size of companies. A greater part of the medium- and long-cycle educated engineers are employed either in small or large firms at the expense of the medium-sized companies. Today 30 per cent of the graduates are employed in firms with more than 1,000 employees. At the same time more than 93 per cent of the companies have less than 10 graduates employed (included are the self-employed).

The IT-industry especially has experienced a large increase in the employment of graduates the last 10 or 15 years. This is also true for the business in consulting. The large and traditional employment areas as electronics, building and construction and the metal industry have in the same period experienced a much more modest development in the employment figures.

For the last 4 or 5 years the unemployment of the medium- and long-cycle educated engineers has dropped dramatically and is still decreasing. Today the problems of unemployment are related to structural issues and short-term frictional unemployment, and not depending on the actual cyclical movement of the Danish economy.

Short-cycle engineers between skilled workers and engineering graduates

In 1993 the total number of employed short-cycle engineers was 80,542 with nearly 37 per cent employed in the private service industry. This dominating pattern has further developed the latest years, and contains a growth in different industries as consulting, finance, trade and administration.

Conversely is the manufacturing industry now experiencing a decrease in numbers of graduates employed and the employment in the public service sector is stagnating as well. The short-cycle engineers task and functions have been based on the fact that they are able to examine and asses both the practical and theoretical options and problems in connection with technical/engineering ideas and proposals. Due to this the short-cycle engineer is able to handle and solve engineering problems of rather complicated character.

The educated short-cycle engineer takes care of both wide, overall and management tasks in the enterprises and of more specialised tasks often based upon the competence acquired in the vocational education and training course. This is the reason why the field of tasks for the short-cycle engineer most typical has been in the *area between* the more theoretical educated engineers and the practical oriented skilled workers.

The technological development has made the competition between the short-cycle engineers and other professionals more significant. The skilled workers acquire continuously more theoretical knowledge and lift of qualifications in a way that they are able to take over some of the task of the short-cycle engineers. The competition is especially remarkable in connection with changes in organisational areas and conditions of production where the skilled workers have succeeded in expanding their task area. The short-cycle engineers experience at the same time a pressure from the medium- and long-cycle engineers who will out-compete the short-cycle engineer. The unemployment for short-cycle engineers increased from 4 pct to 6 pct in 1993.

TABLE DK-3.

Functional distribution of short-cycle engineers in manufacturing industry in Denmark, in per cent

Function in manufacturing industry companies	%
Development	34
Planning	21
Production	16
Marketing	10
Maintenance	10
Computer services	9
In total	100

Source: The Short-cycle Engineers' Competence and Location on the Labour Market, DTI, 1996

Further the technological developments have put a demand of changed qualifications to the short-cycle engineers. During the last few years comprehensive changes took place in the technologists tasks and function: increased individualisation, increased integration of functions and professional diffusion on still more and new tasks. The variety of tasks has increased and it its more and more difficult to delimit the short-cycle engineers to single homogeneous groups who maintain uniform tasks.

Also the enterprises' way of organising the production have effected the tasks of the short-cycle engineer. To a great extend the enterprises have externalised part of the production which again raise demands of competence in areas as management of projects and communication. At the same time the enterprises change their working conditions, ways of working and routines. Through these changes the ability to co-operate and take part in projects and the ability to define tasks becomes central in the way of organising the work.

In spite of the fact that the main part of the short-cycle engineers have shown that they were able to adapt to new conditions and were flexible according to the changed working condition, some part of the engineers have experienced an increasing mismatch between their real competence and the qualifications needed to handle the new conditions.

The challenge on the labour market today is that the labour market is becoming more and more tight. The demand of the industry for more and more people with a short-, medium- or long-cycle education in the engineering field is growing fast, but less and less students are choosing the studies in engineering. Therefore the rate of unemployment is decreasing fast and the labour market is experiencing more and more examples of mismatch problems and bottlenecks.

One way of solving this mismatch between demand and supply of technical skills is by substitution,. both in geographic and vertical terms. But that is not enough. It is urgent to expand the numbers of graduates leaving the educational systems in the coming years to match the growing demand. Another issue is to give the graduates on the labour market the possibility of continuing training.

Today it is not enough to be skilful in a narrow technical sense. The graduates have to have knowledge in personal and organisational matters to. Therefore the focus is changing in the direction of giving the graduates the possibility of continuing training in all aspects of working life, and also to upgrade older graduates with e.g. short-cycle engineering education to a higher level of competencies.

The development in the direction of a technology-based industry- and service-oriented society as well as the information society goes hand in hand with an increasing demand for technicians and engineers of the various specialised areas. A recent nation-wide questionnaire and interviews with companies focused on the job functions of short-cycle educated engineers and their possibilities on the labour market compared with medium- and long-cycle educated engineers.[21]

Overall the major developments on the labour market for the short-cycle educated engineers compared with medium- and long-cycle educated engineers can be listed as followed:

1) The short-cycle educated engineers are mainly situated with jobs within construction, sales and technical services, planning and purchase and logistics whereas medium- and especially the long-cycle educated engineers dominate jobs within development and consulting.
2) The short-cycle engineers carry out in general independent as well as varied team-tasks where it is more common for the medium- and especially the long-cycle educated engineers to have a function as managers.
3) The tasks and the jobs become more and more individualised and differentiated in terms of higher expectations of more personal and general skills or competencies, e.g. IT, project management, economy, marketing, language and cultural/organisational understanding, and not only technical skills alone. The result is that a short-cycle educated engineer with the right personality, ambitions and working experience can be more valuable than a medium- or a long-cycle educated engineer.
4) The demands for short-cycle educated engineers with a vocational background are higher than for short-cycle educated engineers with a theoretical background.

[21] See: The Short-cycle Engineers Competence and Location on the Labour market, DTI, 1996.

TABLE DK-4.

Distribution of medium-cycle and long-cycle engineers by economic sectors, 1993.

	Agriculture	Building / Construc-tion	Manufac-turing	Private services	Public services	Total
Number	-	8.247	16.575	23.697	5.080	53.599
Percentage	-	15.4	30.9	44.2	9.5	100

Source: The Union of Engineers in Denmark, 1998

TABLE DK-5.

Distribution of short-cycle engineers by economic sectors, 1993

	Agriculture	Building / Con-struction	Manufac-turing	Private services	Public services	Total
Numbers	1.152	11.928	23.313	29.771	14.379	80.542
Percentage	1	15	29	37	18	100

Source: The Short-cycle Engineers' Competence and Location on the Labour Market, DTI, 1996

Funding and quality insurance

There are no private tuition fees in Denmark. In Denmark public funding for teaching for medium-cycle programmes in Colleges of Engineering is provided *according to the success of student on yearly examinations*. Funding for short-cycle programmes in Technical Colleges/Schools is provided according to full-time enrolment, but not for student repeating a year. This funding approach is called the "taximeter" system.

In 1992 the Ministry of Education decided to establish the Danish Centre for Quality Assurance and Evaluation of Higher Education. The centre is commissioned to initiate regular evaluations of the study programmes by teams of na-

tional and foreign experts in order to strengthen the quality of higher education at an high professional level. Furthermore, it is the task of the centre to collect national and international experience in the field of evaluation of education and quality development and to ensure a dialogue between the centre, the institutions of higher education, and the employers of the graduates.
The centre is an independent agency under the Ministry of Education and it has a brief to initiate evaluation of higher education, develop appropriate methodologies, offer advice and disseminate its findings.
In 1995 the Centre carried out a evaluation of short-cycle technical programmes at the Technical Colleges. This evaluation was initiated on the request of the Council for Further Technical Education.

Improving the quality of teaching and the output of education was also the aim of a new initiative from the Ministry of Education in 1997 called “Visible Quality”. It should establish a model for comparisons of quality between schools and between programmes. The model contains two sections, one in which the objectives are stated and one in which the prerequisites are listed. The proposals are being discussed with various partners in the education process and within 1999 a final model should have been produced which will be mandatory to all educational institutions to use.

The role of the social partners

In Denmark there is a long-standing tradition which has given the labour market organisations responsibility for the development and organisation of vocational education and training. The contents and structures of these educational programmes are laid down by the Ministry of Education in close, institutionalised co-operation with the social partners. A co-operation called “the Danish model”.

As far as the short-cycle education is concerned a number of councils and committees take part in the decision-making process with either decisive or recommending influence. These advisory bodies are composed with equally representation of the employers as well as employees. The educational programmes

provided are subject to constant change in step with the general development of society. The principle that the educational programmes are most effectively kept up to date and relevant through the active participation of the labour market organisations is widely supported. Their participation is also a guarantee that the content of the individual education courses fulfils the requirement of the labour market, and that the qualifications provided have been found acceptable and useful by employers and employees in the enterprises.
At this level the objectives, scope, duration and so on of the educational programmes are defined.

Besides the above mentioned advisory bodies there are local educational advisory bodies at each Technical College. At this level the guidelines are converted into concrete plans for the educational programmes.

In general the social partners play an important role concerning the short-cycle education. New legislation and changes or innovation within the area are made in close co-operation with the social partners.

As far as the medium-cycle education is concerned there is not the same influence on the education by the labour market organisations. The main reason for this is that the Engineering Colleges are submitted to the Act of Universities, which gives extensive autonomy to these institutions and does not include co-operation with the social partners. They are only represented in the governing board of the colleges if the headmaster and the teachers look upon participating of the social partners as a benefit for the education. More and more colleges have members representing the social partners in their governing boards.

The Engineering Colleges make their own decision as to for instance which programmes they want to offer, how many qualified students they want to admit to the different programmes within their capacities, and how they will spend the funding within the institution etc.

TABLE DK-6.

Key data and information concerning Engineering Education and Training in the Non-University Sector in Denmark

1.	Engineering education outside universities	Medium-cycle engineering education at the Colleges for Engineering and short-cycle engineering education at the Technical Colleges.
2.	Formal degrees, titles	Colleges for Engineering: Diploma-engineer/ Bachelor of Science in Engineering and Export engineer; Technical Colleges: Advanced Technicians in different areas of engineering, Construction Architect, Diploma in Food Business and Construction Engineer in Textile and Garment, Technologist in Environment, Laboratory and Chemical.
3.	Duration	Colleges for Engineering: 3½ years; Technical Colleges: 1½ - 3½ years
4.	ISCED-classification	Colleges for Engineering: ISCED level 6; Technical Colleges: ISCED level 5[22]
5.	EU-directives	Medium-cycle (First directive); short cycle (mostly Second directive)
6.	Labour force	Long- and Medium-cycle engineers: 53.599[23] in 1993; Short-cycle engineers: 80.542 (1993)
7.	Number of students	Intake of full-time students on Colleges of Engineering (medium-cycle): 6.000 (1995/96); Intake of full-time students at Technical Colleges (short-cycle): 4.500 (1995/96)
8.	Co-operation with industry	Colleges for Engineering: Mandatory work placement - ½ year of trainee service/work experience paid by the employer. Technical Colleges: Mandatory work placement for several educational programmes.
9.	Labour market acceptance	Low unemployment, strongly growing employment prospects for engineering qualifications
10.	Access to regulated professions	Technical Colleges: Electrical Engineer and H.V.A.S. Engineer with specialisation / authorisation .

[22] Construction Architect, Diploma in Food Business and Construction Engineer in Textile and Garment and Technologist in either Environment, Laboratory or Chemical are all educational programmes in continuation of a short-cycle education taking place at the Technical Colleges with a ISCED level at 6.

[23] Include long-cycle engineers as well.

Translation of Danish institutions

Lang videregående uddannelse	Long-cycle higher education
Mellemlang videregående uddannelse	Medium-cycle higher education
Kort videregående uddannelse	Short-cycle higher education
Teknisk Universitet	Technical Universtity
Ingeniørhøjskole	Colleges of Engineering
Teknisk Skole	Technical Colleges
Teknisk Landsforbund	Union of Technicians
Erhvervspædagogisk Læreruddannelse	The Danish Institute for Educational Training of Vocational Teachers)

Dutch Higher Professional Education

Ruud van der AA

The Dutch system for higher education consists of a clear binary structure with university education on one side and higher professional education on the other side, each having their own identity as defined by law.

At the level of higher education in the Netherlands there is, outside the traditional universities, only one pathway of engineering education and training leading to the title of *ingenieur.* This higher professional education (HPE) is provided by HBO institutes, in Dutch known as *hogescholen*[24]*.* From an international perspective, the level of these *hogescholen* can be compared to the level of Germany's *Fachhochschulen* and to Bachelors courses at British universities and polytechnics. For the sake of transparancy and international communication as regards education and labour market, the Dutch Minister of Education, Culture and Science allowed the *hogescholen* in 1998 to use the name 'University of Professional Education'. By law HPE is defined as education that is geared to the transfer of theoretical knowledge and the development of skills of direct relevance to the world of work.

Legal framework and course design

Legally defined as such, higher professional education has existed in the Netherlands since 1968. Up till then HPE was legally seen as secondary education although this was not seen as appropriate for several years. In the perspective of the conditions for admission HPE was clearly seen as post secondary education. Only in 1986 the legal association of HPE with secondary education came to an end. From than on HPE was officially recognised as a form of higher education, regulated by its own law. Since 1993 all forms of higher

[24] In English, the word *hogeschool* is often translated as polytechnic or professional college.

education, HPE as well as universities, are regulated by the same Act on higher education and scientific research (WHW). Since then the boundaries between university and HPE are more easily crossed, although this was already officially arranged in the 1980s. It can be concluded that HPE in the Netherlands clearly has emancipated during the last decades into an officially recognised form of higher education, which now and then even challenges the (higher) status of the universities. Furthermore we notice that HPE in the Netherlands have had a notable emancipatory role in Dutch education, since it promotes the social mobility of students who initially do not have the right qualifications to enter into university education.

For virtually all programmes in HPE the length of the study programmes is legally determined at four years. In general the HPE courses have the same duration as the university courses, except for the engineering courses. As a result of pressures from the technical universities, supported by the central employers organisation and professional bodies, showing the inadequacy of the four year framework, the government decided in 1997 to expand the formal length of study for engineering programmes at the technical universities to five years. The engineering courses in HPE remained four years. Results from a survey in 1999 among HPE graduates show that there are virtually no differences between the nominal and actual course duration of engineering courses.

Orientation towards the occupational practice

The purpose of HPE as defined by law is to offer theoretical instruction combined with the development of skills required for practical application in a particular profession. The focus is on one specific professional field. Industrial training periods are an important part of the training The main characteristics of HPE can be described as follows:

- The curriculum combines theoretical education with mandatory practical work outside the institution, under supervision of the *hogeschool*.

- The curriculum is geared to needs for manpower, but the final decisions in matters of curriculum are made solely by the *hogescholen* themselves, though ultimately subject to approval by the Ministry of Education, Culture and Science (also see section on quality assurance).
- With some exceptions, the *hogescholen* have a strong regional basis and are part of a network consisting of local industry, chambers of commerce, etc.

Additionally to its educational activities the HPE institutions undertake applied research in favour of regional small and medium sized industries, indicating a clear transfer of knowledge. Research activities are often carried out by graduating students. In this respect there is a direct relation to the teaching activities within the curriculum. It is however important to notice that, in contrast to the university sector, the funding mechanism for the HPE sector does not provide for research activities, since conducting research is not seen as a task of HPE. Recently the central employers organisation stressed that the knowledge transfer function of HPE should be improved.

Typical for Dutch HPE is its strong orientation towards the occupational practice. Therefore a work placement is an obligatory part of the study programme. This aspect distinguishes HPE most from university education. In the engineering courses the practical training in general lasts between half a year and ten months, and usually takes place in succession in two companies. During the practical period every student has a supervisor both at the faculty and in the workplace. An agreement is set up as regards activities, responsibilities, objectives and other requirements, which have to be fulfilled. The student returns periodically to the institute to turn in progress reports and participate in discussions. At the end of the practical period the students are required to turn in detailed reports on their individual experiences. To organise the work placements there is a very close relationship with regional branches of industry. Besides the work placement in the second or third year, the final project in the fourth year generally takes place outside the *hogeschool*, for instance within a company or research institute.

In 1999 the HPE engineering faculties have started a national project for renewal of all curricula. The main aim is to define, in co-operation with the industry, the required professional qualifications in terms of competencies, which is wider than knowledge only. These competencies will be translated into educational aims and curricula. These will remain the responsibility of the engineering faculties themselves.

Supply of courses and student numbers

At this moment there are about 68 HPE institutes in the Netherlands. About 30 of these offer engineering courses. The total number of HPE students in 1998/'99 was 285 thousand, of which 53 thousand in engineering courses.

At the moment HPE is divided into seven sectors of education: behaviour and society (14 per cent of the HPE enrolment), agriculture (3 per cent), engineering and technology (19 per cent), health care (9 per cent), economics and management (30 per cent), arts (6 per cent), and teacher education (19 per cent). So the engineering courses attract almost one fifth of all HPE-students. Although the number of students attending HPE increased significantly during the 1980s and 1990s the proportion of students following an engineering course dropped with 2 per cent, obscuring the fact that in recent years certain courses has shown a dramatic decline in the number of students, e.g. electrical engineering. The modest supply of HPE graduates has been perceived as a serious labour market problem for several years now.

Every sector in HPE contains a wide variety of separate study programmes. For technology and engineering education there are about 35 specialisation options. There is however a tendency to integrate related courses, especially during the first two years of study. In 1998 the most popular options among the students were computer science, architectural engineering, mechanical engineering and electrical engineering. The proportion of females among HPE students in engineering courses has increased in the last decade from 12 per cent in 1990 to 16 per cent in 1998. The proportion of female students is highest in the courses for industrial engineering and medical and biological laboratory techniques, and lowest in car engineering and electrical engineering.

Table NE-1.

Most popular studies among new entrants in higher professional education (1994-1998)

Field of specialisation	1994	1995	1996	1997	1998	1997-1998
Architecture engineering	1541	1646	1750	1763	1696	-4%
Electrical engineering	1840	1559	1528	1537	1593	4%
Computer science	897	1074	1315	1768	2298	30%
Mechanical engineering	2103	1775	1660	1693	1630	-4%
Industrial engineering	1337	1582	1288	1362	1499	10%
Total	7718	7636	7541	8123	8716	7%

Source: HBO-raad, *Het HBO ontcijferd*, Den Haag, juni 1999; *R. van der AA, country report*

Further routes of graduates

A great number of HPE institutes offer master courses as well, often in co-operation with British universities in which case a UK masters degree is conferred. Recently, the Dutch Minister of Education, Culture and Science decided to introduce an accreditation of these master courses and other courses given at Dutch universities as post *doctoraal* studies. Graduates of HPE institutes have access to post M.Sc. engineering courses given at universities. Up to 50 per cent of the participants of these courses initially completed a HPE study.

Besides the master courses about two-thirds of all *hogescholen* offer other post-HPE programmes as well. These programmes are available in almost every sector and vary in length from several weeks to several years. They are geared towards university and HPE graduates and provide advanced professional training, refresher courses, or custom-made courses designed to meet the specific needs of a particular group. The majority of these courses are not funded by the Dutch government, nor are they regulated by the Higher Education and Research Act (*WHW*).

HPE graduates in engineering may transfer to university with transfer credits or decide to do one extra year in engineering at HPE level (extra subject specialisation). One and a half year after completing their study it appears that 12 per cent of HPE graduates in engineering decided to continue their educational career, so not directly entering the labour market.

According to the International Standard Classification of Education (ISCED) HPE is rated as university level education (i.e. ISCED 6/7). At first sight this appears to be somewhat exceptional compared to most other countries. Indeed, in the international classification of educational levels, education at the tertiary level that leads to an award which is not equivalent to a first university degree, is regarded as ISCED level 5. However, if the system allows students, who successfully complete their study at ISCED level 5, to proceed to university programmes in the same field, this education is considered to be ISCED level 6/7. This argument also applies to the Dutch HPE. Moreover, in the Dutch system it is possible for HPE-students, who finish their first year, to pass to a university course in the same field of study. In this respect Dutch HPE can be considered as a “first phase” of university education. Moreover, HPE graduates are allowed to do their thesis at a university and each year some of them actually do so. Therefore, according to the ISCED-classification, the Netherlands do not have any students at ISCED level 5. These students are all rated among the university level. Although formally HPE is rated as university level education (ISCED

6/7), it is not perceived as such by young people in the Netherlands who are about to make their choice of study.

In the academic year 1998/1999 almost 18 per cent of the enrolment in the first year at the universities had an HPE background. Thirteen per cent of these students successfully completed a (full) four year HPE-course, and about 5 per cent were HPE-students who decided to go to the university after completing the first year in HPE. Conversely this means that approximately 2 per cent of the HPE enrollment continu in university education after completing the first year and that 5 per cent of the HPE graduates (directly) continue their educational career at university, where they usually follow a shortened course.

Degrees and title for engineers

HPE students who complete all the requirements of the engineering course are granted an engineering degree. The concept of a first degree or undergraduate and graduate degrees does not exist in the Netherlands. HPE graduates of courses in engineering, agriculture and environmental science may use the title *ingenieur*, abbreviated as *ing*. Engineering graduates from university are also called *ingenieur*, however differently abbreviated as *ir.*, indicating the difference in educational pathway. The titles ing. and ir. are defined and protected by law. Graduates of all HPE courses, regardless of their discipline, are allowed to use the non protected title ‘bachelor’ instead of the *ing*. title. This is especially relevant for graduates who go abroad for further study or work. The diverging background of the two engineers leads to horizontal rather than vertical differences on the labour market, although it appears that the career perspectives of university engineers are slightly better.

New developments to reduce the shortage of engineers

As mentioned the engineering courses in HPE include an internship within a company. In recent years two new alternatives has been introduced in higher professional education, alternatives in which there is even a closer relationship between education and the business community. These alternatives are known as ‘co-operative education’. In this form of education the fourth year of study is a combination of learning and working, in which the participant is student as well as an employee at the same time. At present there are about eight *hogescholen* that offer *MKB*-courses, especially in technology and engineering. In the near future these experiments will be legally settled as equal alternatives to the current engineering courses.

TABLE NL-2.
Graduates from higher professional education (1993-1997)

Subject	1993	1994	1995	1996	1997	1996-1997
Architecture engineering	679	745	907	1017	928	-9%
Electrical engineering	1865	1742	1792	1667	1336	-20%
Computer science	714	739	793	704	647	-8%
Mechanical engineering	1581	1612	1608	1563	1467	-6%
Industrial engineering	1247	1300	1536	1319	1238	-6%
Total	6086	6138	6636	6270	5616	-10%

Source: HBO-raad, Het HBO ontcijferd, Den Haag, juni 1999

The supply of new graduates has decreased in the nineties, but the demand for engineering high level qualifications has not done so (see table NL-2). To reduce the structural shortages of engineers on the Dutch labour market, in 1999 a national committee has been set up (AXIS) to develop innovative ideas concerning the alignment of education and employment. This committee is a joint initiative of the Ministry of Economic Affairs, the Ministry of Education, Culture and Science, the national organisations of employers and the HPE Council. More in particular the committee will try to develop ideas that will enhance the attractiveness of engineering courses to new students. Moreover, reducing the dropout rate is also an important mission. Rearranging the existing courses to new ones will be an important strategy of the committee. At the moment several

AXIS projects are being implemented aiming at improving the relations between HPE, secondary education and local industry in order to foster the interest of young people for engineering.

Employment and labour market trends

Graduates from HPE education are becoming more and more part of the flexible workforce. In 1991 72 per cent of the HPE graduates had a steady job (one and a half-year after finishing the study). In 1995 this proportion had declined to 63 per cent and 60 per cent in 1997. Probably influenced by the shortages on the labour market this proportion again increased in 1998 to 66 per cent. This general development also appears to apply for HPE graduates in engineering education.

Table NL-3.
Rate of unemployment among (full-time and part-time) HPE graduates one and a half-year after graduating (1993-1997)

Educational attainment	1993	1995	1998
HPE in Engineering and Technology	17%	6%	1%
HPE in Agriculture	12%	9%	3%
HPE in Teacher Education	10%	7%	3%
HPE in Economics and Management	11%	4%	2%
HPE in Health Care	7%	2%	2%
HPE in Behaviour and Society	10%	7%	3%
HPE in Arts	28%	12%	6%
Total HPE	12%	6%	3%

Source: ROA, *HBO-Monitor 1993, 1995, 1998*

The jobs of HPE graduates are mainly situated in commercial services (24 per cent), industry (15 per cent), health services (15 per cent) and education (13 per cent). Also most graduates from engineering courses can be found in commercial services (33 per cent) and industry and utility companies (31 per cent). Additionally, it is reported that the majority of the HPE graduates (62 per cent) works in the profit sector. This even more applies to HPE graduates from engineering courses of whom 90 per cent works in the profit sector, which is about the same for HPE graduates from Economics and Management.

On an national level every year a survey is conducted among graduates from higher professional education (*HBO monitor*); this survey takes place one and a half year after leaving school. In 1998 the proportion of unemployed among HPE graduates in engineering was 2 per cent, whereas for all HPE students it was 3 per cent. In particular the period 1993-1995 showed a sharp decline in unemployment among graduates. Due to the flourishing economy in the Netherlands at the moment, unemployment in general has reached the lowest levels since decades. There are only slight differences in unemployment between various engineering courses in HPE.

Most graduates from engineering courses can be found in commercial services (33 per cent) and industry and utility companies (31 per cent). Nine out of ten graduates work in the profit sector. Almost two third of the engineering graduates work in large companies with over 100 employees. This is about the same for all HPE graduates. This is more or less in proportion to the distribution of employment in the Netherlands.

Of all HPE graduates, engineering graduates who enter the labour market earn the highest incomes. This situation has occurred only since a few years, which is probably an answer to the strong need for engineering qualifications on the labour market. There are, however, some differences in income between HPE graduates from various engineering courses. For instance, the income of graduates in computer and information science, (technical) business administration, and operational technology is above average, whereas the income of graduates in architecture and construction engineering, environmental science, and laboratory techniques is clearly below average.

TABLE NE-4.

Distribution of graduates from HPE by industries, 1996, Engineering fields of study compared to all fields

Branches:	HPE engineering education %	HPE (overall) %
Industry	31	15
Building industry	8	3
Trade and repair	10	8
Transport, post and telecommunication	6	4
Financial business	2	6
Commercial business	33	24
Public management	4	5
Education	2	13
Health services	4	15
Other services	0	9
	100	102
Total (N=100%)	8,100	31,700

Source: HBO-Monitor 1996; R. van der AA, country report.

About 80 per cent of the HPE-graduates report a good/sufficient alignment between their education program and the work they are doing. However, it seems that HPE graduates, although the training received is notably seen as relevant for the present work, the entry level in terms of required work experience is quite modest.

According to a majority of graduates (55 per cent), who were questioned in 1997, the curricula in engineering should pay more attention to recent developments in the field, as for instance new technologies. In line with this, almost half of the graduates (45 per cent) has the opinion that too little attention is paid to information and communication technology (ICT). Besides this, many graduates also would like to be trained more in other competences, as for instance presentations and negotiating.

The alignment of education and the labour market is rather a dynamic than a static event. Continuing education often plays an important role in facilitating the transition from education to a specific working environment. During their first one and a half year on the labour market about 40 per cent of all graduates participated in some sort of continuing education.

Quality assurance, funding, tuition fees and grants

Each *hogeschool* is responsible for determining the content, educational objectives, examination requirements, and workload for every study program it offers. Although educational objectives will have to meet nationally determined standards, given the freedom that *hogescholen* have to determine how those standards are met, no two study programmes need to be exactly alike. To avoid extreme differences on this the freedom of the institutes is limited to 30 per cent of the curriculum, the other part more or less being equal between institutes. This leaves the opportunity to the institutes to meet the specific qualification needs of the regional branches of industry and qualification needs relating to new technology.

The HPE institutes are deemed to be self-regulating as far as quantity and quality control are concerned. This implies that educational institutions are not only primarily responsible for the study programmes they offer but also for assessing and monitoring quality. There are no uniform requirements for this. However, internal evaluation should take place every year and an integral inspection by an external review committee is conducted every five or six years. The external committee consists of external experts from industry, universities and other organisations. The review committee reports to the HPE Council and ultimately to the Ministry of Education, Culture and Science.

Recently the Minister of Education, Culture and Science has decided to start experiments with formal accreditation of HPE courses. The current system of quality assurance will be conclusive for the decision of formal recognition. All public universities and HPE institutes are funded by a central government grant, calculated on the basis of a general formula. This funding is a lump sum in order to enable institutes to formulate their own policies. The budgets of the institutes do not require ministerial approval. Institutes render account of their expenditures in their annual reports.

Although the funding of Dutch higher education is almost entirely depending on contributions of the national government, in recent years the budgets of institutes for higher education increasingly are financed in a more direct way by tuition fees[25]. Especially as regards the HPE institutes it is the policy of the national government to strengthen the relationship between the number of enrolments and the institutes' budget. By the government this is seen as an important incentive for the HPE institutes to perform an adequate and early selection of new students and to enhance the 'consumability' of study programmes, in order to avoid drop-out of the study program. The current situation, however, still is that tuition fees are deducted from the governmental grant.

As concerns the funding of universities the government aims at stabilising their income position, which just implies a less demand oriented funding mechanism. The main reason for the difference in funding between HPE institutes and universities is the simple fact that in the coming years for the HPE institutes a growing number of students is expected. For the universities a steady number of enrolments is envisaged. Also because of a decrease in the length of study time the basis for funding is becoming smaller.

All HPE students who are in a full-time study program have to pay the same tuition fee. There are no differences between different fields of study. For the year 1997/1998 the tuition fee for the HPE sector was legally determined at 2.750 Dutch guilders, which is approximately 1.250 ECU's.

Student grants are available to those students who are enrolled at a course of study, which is officially approved of by the Minister of Education, Culture and Sciences. The majority of these programmes is offered by the state-funded universities and the HPE institutes, but they can also be offered by private institutes, which also can be officially recognised by the Minister.

The financial support for students consists of two components: a basic grant and a supplementary grant. The basic grant is initially given to the student as a conditional loan. This loan is converted into a grant if (i) during the first year (*propedeuse*) the student earns enough number of credits (50 per cent), and (ii) completes the study program within 6 years. If he/she fails to do so, the grant is converted to an interest-bearing loan. In recent years there has been much discussion about this rationale of financial assistance for students. The supplementary grant is not converted since it is given as a loan and remains so during the study program.

The basic grant can be supplemented by a loan up to a certain maximum. The exact amounts of grants and loans depend on an estimation of the national cost-of-living. Also the parent's ability to contribute in the costs and whether or not a student is living with his parents are taken into account. The same system of grants applies to students in both sectors of higher education (HPE as well as universities).

The Dutch government is seen as having a duty to provide higher education. Based on mutual agreed policy of cabinet and parliament the government allocates annual budgets to the universities and HPE institutes. The government also sets the educational policy framework within which the universities and HPE institutes have to operate. The government's conception of the role it

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[25] For a more profound description see: R. van der Aa, *Consumentenkeuze in het hoger onderwijs; een internationaal vergelijkend onderzoek* (Consumer choice in higher

should play in higher education has undergone significant changes in the last decade. It is even stated that the Netherlands offer the most interesting case in Western Europe for studying recent changes in the relationship between the government and the higher education institutions. The changed conception of the government's role has resulted in the Higher Education and Research Act (*WHW*) of 1993.

Following main developments in the UK, the underlying principle of the *WHW* is to give the institutions more autonomy and greater freedom of policy within the framework as set by the government. This is viewed as a means of enabling the higher education system to respond more effectively and decisively to changing needs of society. Each HPE institute is responsible for determining the content, educational objectives, examination requirements, and workload for every study program it offers. Although educational objectives will have to meet nationally determined standards, given the freedom that the HPE institutes have to determine how those standards are met, no two study programs need to be exactly alike. For specific professions as nursing and architecture, less freedom is permitted with regard to the curriculum, because of legally defined requirements. Regulation and planning beforehand has been replaced in recent years by control of a more general nature afterwards. At the same time the *WHW* stresses that despite decentralisation, the government remains responsible for the "macro-efficiency" of the system, i.e. the efficient distribution of study programs to societal needs.

The system of quality control is a critical component of the *WHW*. Quality control has three functions[26]. The first of these is to help the institutions to ascertain the quality of their work; they can then take steps to improve quality on the basis of the findings. Secondly there is a strong element of accountability in the quality control system. By making regular, independent, accurate, and publicly

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education; an international comparative research), NEI, Rotterdam, 1998.

[26] See: P. Schuler, J. Stannard, R. Warmenhoven: The Education System of the Netherlands, Special Country Report 1996, Nuffic.

available assessments, institutions are more accountable to society for the way in which they spend public funds. In this respect internal evaluation by the HPE institutes as well as officially installed review committees (peer review) play an important role. The government has the means at its disposal to curtail funding in cases where quality is judged to have been inadequate for a number of years and where official warnings have not resulted in improvements. Thirdly, it is assumed that the results of quality assessment will be noted by members of the public and used, for instance, by students when deciding what and where to study, or by companies looking for an institute to undertake contract work (research or teaching).

The HPE institutes are deemed to be self-regulating as far as quantity and quality control are concerned. This implies that educational institutes are not only primarily responsible for the study programs they offer but also for assessing and monitoring quality. They are free to decide what form quality control should take as long as they adhere to the statutory requirements regarding procedure. There are no uniform requirements for this. However, internal evaluation should take place every year, and an integral inspection by an external review committee is conducted every five or six year. The review committees consist of external experts from industry, universities and other organisations. The committee reports to the HPE Council and ultimately to the Ministry of Education, Culture and Sciences.

Recently the Minister of Education, Culture and Science has decided to start experiments with formal accreditation of HPE courses. The current system of quality assurance will be conclusive for the decision of formal recognition.

The role of the social partners

At national level as well as at institutional level contacts are organised with the business community. The HPE institutes are themselves responsible for organising contacts with the business community. Each institute has its own advisory councils or occupational committees, responsible for advising on curriculum development in relation to trends in the labour market. The task of such committees is primarily to gauge the extent to which courses meet the demands of the labour market and to promote regular contact with the occupational field. In addition a large proportion of the institutes have an industry/occupational advisory council at institutional level.

At national level there are meetings on a regular basis between representatives of the Association of Dutch Polytechnics and Colleges (the HPE Council: *HBO-Raad*) and representatives of professional bodies from various branches of industry. In the past these councils have been closely involved in modifying the courses offered. This will be continued in the future. At national level there are also contacts with the labour unions and employers' association. At regional level the HPE institutes are increasingly co-operating with business and other organisations.

TABLE NL-5.

Key data and information concerning Engineering Education and Training in the Non-University Sector in the Netherlands.

1.	Engineering education outside traditional university	Engineering courses in Higher Professional Education (HPE)
2.	Formal degrees, title	*Ingenieur,* abbreviated as *ing.*
3.	Duration	4 years
4.	ISCED-classification	ISCED 6
5.	European directives (first and second)	HPE is included in the European First General Directive (Council Directive 89/48/EEC of 21 December 1988 on a general system for the recognition of higher education diplomas awarded on completion of professional education and training of at least three years''duration)
6.	Quantitative relations in the labour force (rough figures)	In labour force with previous education on HPE level in technical fields in 1998: 246.000
7.	Number of students in relation to other routes	Secondary vocational education in technical fields in 1998/'99: 30.400; HPE technical fields in 1998/'99: 53.300; University in technical fields in 1998/'99: 22.900
8.	Co-operation with industry (what kind of co-operation, formalised or not)	Mandatory work placement during the third year. Final project in fourth year in close co-operation with enterprises
9.	Labour market acceptance	Very low unemployment. Higher income than HPE students from non-engineering fields of study
10.	Entitlements and access to regulated professions	Regulated professions for HPE graduates are: teacher in HPE, fire officer, navigation and marine engineer, architect (after post HPE course)

Listing of abbreviations, organisations and institutes

Abbreviation (Dutch)	In full English	Dutch translation
CBS	Central Bureau of Statistics	Centraal Bureau voor de Statistiek
HAVO	Senior general secondary education	Hoger algemeen voortgezet onderwijs
HBO-raad	Dutch council of HPE institutes	HBO-raad vereniging van hogescholen
HOOP	Higher Education and Research Plan	Hoger Onderwijs en Onderzoeksplan
HPE (HBO)	Higher professional education	Hoger beroepsonderwijs
ISCED	International Standard Classification of Education	Internationale onderwijsclassificatie
NIRIA	Dutch Association of Engineers	Nederlandse ingenieursvereniging
MAVO	Junior general secondary education	Middelbaar algemeen voortgezet onderwijs
MKB Nederland	Dutch employers' association for small and medium sized companies	MKB Nederland
MTO	Secondary technical education	Middelbaar Technisch Onderwijs
NEI	Netherlands Economic Institute	Nederlands Economisch Instituut
PVE (VBO)	Pre-vocational education	Voorbereidend beroepsonderwijs
ROA	Research Centre for Education and the Labour Market	Research Centrum voor Onderwijs en Arbeidsmarkt
USVE (MBO)	Upper secondary vocational education	Middelbaar beroepsonderwijs
VWO	Pre-university education	Voorbereidend wetenschappelijk onderwijs
WHW	Act on higher education and scientifuc research	Wet op het hoger onderwijs en wetenschappelijk onderzoek
WHBO	Higher Professional Education Act	Wet op het Hoger Beroepsonderwijs

Portuguese Polytechnic Education

Augusto G. Medina, Fernanda Oliveira

Higher education expanded very quickly since the 80's in Portugal. The number of students who have completed secondary education increased from about 6,900 (1970/71) to about 30,000 and to 125,000 (1990/91).[27] The gap between applicants and vacancies in public Higher Education grew till 1996. Polytechnic education contributed to a great deal to the expansion of higher education. The sector should provide the country with shorter, vocational courses and promoting instruments for regional development. The development since 1979 and 1980 (ratified by the Basic Law for the Education System published in 1986) created two separate subsystems – university and polytechnic, thus a binary organisation has been established.

After changes of the law (1977) the two subsystems of higher education are able to award *bacharelato* and *licenciatura*. Postgraduate degrees (mestrado and doutoramento) continue to be the exclusive reserve of the Universities. [28] One part of the polytechnic licenciatura is organised in two cycles, the first of which corresponding to a bacharelato degree. The communication between the two institutional areas of higher education in Portugal is legally guaranteed and students are able to move from one to the other.[29]

The introduction of private institutions of higher education was an important factor to the development in the 90's as well. About 30 per cent of the students were enrolled in private institutions, more than 60 per cent in public institutions

[27] Ministry of Education/Directorate-General for Higher Education: Higher Education in Portugal, December 1999, p. 13.

[28] Ministry of Education/Directorate-General for Higher Education: Higher Education in Portugal, December 1999, p. 19.

[29] Minstry of Education, op.cit., p. 19.

and a small percentage in the Universidada Católica.[30] Polytechnics and Universities are of a public and a private nature.
Currently there are two profiles of engineers in Portugal: those with an University education, who are called *engineers and* those with a Polytechnic education, who are called *technical engineers*.

Polytechnic Education background

Polytechnic education started in 1837 with the creation of the Lisbon and Porto Polytechnic Schools. In the XX century other schools were created, in order to overcome the shortage of higher education graduates at the intermediate level, to diversify higher education and to meet the demand in various socio-economic sectors. Yet, it was only in 1990 that a legal diploma was issued (law 54/90 of 05.09), defining the scientific, pedagogical, administrative, financial and disciplinary autonomy of Polytechnic Institutes.[31]

Polytechnic Institutes are higher education institutions that include two or more higher education schools and other organic units in a given region. Polytechnic Education is also conducted in some Universities. Instruction covers the fields of Technology, Arts and Education. The current network of public Polytechnic Education includes 15 Polytechnic Institutes, the Universities of Algarve and Aveiro, three military schools, and 14 private institutions. Additionally, there are 22 higher education nursing schools, 3 education health technology schools, the Infante D. Henrique Marine School, the Estoril Higher School for Tourism and Hotel, and the Higher School for Preservation and Restoration.

[30] Minstry of Education, op.cit., p. 17.

[31] See: Ministry of Education: The Portuguese Education System. The System Today and Plans for the Future, 2nd Edition, December 1999, Lisboa, p. 55ff.

Engineering Polytechnic Education

The Polytechnic Education programme is shorter than University programmes and confers a “Bacharelato” degree. After completion of a “Bacharelato”, students have two options:

- To enrol in a two year programme, Programme of Specialised Higher Education (Curso de Ensino Superior Especializado – CESE). Upon completion of the CESE programme students receive a degree equivalent to a “Licenciatura”.

- Apply to a University, where after two years of studies they can receive a “Licenciatura” degree.

TABLE P-1.

Main landmarks in the history of the training of engineers in Portugal

1837	➢ Polytechnic School of Lisboa
	➢ Polytechnic Academy of Porto
1852	➢ Industrial Institute of Lisboa
1854	➢ Industrial School of Porto
1911	➢ Technical Higher Institute of Lisboa
1915	➢ Technical Faculty of Porto
1921	➢ Faculty of Engineering of Porto
1971	➢ Engineering Programme at the University of Coimbra
1973	➢ Universities of Minho, Aveiro, Évora and Nova of Lisbon
80’s	➢ Universities of Algarve, Beira Interior, Trás-os Montes e Alto-Douro, Açores and Madeira;
	➢ Public Polytechnic Institutes
90’s	➢ Private Universities
	➢ Polytechnic Institutes

Source: Journal Ingenium, Ordem dos Engenheiros

The number of students enrolling in the first year of both University and Polytechnic institutions is increasing. But, the ratio of enrolment, Polytechnic to University, has remained quite constant, averaging 26 per cent. Between 1989 and 1993, the number of admissions in engineering programmes doubled (approximately 11,000 students enrolled in engineering programmes in 1993/94). Access to the Higher education institutions is limited by a *Numerus clausus*[32] and it is based on the grades obtained at the secondary education level and at national examinations taken in the specific subjects legally established for each establishment/programme. The process is very competitive, as the number of applications surpasses the number of vacancies.

This explains the recent increase in the number of private universities as well as the number of programmes offered by formerly established private universities, most of which were created to attract students which were not able to enrol in public education establishments. In a period of 15 years, the number of programmes in engineering grew from approximately 20 to close to 200. Engineering students account for 17 per cent of Higher Education students. This trend is reversing, as the number of candidates is decreasing due to the stabilisation of the population boom and the *Numerus clausus* in public higher education is increasing.

The training of engineers is dominated by the public sector due to the required large investment that many private universities do not want to assume. In 1993 only 22 per cent of the students enrolling in engineering programmes were in private institutions. In terms of Polytechnic education currently private institutions account for 29.5 per cent of the total number of students.

Polytechnic education currently accounts for 48.8 per cent of the students enrolled in the first year of engineering programmes. Environmental, Electrical, Agronomic and Industrial engineering are fields where the number of students

[32] This is true since 1976, the regime initially applied to some fields of study, such as Medicine, but was expanded the following years to include all courses in all areas, see:

in public Polytechnics surpasses that in Universities. The Polytechnic Education programmes have a duration of 3 years. They are quite intense, with a total load of approximately 2,400 hours. Practical work represents a significant component, corresponding to approximately 60 per cent of the total load. Teaching is often done by professionals, rather than by professors in a range of fields.

According to Professional Association of Technical Engineers ("Associação Profissional de Engenheiros Técnicos" – APET) the Polytechnic Engineering Education programmes are classified in eight fields:

TABLE P-2.

Engineering fields with respective examples of degrees

	Field	Examples of Engineering Degrees
1.	Agronomic	Agricultural; Agri-Food Industrial; Biotechnological; Food; Forestry; Rural; Zoo-Technical
2.	Chemical	Ceramics; Chemical; Environmental; Industrial; Industrial Maintenance; Wood
3.	Civil	Civil; Civil and Environmental; Civil and Territory
4.	Computing	Computing; Electrical and Computer; Graphic Computing; Management Computing; Multimedia; Systems Computing
5.	Electrical & Telecommunications	Automation and Control; Communications; Electrical; Electrical and Electronics; Industrial Electrical, Telecommunication Systems and Electrical
6.	Energy & Power	Electrical; Energy and Environment; Renewable Energy
7.	Geo-Technical	Geographical; Geo-Technical; Territory; Topographic
8.	Mechanical	Electro-Mechanical; Industrial Production; Machine; Mechanical; Transportation

Higher Education in Portugal, op.cit., p. 14.

Currently, Polytechnic Engineering programmes are conducted in 15 public Polytechnic Institutes:

- Polytechnic Institute of Beja (IPBeja)
- Polytechnic Institute of Bragança (IPBragança)
- Polytechnic Institute of Castelo Branco (IPCBranco)
- Polytechnic Institute of Coimbra (IPCoimbra)
- Polytechnic Institute of Guarda (IPGuarda)
- Polytechnic Institute of Leiria (IPLeiria)
- Polytechnic Institute of Lisboa (IPLisboa)
- Polytechnic Institute of Portalegre (IPPortalegre)
- Polytechnic Institute of Porto (IPPorto)
- Polytechnic Institute of Santarém (IPSantarém)
- Higher Polytechnic Institute of Santarém (ISPSantarém)
- Polytechnic Institute of Setúbal (IPSetúbal)
- Polytechnic Institute of Tomar (IPTomar)
- Polytechnic Institute of Viana do Castelo (IPVCastelo)
- Polytechnic Institute of Viseu (IPViseu)

In addition, education at polytechnic level is also offered by the Universities of Algarve and Aveiro, by three military schools (Military Academy, Higher Polytechnic School of the Army and Naval School) and by 14 private institutions:

- Autonomous Polytechnic Institute
- Cocite
- Dinensino
- Higher Institute of Administration, Communications and Enterprises
- Higher Institute of Advanced Technologies
- Higher Institute of Education and Sciences
- Higher Institute of Entre Douro e Vouga
- Higher Institute of Health Sciences
- Higher Institute of Intercultural and Multidisciplinary Studies
- Higher Institute of Languages and Administration
- Higher Institute of Paços de Brandão
- Higher Institute of Transportation
- Higher Polytechnic Institute of Gaia
- Institute of Electro-mechanics and Energy

It can be noticed that the Polytechnic Institutes of Lisboa, Porto, Castelo Branco and Coimbra are, by this order, the institutions with the greater number of students.

Quality control institutions

The fast increase in the number of programmes in engineering education, together with the expansion of higher education, led to concerns in terms of the quality of both the level of the students and of the engineering training programmes. Between 1989 and 1993, the number of admissions in engineering programmes doubled while the average grades of the students decreased. In order to ensure the quality of Higher Education, the Portuguese Association of Engineers (“Ordem dos Engenheiros”) established a quality control system. Similarly, the Ministry of Education is carrying out an evaluation scheme of public Universities, which will be further extended to private Universities and to Polytechnic establishments. Currently the quality of the Programmes offered is quite heterogeneous.

In terms of Polytechnic Engineering Education, quality is controlled by Professional Association of Technical Engineers (“Associação Profissional de Engenheiros Técnicos” – APET). This is a private association created in 1974 in continuation of a previous “Grémio” (an association founded about one hundred years ago). This association represents the technical engineers in terms of professional deontology. It aims at promoting the recognition of the profession at a government level, in professional associations and in employers associations. It also plays some role in commissions in charge of reviewing the technical regulation and the concession of contractor’s brevet for civil construction works. APET is currently discussing with the Government a request to give a chartered status to APET, similar to that of the “Ordem dos Engenheiros”.
Since 1993, both the “Ordem dos Engenheiros” and the APET constituted the Portuguese FEANI committee, although there is no formal co-ordination of the

two associations. FEANI, the European Federation of National Engineering Associations fosters unity of engineers in Europe, aiming at strengthening the position, role and responsibility of the engineers in the society and facilitating the mutual recognition of professional qualifications of engineers in Europe.

FEANI provides those engineers who wish to practise outside their country with a certificate of competencies, and the potential employers with detailed data about the formation - education and experience - of the individual engineer. Engineers may be registered either after having completed an approved programme of engineering education, or on being awarded the designation of European Engineer EUR´ING. According to FEANI, the qualification as engineer requires an approved engineering education following an appropriate secondary education. But the full professional competence is only reached after gaining a valid professional experience. The minimum total period of formation - education and experience - required by FEANI, is seven years, including at least:

- A secondary education at a high level validated by one or more official certificates awarded at about the age of 18 years;
- Three years of engineering education given by a university or other recognised body at the university level, admitted by FEANI;
- Two years of valid professional experience, the balance to seven years should be covered by education or experience.

Of course, systems of formation in different countries and even within the same country vary considerably. FEANI however admits that these differing systems can coexist, provided that engineers who emerge from them are competent engineers. In terms of Polytechnic Education, the following institutions were approved to confer the title EUR´ ING:

- Polytechnic Institute of Lisboa
- Polytechnic Institute of Coimbra

- Polytechnic Institute of Setúbal
- Polytechnic Institute of Viana do Castelo
- University of Faro

In addition to the control of the associations of the sector, the Ministry of Education is also developing efforts to ensure the quality of Higher Education. The Foundation of Portuguese Universities started a few years ago a process of quality control that aimed at evaluating all the University programmes by the year 2000. The results of the evaluations are not public. In the first stages, when the institutions do not have the required standards, the jury issues a number of recommendations only but penalties are envisaged for the future. This process has suffered some delays and there are still a considerable number of institutions to be evaluated. However, the implementation of such a programme was very important to implement the culture of quality monitoring in Higher Education institutions. Many of them have created offices for a continuous self-evaluation, such as the Universities of Minho, Porto, Aveiro and Beira Interior.

This process is being applied to the public Universities and to the Portuguese Catholic University. A pilot process was also developed with private Universities, although the levels of requirements are lower. A decree-law was also recently approved to extend this quality control to Polytechnic Institutions.

In addition, the Foundation of Portuguese Universities is conducting a number of studies on issues such as the articulation between teaching and research, the harmonisation of study plans and the mobility of students and faculty. These studies aim at providing the institutions with information for discussion and reflection.

It is also worth mentioning that some Universities were evaluated by the Council of European Rectors.

In *Portugal* tuition fees are required at private Polytechnics or Universities, not at those ran by the state. Concerning quality the difference in funding does not at all mean that those with private financial contributions by the students provide more quality or are attracting the student with stronger educational background.

The level of first-year students

In order to assess the level of the students enrolling in engineering programmes, the Portuguese Association of Engineers ("Ordem dos Engenheiros") established a classification of the different engineering training institutions in four groups, according to the grades of the students enrolling in the first year. The following table shows the distribution of institutions both at a University and at a Polytechnic level in terms of this classification system. It is clear that the level of students enrolling in Polytechnic education is lower, with approximately 50 per cent classified in the lowest group, which indeed encompasses very low grades. Only one Polytechnic establishment was classified in the best group.

TABLE P-3.

The best twenty programmes in University engineering education programmes, according to the grades of the students admitted to the first year in 1992/93

Number of order	Institution	Programme	Min. grade	Max. grade	*Numerus Clausus*
1	IST*	Physics Technology	82.0	74.0	45
2	Uporto	Industrial Management	79.5	76.0	20
3	IST	Aeronautics	78.0	77.0	35
4	Uporto	Chemistry	74.0	68.5	40
5	Ucoimbra	Chemistry	70.5	64.5	40
6	IST	Electrical	68.0	60.0	240
7	Uporto	Electrical	68.0	57.5	160
8	IST	Civil	67.5	57.5	175
9	IST	Computing	67.0	56.0	200
10	UNLisboa	Chemistry	65.0	60.5	45
11	IST	Industrial Management	64.5	53.0	30
12	Uporto	Civil	64.0	56.5	110
13	IST	Mechanics	64.0	55.5	175
14	Ucoimbra	Computing	64.0	52.5	10
15	UTLisboa	Agronomy	63.5	60.5	100
16	UNLisboa	Environment	63.0	60.5	40
17	Uminho	Agri-Industry	62.5	57.0	40
18	IST	Chemistry	62.0	38.5	120
19	Uminho	Computing/Systems	62.0	55.0	90
20	IST	Environment	61.0	46.0	60

*IST = Instituto Superior Técnico” in Lisboa

Source: “Ordem dos Engenheiros”

Table P-3 shows the best 20 University engineering programmes in 1993, according to the level of the grades of first year students. Almost 50 per cent of these are programmes of the “Instituto Superior Técnico” in Lisboa, and the Faculty of Engineering of the University of Porto comes in second place, accounting for 20 per cent of the programmes. Chemical and computing engineering are the programmes attracting the best students.

Engineering education at secondary level

Two types of technical training programmes were recently set-up, at the secondary level aimed at preparing students that will not pursue higher education for their integration in the labour force:

- Technological programmes
- Vocational/Professional schools

The creation of technological programmes in 1983, within the scope of secondary education, was part of an emergency plan to reorganise technical education and represented a training alternative of a vocational nature within the formal educational system. All courses in these programmes must contain scientific, general, technical, technological and vocational training components and the inter-linkage between the different courses must be guaranteed. The curricular plans have a structure defined at a national level, which allows for the introduction of regional and local specifications in technological courses. The involvement of private institutions at this level is quite low, roughly 7.4 per cent. A total of 70,000 students were enrolled in technological programmes at the secondary level in 98/99.

The professional schools were added in 1989 as an alternative to the regular education system. Teaching is organised into a three-year curriculum, primarily aimed at meeting local and regional needs, by means of diversified programmes. A wide variety of programmes are offered grouped under 17 areas of studies. Administration, Services & Commerce, Hotels & Tourism, Computing, and Agri-food & Aquatic Production account for over 50 per cent of the students in 98/99.

The programmes include a training component in the work environment. This may take the form of a working experience, a training period or technological and professional project. Completion of 3rd cycle of basics (9 years of education) is a requirement for entry. Upon completion of the programme a level III professional qualification diploma (ISCED level 3) and a secondary education diploma are awarded.

The vocational schools are formally set up under a programme-contract defining the school's statutes and education project, training areas and profiles, human and material resources, finance sources and management, as well as the nature and goals of the vocational school and its designation and condition of admission. These schools are normally created under local initiatives focused on bringing together companies, corporate or trade union associations and other parties.

Employment and labour market

More than 50 per cent of the work force have a training lower than "Basic Education" (9 years of education). Secondary and professional education accounts for 14 per cent of the total work force. Workers with a higher education represent only 5.7 per cent, as of 1998. Polytechnic graduates represent 32 per cent of the total number of workers with a higher education in 1996.

Due to the rapid growth of higher education in recent years, particularly at the private level, there has been a rising problem of integrating graduates in the labour market. Industry is mainly composed of small and medium enterprises, many of which lack competitiveness and are therefore struggling with the opening of regional and global markets. Many of these companies have a low cost strategy. They try to reduce their labour costs and are insensitive to the advantages of recruiting qualified staff. In addition, these companies believe that higher education training is too theoretical for the real needs of the industry. An analysis of a survey conducted by the Ministry of Labour regarding training needs of company's shows that 80 per cent of the needs concern training aimed at improving the practical skills, attitudes and behaviour required for the profession. Over 80 per cent of the companies think this training should be conducted in the company.

The skills of the new engineers might be an important asset in the development of industry, but the lack of means, structures, and also a closed minded mentality prevent the Portuguese economy from profiting by this potential. The number of engineers is expected to grow to 10,000 per year (40 per cent in Polytechnic Education) by the year 2000. This appears excessive to Portugal.

Unfortunately, there are no data available in terms of employment of engineers. For this reason, a survey was conducted in the framework of this project, based on a set of inquiries and interviews. However, in broad terms, the difference between engineers (University Educated) and technical engineers (Polytechnic Educated) appears to be the following:

- In the public sector, the wages of a technical engineer in the beginning of his career are about 30 per cent less than those of an engineer. At the end of his career this difference is still about 25 per cent.
- In the private companies, the situation greatly depends on the sector. In the sectors of mechanical and electrical engineering, the difference in wages is quite small. In terms of demand, it appears that employers look indifferently for the two types of engineers.
- In terms of liberal profession, technical engineers have a legal recognition to develop projects, similar to that of engineers.

Engineering education establishments survey results

A survey was conducted to better understand the opportunities of engineers and technical engineers in the labour market. Four University and three Polytechnic Institutions were surveyed. The University Institutions had a range of 45 to 595 students in 1 to 8 engineering programmes. The Polytechnic Institutions had a range of 169 to 270 students in 2 to 5 technical engineering programmes.

The results of the survey are the following:

- The rate of employment (per cent of students employed during the first year after graduation) for the University Institutions is 90 to 100 per cent. The Polytechnic Institutions rate of employment ranges from 56 to 80 per cent.
- The preferred sector of employment for the University Institutions is the Industry. The preferred sector of employment for the Polytechnic Institutions is services, education, primary production, and state-run agencies.
- Most Polytechnic Institutions do not have a structure in place to interface with the Industry sector. This has some significant implications.

    1. The Institutions do not conduct a follow-up analysis of alumni placement and, therefore, may not be providing the education required to optimise the probability of employment upon completion of the degree.
    2. The Institutions do not analyse the industry's needs on a regular basis and, therefore, may not be meeting the changing needs of the industry.

Company survey results

A survey was conducted to better understand the labour markets perceptions of engineers and technical engineers. Seven companies participated in the survey (Five industrial and two service companies). The number of employees were between 43 and 510. The percentage of engineers (University and Polytechnic graduates) represented from 4 to 50 per cent of the employees per company. The results of the survey are the following:

- The companies employ mostly University engineers, 73 to 100 per cent.
- Functions depend on the type of education background in 50 per cent of the companies surveyed.
- Salary level does not depend on the type of education in 86 per cent of the companies surveyed (depends on function and performance).
- 67 per cent of the companies surveyed consider that background and performance differs between University and Polytechnic engineers.
    1. University engineers are considered to have a better background for management functions and other functions requiring responsibility.
    2. Polytechnic engineers are considered to have a more practical training, which facilitates insertion in industry.

TABLE P-4.

Key data and information concerning Engineering Education and Training In the Non-university Sector in Portugal

1. Engineering Education outside traditional university	Polytechnic Education 1st Cycle and 2nd Cycle; Technological, Vocational/Professional Programmes.
2. Formal degrees, titles	Primary degree “Bacharelato”; Secondary degree “Licenciatura” in the fields of: Agronomic, Chemical, Civil, Computing, Electrical and Telecommunications, Energy and Power, Geo-technical and Mechanical.
3. Duration	“Bacharelato”: 3 years; “Licenciatura”: 2 years (additional) Technological, Professional Programmes: 3 years; Vocational Programmes: Vary
4. Classification in the European directives	
5. Quantitative relations in the labour force (rough figures)	Polytechnic educated (technical engineer): 86.500 in 1998
6. Number of students	Polytechnic programmes:12.000 (4.000 graduates per year, estimate by year 2000);Technological programmes: 70.000
8. Co-operation with industry (what kind of operation formalised or not)	Professionals from the industry conduct much of the teaching at the Polytechnic Institutions. This fosters a strong informal relationship between the Polytechnic Institutions and Industry. A high industry acceptance of Polytechnic graduates practical knowledge.
9. Labour market acceptance	Growing acceptance of Polytechnic graduates versus University graduates due to their more practical training.
10. Entitlements an access to regulated professions	Some Polytechnic Institutions are approved to confer the title EUR’ING.

Source: SPI

Translation of universities and institutions

Autonomous Polytechnic Institute => Instituto Politécnico Autónomo

Cocite => Cooperativa de Técnicas Avançadas de Gestão Informática

Higher Institute of Administration, Communications and Enterprises => Instituto Superior de Administração, Comunicação e Empresa

Higher Institute of Advanced Technologies =>Instituto Superior de Tecnologias Avançadas

Higher Institute of Education and Sciences => Instituto Superior de Educação e Ciências

Higher Institute of Entre Douro e Vouga => Instituto Superior de Entre Douro e Vouga

Higher Institute of Health Sciences => Instituto Superior de Ciências da Saúde

Higher Institute of Intercultural and Multidisciplinary Studies => Instituto Superior de Estudos Interculturais e Transdisciplinares

Higher Institute of Languages and Administration => Instituto Superior de Línguas e Administração

Higher Institute of Paços de Brandão => Instituto Superior de Paços de Brandão

Higher Institute of Transportation => Instituto Superior de Transportes

Higher Polytechnic Institute of Gaya => Instituto Superior Politécnico Gaya

Higher Polytechnic Institute of Santarém (ISPSantarém) => Instituto Superior Politécnico de Santarém

Higher Polytechnic School of the Army => Instituto Militar dos Pupilos do Exército

Institute of Electro-mechanics and Energy => Instituto de Electromecânica e Energia

Lisboa Autonomous University of Luís de Camões =>Universidade Autónoma de Lisboa Luís de Camões

Military Academy => Academia Militar

Naval School => Escola Naval

New University of Lisboa (UNL) => Universidade Nova de Lisboa

Portuguese Catholic University => Universidade Católica Portuguesa

Polytechnic Institute of Beja (IPBeja) => Instituto Politécnico de Beja

Polytechnic Institute of Bragança (IPBragança) => Instituto Politécnico de Bragança

Polytechnic Institute of Castelo Branco (IPCBranco) => Instituto Politécnico de Castelo Branco

Polytechnic Institute of Coimbra (IPCoimbra) => Instituto Politécnico de Coimbra

Polytechnic Institute of Guarda (IPGuarda) => Instituto Politécnico de Guarda

Polytechnic Institute of Leiria (IPLeiria) => Instituto Politécnico de Leiria

Polytechnic Institute of Lisboa (IPLisboa) => Instituto Politécnico de Lisboa

Polytechnic Institute of Portalegre (IPPortalegre) => Instituto Politécnico de Portalegre

Polytechnic Institute of Porto (IPPorto) => Instituto Politécnico de Porto

Polytechnic Institute of Santarém (IPSantarém) => Instituto Politécnico de Santarém

Polytechnic Institute of Setúbal (IPSetúbal) => Instituto Politécnico de Setúbal

Polytechnic Institute of Tomar (IPTomar) => Instituto Politécnico de Tomar

Polytechnic Institute of Viana do Castelo (IPVCastelo) => Instituto Politécnico de Viana do Castelo

Polytechnic Institute of Viseu (IPViseu) => Instituto Politécnico de Viseu

Technical University of Lisboa (UTLisboa) => Universidade Técnica de Lisboa

University of Açores (UAçores) => Universidade dos Açores

University of Algarve (UAlgarve) => Universidade do Algarve

University of Aveiro (UAveiro) => Universidade de Aveiro

University of Beira Interior (UBInterior) => Universidade da Beira

University of Coimbra (UCoimbra) => Universidade de Coimbra

University of Évora (UÉvora) => Universidade de Évora

University Fernando Pessoa => Universidade Fernando Pessoa

University Independente => Universidade Independente

University of Lisboa (ULisboa) => Universidade de Lisboa

University Lusíada => Universidade Lusíada

University Lusófona => Universidade Lusófona de Humanidades e Tecnologias

University of Madeira => Universidade da Madeira

University of Minho (UMinho) => Universidade do Minho

University Moderna => Universidade Moderna

University of Porto (UPorto) => Universidade do Porto

University of Trás-os Montes e Alto Douro (UTAD) => Universidade de Trás-os-Montes e Alto Douro

German Fachhochschulen

Birgit Bauer, Wolfram Pfeiffer, Arthur Schneeberger

In Germany, engineering education outside traditional universities is organised in Fachhochschulen and in Technikerschulen, these are technical schools at further education level. Whereas the Fachhochschulen are well-known, the Technikerschulen are not so well-known internationally. Nevertheless they make up a major part of engineering education and training in Germany. The various routes' importance can be seen by looking at how many graduates they produce each year: universities: 19,000 Diplomingenieure (1996), Fachhochschulen: 30,000 Diplomingenieure (FH), Technikerschulen: 23,000 "Staatlich geprüfte Techniker" (estimation).

Since 1971 there have been two major engineering education routes at the tertiary level: traditional universities and Fachhochschulen. The Fachhochschulen replaced the former "Ingenieurschulen"[33] and under the International Standard Classification of Education (ISCED) they are classified together with the universities. The reason for categorising them at this level is the content and length of their programmes. Until recently, Fachhochschulen did not exist in many countries besides Germany and Holland. Switzerland started to transform its Higher Vocational and Technical Education and Training System ("Höhere Fachschulen") to Fachhochschulen in the year 1997 however.

In 1997 there were 147 Fachhochschulen in Germany[34] of which 96 were state-run and 51 were private-run institutions. Within the "new" Länder or federal states (former East Germany) 21 Fachhochschulen have already been founded partly developing from the former GDR’s specialised universities. In the framework of the diversification of post-secondary higher education, Polytechnics

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[33] Manfred Mai: Ingenieurstudium im Ausland, VDI-Verlag, 3. Auflage, 1991, Düsseldorf, p. 32.

[34] BMB+F: Grund- und Strukturdaten 1998/99, Bonn, December 1998, p. 138.

have taken on offering application-oriented scientific courses. This has led to new study concepts such as small seminar-groups and the integration of practical contents, co-operative engineering education and integrated studies abroad. The main characteristics of Fachhochschulen, which have no right to award doctorates or post-doctoral qualifications (habilitation), are the primacy of teaching (with a relatively high teaching load for the professors) as well as a subject spectrum that is oriented towards vocational fields. This is the main institutional difference to traditional universities in academic terms.

Aims, course design and funding

In contrast to the former British Polytechnics, the Fachhochschulen provide degrees in single courses of study mostly equivalent to the Master's degree. The Fachhochschule graduates' average age is 28 years. In 1998 the Standing Conference of Rectors and Presidents of Universities and other Higher Education Institutions decided to use "University of Applied Sciences"[35] as official translation in order to inform the general public and industry about the task and functions of Fachhochschulen. Bearing in mind that all institutions of higher education are supposed to provide students with an academic preparation for their future occupations, Fachhochschulen place special emphasis on practical and applied aspects of training. As far as possible, they also perform tasks pertaining to applied research and development, scientific consultancy and the transfer of technology. These educational functions indicate the importance of Fachhochschulen for technological and industrial development in Germany.

In the past, graduates from Ingenieurschulen received the degree "Ingenieur (grad.)". Since 1979 graduates from Fachhochschulen are awarded the same degree as graduates from technical universities, namely the degree of "Diplom-Ingenieur". In some Länder they have to add "(FH)" to indicate the award comes from a Fachhochschule.

[35] Hochschulrektorenkonferenz, 83. Sitzung des Senats am 20.01.1998 (83rd Senate Meeting on 20 January 1998).

In legal terms Fachhochschulen are classified together with institutions of higher education like universities, technical universities, and the universities of fine arts. Their legal status is regulated by federal law (Higher Education Framework Act) and by the Higher Education or University Acts passed by the Länder. This legislation covers organisational matters, the status of the teaching staff as well as training procedures, and reflects the specific educational function of Fachhochschulen. Unlike the situation in other countries, there are no differences in terms of level and status between individual German Fachhochschulen. Most of them are government-managed institutions, they are *funded entirely from public sources,* and their technical facilities and laboratories are constantly updated in line with recent technological developments. There is no qualitative difference between government-run Fachhochschulen and the currently existing private ones, since the latter are also subject to government controls, especially with regard to training and examination standards. Curricula are based on public law, on ordinances of the responsible ministries.

Fachhochschulen offer courses in various subjects with an agreement concluded by the Standing Conference of Ministers of Education and Cultural Arts. The most popular subject categories in quantitative terms are engineering and business administration. In absolute figures, about 40 per cent of new entrants in Fachhochschulen were studying engineering subjects in 1996; at universities however the relevant figure was only 14 per cent.[36]

Education at Fachhochschulen is characterised by complementary elements: theoretical education in line with scientific and technological progress (the graduates should be able to apply scientific methods and knowledge on their own and contribute to technological development and diffusion) and application-oriented training with close links to the practical requirements of industry. The graduates are trained in broad fields of study, not in narrow specialisations. Thus, they should be able to develop flexibility to adapt to changing job market conditions and to translate basic innovations and technical developments into

[36] BMB+F: Grund- und Strukturdaten 1998/99, Bonn, December 1998, p. 152.

practice. To sum up we can state that Fachhochschulen differ from German university studies by their stronger orientation towards the private sector and occupational fields outside traditional academic professions (liberal professions and civil service), shorter study durations, a higher degree of students coming from the dual system (i.e. dual vocational education and training), a much more structured organisation of studies and less focus on academic research due to their primary orientation to application and diffusion of technology.

The educational level of the Universities of Applied Sciences depends on the equipment the educational institutions have at their disposal and on the qualifications of their teaching staff. Professors at Fachhochschulen usually have attained a doctorate and practical experience, including several years in a responsible position in industry or commerce. Today there are some tendencies towards strengthening the co-operation between the different types of higher education institutions in Germany.

Connection to professional practice, duration of programmes

Appointed professors are personalities who have distinguished themselves by special achievements during their active time in industry. Their previous experience within industrial enterprises is to ensure practice-orientation of classes. Practical experience is generally limited to experience in the enterprises' research departments however. A doctorate is not a necessary precondition for their appointment, post-doctoral teaching qualifications have long been an exception. In the course of their teaching activities professors keep close, personal contacts to industry, especially under contracts as advisors for particular enterprises.

The practical orientation of the engineering sciences is further guaranteed by the fact that research at the institutions has a close connection to the development of new products and techniques for industry. Third party sponsorship by enterprises and industrial research are typical means by which these engineering sciences institutes obtain financial resources. It is disproportionately more common in the engineering sciences than in other scientific branches that such funds are obtained. Industrial research finds access to the engineering sciences not so much through the material taught but more through theses and final papers: in particular the final papers of engineering students are often closely related to proceeding research projects of industrial enterprises. The orientation towards professional practice is established by the students' timetables that oblige them to complete practical training periods in the course of their studies.

Commonly a practical training of 26 weeks' duration is required, half of which has to be taken during the basic course (basic practical training). The remaining 13 weeks form the special practice training later in the studies. Very often students have to furnish proof of 8 weeks of practical training before they can enrol. It is recommended to complete the whole of the 13 weeks' basic practical training in advance. The task of these training periods is to provide students with sufficient contact and insight into their later professional field. Also special excursions count as external education and training: These are excursions to industrial enterprises that are to enhance the students' comprehension of industrial practice as well as their contact to engineers in employment. Participation in special excursions is a precondition for the final examination. Last but not least we have to mention laboratory training courses that offer students the opportunity to supplement their theoretical education with observations and experiments. Applied classes in law and economics are other options available to many full-time engineering students. Introductory courses in business management and law are also part of many students’ timetables.

Degree courses at Fachhochschulen usually take a minimum of three to four years, i.e. six to eight semesters (only Architecture takes 9 semesters), not counting the time required for examinations.[37] In most cases periods of practical training are integrated in the degree courses. If examinations are included, degree programmes usually take 3 ½ years. Four years to 4 ½ years are needed in those cases in which practical training is integrated in the course. These are minimum durations however. The typical duration of engineering studies at traditional Fachhochschulen was 5.2 years in 1996 compared to 6.4 at universities (with a regular duration of 5 years).[38] Due to biographical circumstances, Fachhochschule graduates tend to be older than university-graduates For example, the average graduation age at Fachhochschulen was 28.3 years in 1996, and at universities it was 27.8 years of age.[39]

Each year of study at a Fachhochschule is made up of two semesters, amounting to up to a total of 38 weeks of lectures. The period between terms are intended to be used for the preparation or assimilation of new material, for home study or preparation for examinations. Training in many practical and laboratory courses aims to encourage students to carry out application-related work on their own. The final examination comprises a thesis, written examinations and oral examinations. The thesis should demonstrate the students' capability of solving applied technology problems on their own and using academic methods, knowledge. in engineering fields of study students very often prepare their thesis in collaboration with industrial companies or technology-oriented service industry.

Admission, enrolment and number of graduates

To understand German Fachhochschulen we must analyse entrance requirements in comparison to traditional universities. The admission requirement to a Fachhochschule is the so-called "Fachhochschulreife". The Fachhochschule is still the main road for former apprentices heading towards higher engineering education. Whereas in 1996 only 21 per cent of German male new entrants in

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[37] Klaus Habetha: The National System of Higher Engineering Education in Germany. In: M. Giot, Ph. D. Grosjean (eds.): The National Systems of Higher Engineering Education in Europe, Pisa, 1995, 179.

[38] BMB+F: Grund- und Strukturdaten 1998/99, p. 240.

[39] BMB+F: Grund- und Strukturdaten 1998/99, p. 242.

engineering education at universities came from the dual system and 79 per cent were "Abitur"-holders, in Fachhochschulen 65 per cent of new students came from the dual system; among female beginners this ratio was 24 to 49 per cent.[40]

TABLE G-1.
Student enrolment in engineering subjects by institution, 1996/97

Institution	Student enrolment in all fields of study	Share of engineering students		Distribution of engineering enrolment
		Absolute	Relative	%
Universities	1,199,996	120,000	10.0 %	35.6
Comprehensive Universities	145,135	29,600	20.4 %	8.8
Universities of Applied Sciences	397,507	185,200	46.6 %	55.0
Universities of fine arts	30,108	1,700	5.8 %	0.5
Universities for teacher training	18,659	500	2.6 %	0.1
Total	1,791,405	337,000	18.8 %	100.0

Source: Statistisches Bundesamt Wiesbaden, 1997, pp. 60; own calculations

55 per cent of all students enrolled in engineering tertiary degree programmes are enrolled at Fachhochschulen, 36 per cent at universities and about 9 per cent fall to the Gesamthochschulen (Comprehensive Universities). It should be noted that the Gesamthochschulen provide both types of degree programmes (university and Fachhochschule type programmes) and that they are entitled also to award the Ph.D. or further research degrees (Promotionsrecht and Habilitationsrecht), which Fachhochschulen do not have.[41] About six per cent of engineering students are enrolled at the universities of fine arts

[40] BMB+F: Grund- und Strukturdaten 1998/99, Bonn, December 1998, p. 186.

[41] Statistisches Bundesamt: Internationale bildungsstatistische Grundlagen. Vergleich der Bildungssysteme ausgewählter europäischer Länder unter besonderer Berücksichtigung der beruflichen Bildung und Hochschulbildung, Wiesbaden, 1997, p. 61.

(Kunsthochschulen), including architectural and design studies. Less than 3 per cent of engineering students fall to universities for teacher education and training (Pädagogische Hochschulen).

TABLE G-2.

Number of successful examinations at engineering subjects at Fachhochschulen

Engineering subjects	1985*	1992*	1993	1998
Mining, metallurgical engineering	110	120	148	73
Mechanical engineering, process engineering	7429	11703	12293	9890
Electrical engineering	4760	7009	7864	6379
Transport technology, nautical science	205	218	798	902
Architecture	3102	3231	3089	3949
Regional panning	0	51	56	162
Constructional engineering	2002	2179	2367	4042
Surveying	555	427	421	833
Engineering, general	0	0	0	180
Total engineering science	18163	24938	27036	26410
Computer science**	898	2196	2469	2692

* Former area of the FRG

** Part of the subject category Mathematics, natural science

Source: Bundesamt für Statistik, Wiesbaden

The output of "Diplomingenieure" (FH) was about 30,000 graduates in 1996 compared to 19,000 at universities.[42] With 61 per cent the share of engineering graduates from Fachhochschule is even higher than the share of student enrolment at this institution, which is mainly due to shorter course durations. When we have a look at numbers of engineering students who graduate in different fields of engineering there are some differences, particularly since 1993 when the reunification of the German states took place. In the 90s there was a decline

[42] BMB+F: Grund- und Strukturdaten 1998/99, p. 212.

in most of the classical fields of engineering, which was partly due to a negative public opinion about related job prospects. That was not true for architecture and constructional engineering.

For computer science there was a higher graduate number in 1997 (3,042). The same happened at universities (1997: 3,561 – 1998: 3,291). That is one of the reasons for public concerns about the labour market supply for IT-qualifications. But there are others, such as long study durations, lack of two- and three-year courses and a too late reaction to the diversification (horizontal and vertical) of IT-qualifications in the vocational training and education outside higher education.

Co-operative education: Berufsakademien

A special variation of Fachhochschulen are the *Berufsakademien* (translated as Universities of Applied Studies or Universities of Cooperative Studies) in Baden-Württemberg which combine academic and technical with in-house education and training by companies. In 1998, 64 per cent of all students enrolled at Berufsakademien (a total of 19,191) fell to the state of Baden-Württemberg, the other students were enrolled in Berlin, Saxony, Lower Saxony, Schleswig-Holstein, Thuringia and the Saarland.

For this survey we use the example of Baden-Württemberg to demonstrate the aim and the function of Berufsakademien.[43] The Berufsakademie, an institution in which employers and state co-operate in a system of higher education, was founded in the year 1974 and is based on a Baden-Württemberg state regulation. Currently there are about 4,000 places of study. Therefore it is among the largest educational institutions in Stuttgart. The engineering sector of the BA-Stuttgart offers studies in Electrical Engineering, Information Technology, Me-

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[43] The description of the BA is based on: http://amadeus.informatik.ba-stuttgart.de/studieninfo/eng101.html dated 19.04.2000.

chanical Engineering and Mechatronics. The main characteristics of the Berufsakademie include:

- Alternation of theoretical studies at the Staatliche Studienakademie and practical training on the job in a company or social institution according to the long-established dual principle of vocational training in Germany.
- The courses are usually finished within three years or six semesters.
- Phases of theoretical studies alternate with periods of on-the-job training of equal duration (12 weeks duration in a term of six months).
- The Berufsakademie combines classical university studies with the tradition of dual vocational training in Germany.

The combination of on-the-job training with academic work meets both the wishes of a growing number of students as well as employers who demand new skills amongst their middle management. The enrolment requirements at Berufsakademien include: the German university entrance examination (Abitur) and the completion of a training contract with one of the training companies or institutions co-operating with the Berufsakademie.

A student enrolled at a Berufsakademie is both a student and an employee. He is a student at the Studienakademie (the government-funded academic institution) and an employee undergoing training in a company or with a service provider. A Berufsakademie thus has two learning centres: a Studienakademie as "the centre of academic course work" and the company providing "the centre for on-the-job training". The conditions of the traineeship are laid down in a trainee contract. It commits the employer to releasing students for study terms at the Studienakademie and it stipulates that employers pay a training allowance varying from DM 900 to more than DM 1,500 a month. The allowance is also paid for the months that students spend at the Studienakademie.

The programmes take three years. The first part is devoted to basic studies and training (two years) and leads to the first vocational qualification. The final degree is achieved after the third year, which provides more specialised studies and training. Upon completion of their studies in the engineering fields, students are awarded the "Diplom-Ingenieur/in (BA)" degree. In September 1995, the Standing Conference of Ministers of Education and Cultural Affairs (Kultusministerkonferenz) declared Berufsakademie degrees equivalent to the degrees awarded by the Fachhochschulen. The Ministry for Science, Research and Arts funds, staffs and supervises the teaching at the Studienakademie. A certain minimum number of lecturers at Studienakademien are full-time staff. Full-time lecturers account for 40% of the institute’s staff and the remaining part-timers are drawn from universities, Universities of Applied Sciences (Fachhochschulen) and professionals from companies.

The Berufsakademie Stuttgart has good external relations with other partner institutions. While in the past emphasis was laid on the exchange during the practical phases (internships), more and more importance is being placed on the exchange during the theoretical phases. In Europe this exchange activity has been especially supported by the SOCRATES/ERASMUS programme, where one main focus is on mutual recognition. This is done under the European Credit Transfer System (ECTS). Due to the efforts to intensify and extend the relationship of the Berufsakademien to partner institutions abroad the BA Stuttgart has established the international study course Information Technology Management among other courses. In this study programme the instruction and coursework is carried out in English mainly.

Employment areas

Due to different political and economic contexts and the problems of the German reunification there are also remarkable differences in the employment situation of engineering graduates in the old Länder (former western part of Germany) and the new Länder. In the eastern states considerable problems of adaptation can be observed (see Table G-3), although the unemployment rate is quite low compared to other occupation. Tendencies of inadequate employment are empirically evident. In the new Länder e.g. only 35 per cent of 134,000 Fachhochschule graduates in the field of engineering were employed at Ingenieur-level in 1995, compared to 59 in the former area of the FRG (see Table G-3); the share of labourers and similar occupations reached 20 per cent in the new Länder .

Engineering degree-holders from Fachhochschulen are usually employed in the fields of design, manufacturing, marketing or technical consultancy. The graduates from technical universities are more likely to be employed in research and development. In the private sector graduates from Fachhochschulen are very seldom at a disadvantage compared to graduates from universities as regards employment in industry or in a profession. The rate of self-employed graduates from Fachhochschulen is considerable high (13 or 16 per cent), but lower than for university graduates (15 or 20 per cent, see Table G-3). The rate of executives has become nearly the same for both types of higher education in the old states of Germany (29 to 32 per cent). This indicates that in engineering more decisive career factors than formal degrees include the specialisation in engineering, the individual ambitions, as well as further education and training. In the public there is quite a clear difference in the status and income grouping. But the main aim of establishing Fachhochschulen outside traditional universities has been to steer away the educational flow from the public sector which at the highest level is still the domain of German university graduates.

Table G-3.

Economically active engineering graduates and their income in Germany by institution and area

Area of Germany	UNIVERSITY			FACHHOCHSCHULE		
	1885	1991	1995	1985	1991	1995
OLD LÄNDER (STATES)						
Employed persons	172,100	257,900	315,900	372,900	447,500	524,400
Monthly net income: DM	-	-	4,973	-	-	4,610
CATEGORIES in %						
Self-employed	15	19	20	16	13	16
Civil servants	14	11	9	11	11	10
Executive personnel	40	40	32	29	30	29
Labourers, low skilled employees	7	8	9	7	7	9
MAIN AREAS in %						
Engineers	58	59	49	65	63	59
Technicians	4	4	5	7	8	7
Businesspersons, auditors	8	9	11	7	6	8
Teachers, lecturers	5	3	4	(1)	1	(1)
MAIN INDUSTRIES in %						
Manufacturing	37	40	-	41	45	-
Engineering offices	12	14	-	10	10	-
Construction	8	10	-	10	10	-
Public services	14	11	-	12	13	-
Research, education, etc.	9	8	-	3	3	-
Unemployed	9504	11,558	20,213	14,100	13,457	25,624
Rate of unemployment	5.2%	4.3%	6.0%	3.6%	2.9%	4.7%

Continuation						
Area of Germany	UNIVERSITY			FACHHOCHSCHULE		
	1885	1991	1995	1985	1991	1995
NEW LÄNDER (STATES)						
Employed persons	-	189,500	189,100	-	78,300	134,000
Monthly net income: DM	-	-	3,041	-	-	2,768
CATEGORIES in %						
Self-employed	-	7	15	-	7	13
Civil servants	-	-	(2)	-	-	(2)
Executive personnel	-	41	30	-	35	21
Labourers and low skilled employees	-	11	14	-	11	20
MAIN AREAS in %						
Engineers	-	34	33	-	43	35
Technicians	-	6	6	-	9	9
Businesspersons, auditors	-	11	17	-	9	14
Administrative and office workers	-	7	9	-	7	9
MAIN INDUSTRIES in %			*1993*			*1993*
Manufacturing	-	37	30	-	48	32
Public services	-	11	13	-	8	12
Construction	-	12	12	-	11	14
Trade	-	6	8	-	(3)	8
Engineering offices	-	(3)	6	-	(2)	(4)
Unemployed	-	-	13,306	-	-	5,372
Rate of unemployment	-	-	6.6%	-	-	3.9%

() = only approximate figures

Source: MatAB 1.7/1998

There are no legal obstacles for graduates from Fachhochschulen to do self-employed professional work, e.g. as an architect. The legislation of the German Länder allows graduates from Fachhochschulen as well as from technical universities to establish themselves as architects and permits anyone to call herself/himself an engineer who has been trained in engineering sciences in one of the two routes of higher education. The graduates from both higher education engineering pathways in Germany have access to their respective professions and professional associations. Among them there is in particular the well-known and influential Chamber of Architects and the German Engineers' Association (VDI).

Fachhochschule graduates play a decisive part wherever solutions to practical problems have to be found such as in the planning, development and implementation of new projects or production techniques. The majority of engineering graduates is employed as Diplom-Ingenieure in the mechanical engineering, motor vehicle, building, electrical, textile, printing, timber and paper industries. Thanks to the combination of academic and application-related training, Fachhochschule graduates are particularly well suited for activities in countries which intend to develop new industries or to improve the technical standards of existing ones. Consequently, a large number of graduates are employed by German industrial enterprises in the planning, co-ordination and implementation of construction and industrial projects which they carry out for foreign governments.

Prospects of new graduates

The unemployment rate of graduates from the Universities of Applied Sciences is lower than that of university graduates. In 1995 in the old Länder the unemployment rate of Fachhochschule graduates from engineering was 4.7 per cent (universities: 6.0 per cent), in the new Länder it was 3.9 per cent for Fachhochschule graduates against 6.0 for university-graduates.[44] The employment prospects for engineering graduates on the whole are better in the year 2000

[44] Akademiker/innen – Studium und Arbeitsmarkt, MatAt, 1.7/1998, p. 14ff.

than at the beginning of the 1990s but there are differences between fields and growing problems of older graduates[45].

Labour market prospects at the beginning of the nineties showed some problems for Diplom-Ingenieure not known for decades. It is empirically founded that by 1997 (as compared to 1993) the situation had clearly changed for new graduates entering the labour market.[46] But still there are significant differences by age, region or field of study. We see growing employment, skill shortages in some fields, and at the same time a considerable stock of unemployed persons with an engineering degree. Earning expectations and employment prospects of young graduates from engineering are however one of the best when comparing the different fields of study – this is true for university graduates[47] and Fachhochschule graduates as well.

The high occupational productivity of engineering graduates from higher education in both routes is indicated clearly by a comparison of the respective fields of study with the average first income of university-graduates or graduates from Fachhochschulen. Since German Fachhochschulen for engineering sciences take in nearly two thirds of their graduates from the dual system of vocational training (instead of the Gymnasium as their educational background), they are expanding the general social access to higher education and to high income jobs through vocational education in an impressive way. This point underlines the nearly unique role of the dual vocational training in Germany as a tool to promote company-related education and training at upper-secondary and, beyond that, at post-secondary level.

[45] In 1991 36 per cent of the unemployed "Diplomingenieure" were older than 45, in 1998 their share had risen to 69 per cent; see: Renate Acker, Christiane Konegen-Grenier, Dirk Werner: Der Ingenieurberuf in Zukunft. Qualifikationsanforderungen und Beschäftigungsaussichten, IMPULS-Stiftung/Institut der deutschen Wirtschaft Köln (ed.), Köln, 1999, p. 19.

[46] See: Karl Heinz Minks, Rolf Holtkamp, Petra Koller: Der Übergang von Fachhochschulabsolventen in den Beruf. Vergleich der Absolventen 1989, 1993 und 1997, Hannover, 2000, p. 2.

[47] See: Karl Heinz Minks, Rolf Holtkamp, Petra Koller: Der Übergang von Absolventen universitärer Studiengänge in den Beruf. Vergleich der Absolventen 1989, 1993 und 1997, Hannover, 2000, pp. 5.

TABLE G-4.

Net monthly income of higher education graduates from 1997 in their first occupations by fields of study, 1998/99

Institution / field of study	Less than 3499 DM %	3500 – 4499 DM %	4500 – 4999 DM %	5000 and more DM %	Total %
FACHHOCHSCHULEN					
Computer science (n=161)	5	8	18	69	100
Business administration (n=521)	10	19	24	47	100
Electrical engineering (n=367)	8	21	25	46	100
Mechanical engineering (n=704)	10	25	28	37	100
Construction etc. (n=232)	10	32	26	32	100
Architecture, regional planning (n=199)	15	57	16	12	100
Agricultural engineering, nutrition science (n=118)	34	38	20	8	100
Total FH (n=2991)*	12	27	25	36	100
UNIVERSITIES					
Computer science (n=181)	5	12	6	77	100
Electrical engineering (n=230)	10	15	13	62	100
Mechanical engineering (n= 367)	12	15	16	57	100
Economics (n= 864)	12	16	20	52	100
Construction etc. (n= 126)	13	18	18	51	100
"Magister" (n= 631)	46	24	16	14	100
Total university (=6,593)*	25	19	15	41	100

* including other fields

Source: HIS Absolventenuntersuchung 1998/99

The Technikerschulen

The traditional Technikerschulen could survive side by side with the Fachhochschulen and have maintained their importance as institutions for the training of technicians. These technical schools are vocational training institutions that permit persons with practical vocational experience to obtain further qualifications in two-year courses. Graduates from these institutions do not receive a degree, but rather the title of "Staatlich geprüfter Techniker" (state-certified technician). These further education institutions are attended by persons who have completed their vocational training in the dual system. In 1995 46,200 students were enrolled in Technikerschulen and the most popular vocational subjects were: mechanical engineering (9,090 students), electrical engineering (7,574) and constructional engineering (5,300).[48]

Translations of institutions

Fachhochschule	University of Applied Sciences
Technikerschule	Technical School, Further Education College for Technicians
Berufsakademie	University of applied studies
Staatlich geprüfter Techniker	State-certified technician
Technische Universitäten	Technical universities
Kunsthochschulen	Universities of fine arts
Gesamthochschulen	Comprehensive universities
Pädagogische Hochschulen	Universities for teacher training
Architektenkammer	Chamber of Architects
Verein Deutscher Ingenieure, VDI	German Engineers' Association

[48] Statistisches Bundesamt: Internationale bildungsstatistische Grundlagen. Vergleich der Bildungssysteme ausgewählter europäischer Länder unter besonderer Berücksichtigung der beruflichen Bildung und Hochschulbildung, Wiesbaden, 1997, p. 57.

TABLE G-5.

Key data and information concerning engineering education and training in the non-university sector in Germany

1.	Engineering education outside traditional university	Fachhochschulen (FH), Berufsakademien (BA), Technikerschulen
2.	Formal degrees, titles	Diplomingenieur (FH), Diplomingenieur (BA); Staatlich geprüfter Techniker.
3.	Duration	Nominal official duration: FH: 6 to 8 semesters years; universities: 9 years, excluding possible practical periods spend in industry
4.	ISCED (1976)	The Fachhochschule and the Berufsakademie are classified at level 6, the Technikerschule at level 5.
5.	European directives (first and second)	FH: included in the First European Directive (92/51/EEC); respective types of diplomas are included in the Architects' Directive (85/384/EEC); Technikerschule Certificate: included in the Second European Directive (92/51/EEC)
6.	Quantitative relations in the labour force	University graduates to Fachhochschule graduates
7.	Number of students; number of graduates	185,000 students (FH), 120,000 (universities), 29,600 (Gesamthochschule) (1996/97); graduates: 30,000 FH – 19,000 (universities) (1996)
8.	Co-operation with industry	Mostly mandatory work placement – about eight weeks; joint technological projects of colleges and enterprises
9.	Labour market acceptance	Growing employment prospects, problems of older graduates
10.	Entitlements and access to regulated professions	FH-graduates have the same access to professions and associations of engineers and in the private sector the same chances as university graduates; but in the public sector there is a significant difference regarding vertical status

Source: ENGENUS-Project

COMPARATIVE EDUCATIONAL STATISTICS

On the basis of many years of experiences and international communications on educational matters it seems to be important to do as much as possible to avoid systemic misunderstandings. Therefore the work conducted in the course of the OECD-Project "Education at Glance" (1990 and following years) is an important device to improve international understanding and to avoid basic misunderstandings at the same time.

Educational attainment of the labour force

Engineering qualifications can be understood in a better way by having a look at the formal qualification structures in the participating countries. The ISCED can contribute to understanding the specifications of educational systems and degree structures in order to become more open-minded for different systemic solutions. The data used below is classified in the framework of the ISCED 1976, until now (March 2000) there has not been any data based on the new ISCED (1997) available.

At a first glance the comparison indicates different developments of post-secondary education. Four out of six countries show already a quarter of graduates from post-secondary courses in the labour force aged 25 to 64. In Portugal and Austria the diversification of the post-secondary education starts considerably later.

Referring to Germany it has to be mentioned, both universities and Fachhochschulen are classified as ISCED 6 (ISCED 1976). The 10 per cent which are defined as ISCED 5 refer to other educational institutions, e.g. the so-called Fachschulen or Technikerschulen which still represent an important pathway of advanced-level further education for persons coming from the dual system of initial vocational and technical training in that country.

Denmark also shows quite considerable percentages of the labour force with the educational attainment of "non-university tertiary education" (ISCED 5). Short-cycle engineering education belongs to this level.

TABLE C-1:
Percentage of persons with upper secondary and post-secondary educational attainment in the labour force 25 to 64 years of age, 1996, in per cent

Country	Upper secondary education ISCED 3	Non-university tertiary education ISCED 5	University-level education ISCED 6/7	All post-secondary ISCED 5, 6, 7
Netherlands	43	X	27*	27
Denmark	47	8	17**	25
United Kingdom	57	10	15	25
Germany	61	10	15***	25
Portugal	11	4	9	13
Austria	68****	2	7	9

* including HPE (Higher Professional Education)
** including medium- and long-cycle higher education
*** including Fachhochschulen
**** including 9 per cent graduates from 5-years upper secondary technical and vocational colleges (Schneeberger, 1998)

Source: OECD, Education at a Glance 1998, p. 43

For the UK the ISCED-level 5 includes certificates or diplomas of colleges below graduate-level (below Bachelor's). These could be one- or two-year programmes. The UK provides a very broad system of higher education colleges which offer degree and non-degree programmes. Permeability is enhanced by possibilities of credit transfer from programmes to advanced studies or between institutions.

For the Netherlands no data is given for ISCED-level 5. At the same time the Dutch percentage for ISCED 6 or higher reaches by far the highest percentage of the 6 countries. The OECD mentions some specialities with regard to the Netherlands. The country report in the ENGENUS-Project written by Ruud van der Aa shows clearly that, on the one hand, young persons choosing post-secondary educational programmes are aware of the institutional difference between HPE (Higher Professional Education) and university (BO versus WO), on the other hand that there are overlapping contents and qualifications which blur strict demarcations within Dutch higher education.

Portuguese polytechnics and universities are included among university-level education which is defined by at least the Bachelor's degree. The NUS includes vocational and technical education below degree-level. The polytechnics experienced a very rapid growth in the 90s. But as the figures refer to the labour force 25 to 64 years of age, the 9 per cent university-level education might still mean university graduates (from old universities) mainly.

For Austria the ISCED-level 5 indicates only a very low percentage and at the same time the highest percentage at ISCED level 3 (upper secondary education). This is due to the special role of the Austrian five-year technical and vocational secondary colleges (for business administration or tourism or engineering education), which have provided higher and intermediate qualifications for the private sector for a long time whereas the Austrian universities have all along been oriented towards the public sector and the liberal professions.[49] About 9 per cent of the economically active persons boast this educational attainment.[50] The newly established Fachhochschulen (1994) had no graduates in 1996. It is due to this fact that university-level education for Austria includes only long-term

[49] See: Arthur Schneeberger: Universitäten und Arbeitsmärkte. Strukturelle Abstimmungsmechanismen im internationalen Vergleich (=Schriftenreihe des Instituts für Bildungsforschung der Wirtschaft, No. 113), Vienna, 1999, pp. 305.

[50] See: Arthur Schneeberger: Langfristige Trendanalyse der Qualifikationsentwicklung in Österreich. In: Arthur Schneeberger, Monika Thum-Kraft (eds.): Qualifikationsanforderungen und Bildungsströme im Wandel (=Schriftenreihe des Instituts für Bildungsforschung der Wirtschaft, No. 110), Vienna, 1998, p. 34.

studies at traditional universities, in all the other countries this column comprises also alternatives to universities (Fachhochschulen, HPE, medium-cycle higher education) and Bachelor's degrees. This exceptional statistical result for Austria clearly indicates the belated diversification of higher education in this country.

The difficulties of defining post-secondary educational pathways at an international level are widespread and not only due to the underlying subject. The old ISCED-Classification[51] has significant problems in describing long upper secondary educational programmes and short labour-market-oriented programmes at the post-secondary level. The new ISCED-Classification (UNESCO, 1997) might fit considerably better to the ongoing "post-secondarisation" of educational routes to the employment systems in Europe. But until the beginning of the year 2000 no international data in categories of the new ISCED (1997) was available. According to the new ISCED, Fachhochschulen will be ISCED 5A (same classification as universities), Danish short-cycle engineering education or German Technikerschule (Technician School) might be 5B in the future.

New graduates from engineering studies and related subjects

Another statistical approach refers to new graduates relative to the population at the typical graduation age. That can be described for the "university-level" education in terms of the OECD-definition (at least Bachelor's) as well as for the non-university tertiary programmes (mostly shorter courses). Additionally the graduation ratios can be related to the distribution of qualifications between subject categories at both levels (university level and NUS). By putting these two figures into a relation we can get a rough estimation of new post-secondary qualifications in engineering and related fields.

[51] International Standard Classification of Education

TABLE C-2.

Ratio of graduates from universities, polytechnics or non-university tertiary programmes at the typical graduation age (times 100), 1996

Country	Short or long first degree programmes (university-level)	Long degree programmes	Non-university tertiary programmes
United Kingdom	34	12,3	12
Netherlands	30*	10,0	X
Denmark	28	12,4	8
Germany	16	16,0	11
Portugal	16	15,5	6
Austria	10	10,0	5

*exceptional definition (see respective above remark and footnote)

Source: OECD, 1998

The above table shows a variation of between 34 per cent (United Kingdom) and 10 per cent (Austria) for the ratio of university-level graduates to the population of the typical age groups, not differentiating by levels of graduation. Although it is clear that the differences are partly based on different graduation structures and study durations, it informs about the quantitative aspect of academic graduates in all fields of study and in engineering and related subjects. For the Netherlands an exception in the definition of graduates taken into account has been necessary. Otherwise the figure would have been lower than in the labour force as a whole (see Table C-1).[52]

Technical remark: These graduation ratios are used in the estimation of new labour market supply of higher education in the engineering and related fields of

[52] For the Netherlands the OECD indicates 20 per cent graduates from long first university studies and 10 per cent from second university-degree programmes, but there are no short first university-degree programmes documented. Looking at long first degrees only, we would get a too low new graduates ratio. Other figures related to university graduates would be considerably higher (young adults in the population, 25 per cent; labour force: 27 per cent).

study. The other factor of estimation is the distribution of new qualifications by field by subject categories (see Table C-3).

TABLE C-3:

Distribution of university-level and non-university tertiary qualifications (NUS) between subject categories, 1996, in row per cent

Country	DISTRIBUTION BY SUBJECT CATEGORIES					
	Humanities / general	Medical science	Natural science	**Mathematics and computer science**	**Engineering and architecture**	Law and business
UNIVERSITY						
United Kingdom	41	8	10	**6**	**13**	23
Netherlands	45	12	7	**2**	**12**	22
Denmark	40	15	4	**3**	**15**	23
Germany	40	9	11	**5**	**21**	13
Portugal	48	5	5	**3**	**12**	27
Austria	29	9	13	**5**	**15**	29
OECD-country mean	38	11	9	**3**	**14**	25
NON-UNIVERSITY						
United Kingdom	26	14	6	**8**	**14**	32
Denmark	21	6	6	**x**	**19**	48
Netherlands	x	x	x	**x**	**x**	x
Germany	32	33	6	**1**	**19**	10
Portugal	23	22	5	**2**	**12**	36
Austria	65	13	x	**1**	**10**	11
OECD-country mean	27	14	4	**3**	**13**	30

Source: OECD, Education at a Glance 1998, pp. 200

The number of new graduates in the fields of engineering, mathematics and computer science coming from universities or polytechnics to the labour market is significantly higher in those countries which have established *short first university-degree programmes* (U.K., Denmark) or which have so-called long first studies with a relatively short average duration of about four years (Netherlands).

TABLE C-4.1.

Ratio of graduates from different types of universities or polytechnics to population at the typical graduation age (times 100), 1996

Definition = Short or long first degree programmes

Country	Engineering and architecture	Mathematics and computer science	Together
United Kingdom	4.42	2.04	6.46
Denmark	4.20	0.84	5.04
Netherlands	3.60	0.60	4.20
Germany	3.36	0.80	4.16
Portugal	1.92	0.48	2.40
Austria	1.50	0.50	2.00

Source: Calculations based on OECD-data

Countries with a *dominance of long first university-degree programmes* have considerably smaller shares of higher education graduates in general and this also applies to engineering and related subject categories, but this is much more relevant for Austria and Portugal than for Germany. The difference between Germany and the other countries is quite small due to the early establishment of Fachhochschulen as alternatives to the university route. But anyway, the Fachhochschule is not an institution of higher education which provides short programmes and graduation at an early age, but the actual average age of graduation is 28.

In Germany, Austria and the Netherlands university degrees (and also degrees from Fachhochschulen or HPE) are attained within *a single-degree programme of studies* (mostly highly specialised) with a regular duration of between 4 and 6 years. In view of qualification levels they might be more equivalent to the Master's degree than to the Bachelor's in many cases[53], especially if we take the graduation age and the time of education and work experience into consideration.

TABLE C-4.2.
Ratio of advanced-level graduates from universities at the typical graduation age (times 100)

Definition = only long first degree programmes or second degree programmes

Country	Engineering and architecture	Mathematics and computer science	Together
United Kingdom	1.60	0.74	2.34
Denmark	1.86	0.37	2.23
Netherlands	3.60	0.60	4.20
Germany	3.36	0.80	4.16
Portugal	1.86	0.47	2.33
Austria	1.50	0.50	2.00

Source: Calculations based on OECD-data

A comparison which is restricted to long first degree programmes at university and second degree programmes after short first degree programmes produces contrary results to the first and less differentiated comparison (see Table C-2.2). Different qualification and specialisation strategies are the background of this complex picture, which should not be evaluated in a simplifying approach. For a balanced cultural understanding we ought to see contexts and elements of future points of structural convergence as a means of educational and professional mobility in the common market.

[53] For this estimation see: Statistisches Bundesamt: Internationale bildungsstatistische Grundlagen. Vergleich der Bildungssysteme ausgewählter europäischer Länder unter besonderer Berücksichtigung der beruflichen Bildung und Hochschulbildung, Wiesbaden, 1997, p. 235.

Last but not least, if we compare graduation ratios from non-university tertiary programmes, the picture changes again. Germany gets the leading position with reference to engineering. This might be due to the qualifications of the above-mentioned Technikerschule. For the United Kingdom the ratio of graduates from short non-university tertiary programmes for Mathematics or Computer Science is with 0.96 the highest by far of all compared countries.

TABLE C-4.3.

Ratio of engineering or related graduates from non-university tertiary programmes at the typical graduation age (times 100)

Definition: post-secondary tertiary courses, but below Bachelor's

Country	Engineering and architecture	Mathematics and computer science	Together
United Kingdom	1.68	0.96	1.65
Denmark	1.52	X	1.52
Netherlands	X	X	X
Germany	2.09	0.11	2.20
Portugal	0.72	0.12	0.84
Austria	0.50	0.05	0.55

Source: Calculations based OECD-data

The small percentage of tertiary graduates from both the NUS and from university education for Austria is due to the dominance of the SCEs until now in the preparation for engineering and applied technology occupations and for access to the middle management in engineering branches. But the changes could be very fast in the future. Within four years the share of the new Fachhochschulen (founded in 1994) reached 29 per cent of all new entrants in engineering, computer science and other technology fields (see the chapter on Austria in this report).

Gender-specific aspects

The data about female graduates in engineering and related subjects in the countries of the ENGENUS-project indicate a too low participation of young women in technological and engineering fields of education compared to existing employment opportunities.

At degree-level the shares of women in "engineering and architecture" are highest in Portugal (31 per cent) and Denmark (23 per cent). In all other countries it is below 20 per cent of all degrees awarded.

That is also the case for "mathematics and computer science" where Portuguese young women are awarded 51 per cent of all university level qualifications (for the OECD this includes polytechnics and old universities), in Denmark women still obtain 36 per cent of all respective degrees, the Netherlands, Austria and Germany are significantly below the average rate of female graduates in these fields.
The country mean for the OECD-area is 19 per cent for "engineering and architecture” and 27 per cent for "mathematics and computer science”.

Also in the NUS-programmes of engineering education higher female shares can be found in Portugal and Denmark. The higher share (39 per cent) of Austrian female graduates might be due to specialist paramedical programmes.

TABLE C-5.

Female graduates and percentages of qualifications in each subject category that are awarded to women, 1996, in per cent

Country	*Ratio of Female graduates (male)*	WOMEN'S SHARE IN % Hu-manities / general	Medical science	Natural science	Mathematics and computer science	**Engineering and architecture**	Law and business
UNIVERSITY							
Portugal	*20 (m 11)*	73	67	64	51	**31**	60
Denmark	*33 (m 15)*	68	86	50	36	**23**	40
United Kingdom	*36 (m 33)*	63	67	47	27	**18**	49
Germany	*14 (m 18)*	55	46	36	28	**15**	45
Austria	*10 (m 11)*	61	56	41	24	**14**	42
Netherlands**	*31 (m 28)*	61	69	35	13	**12**	43
OECD-Country mean	*24 (m 22)*	66	65	45	27	**19**	47
NON-UNIVERSITY							
Austria	*7 (m 2)*	78	89	89	32	**39**	70
Denmark	*6 (m 10)*	64	91	19	x	**22**	28
Portugal	*9 (m 4)*	87	81	49	40	**22**	68
United Kingdom	*13 (m 10)*	66	88	45	25	**13**	59
Germany	*13 (m 9)*	82	76	34	22	**7**	28
Netherlands	*X (m x)*	x	x	x	x	**X**	x
OECD-Country mean	*17 (m 14)*	62	76	43	23	**17**	48

* after short or long first degree programmes

** long first and second university-degree programmes

Source: OECD, Education at a Glance 1998, pp. 200

SYNOPSIS AND CONCLUSIONS

Social and economic benefits of diversification

All countries in the project have implemented highly differentiated pathways of engineering education at tertiary level. The countries' cultural contexts determine their institutional alternatives to traditional engineering science studies at universities. But in all countries there are some types of advanced-level vocational and technical courses leading to professional or semi-professional status in engineering fields.

Whereas 5 out of 6 countries structure higher education in accordance with clear binary systems, the UK system is an exception because its polytechnics were transformed to universities in 1992. But this does not at all mean that the UK system is not characterised by highly differentiated routes of engineering education. The opposite is true: A variety of vocational and academic routes lead to engineering qualifications and professional status.

At very different times European mainland countries have established alternatives to traditional university studies for engineering sciences in more applied and technical forms and have maintained them until today. But there are remarkable differences in the structure of non-university engineering education routes, the time of diversification, the institutions' relations to universities, and the credits offered to students who possibly want to transfer between to the systems.

Germany started already 30 years ago with its setting-up process of Fachhochschulen of engineering by upgrading its former Ingenieurschulen. In the Netherlands, the important institutional changes in the direction of establishing HPE at tertiary level and as a strong alternative to universities happened in the 1980s. Also Denmark started to develop two pathways outside long-cycle university studies some decades ago. Portugal began in 1979/80 to create poly-

technics education to provide more study places for the growing student numbers and to offer better links of higher education to the labour market and the companies.
Austria established its Fachhochschulen with a considerable delay beginning in 1994, but with very fast development of these new programmes concerning new student enrolment.

Although in all these countries there are some tendencies of "academic drift", they have not been as strong and powerful as in the United Kingdom. In terms of permeability of educational pathways and routes the U.K. example goes for a "unified system of higher education", although educationalists speak of a considerable informal differentiation. The Dutch system comes nearest to the United Kingdom's approach, with plenty of transfer and transferability from HPE to universities, mostly after graduation.

TABLE S/C-1.

The binary system of post-secondary engineering education

Non-university sector	**(Traditional) Universities**
Polytechnics* in the UK	
Polytechnic Education in Portugal	Engineering science studies
Fachhochschulen, Berufsakademien (and Technikerschulen) in Germany	with the main aim
Fachhochschulen (and SCEs) in Austria	at basic research
Short- and Medium-cycle higher education in Denmark	
Hoger Beroeps Onderwijs (HBO) in the Netherlands	

* abolished in 1992
Source: ENGENUS-project, 2000

In all countries of the project, one of the main characteristics of engineering education outside traditional universities is their wider acceptance of young persons with a vocational educational background or with wider ranges of educational backgrounds. In all countries the diversification of engineering education in the post-secondary systems brings about a broadening by means of a differentiation of occupational opportunities. With variations in course lengths it is not only possible to meet the varying needs of individuals and their interests and experience, but also those of organisations which increasingly depend on engineering and technology-related skills at quite different vertical levels.

Besides differences in programme length, there are also needs of diversification in the orientation of programmes, including the methods which are being used in terms of learning. Besides national differences it seems appropriate to keep or maintain some form of binary system. A case in point is the British system where the binary system was abolished, but a number of years later the former differences appeared in the form of courses that lead to Incorporated Engineer status, as well as those which lead to Chartered status.

There are significant differences in institutional arrangements for meeting labour market needs. In some countries e.g. the non-university sector was established to meet local labour market needs, as opposed to national ones. In addition to the occupational orientation of non-university provision, the use of funding mechanisms can be viewed as a way in which mismatches might be reduced.

TABLE S/C-2.

Institutions and duration of programmes for engineering education outside engineering science studies at (old) universities

AUSTRIA
Secondary Colleges for Engineering (SCEs) (5-years); since 1994 Fachhochschulen have been developing very fast; as a rule their duration is 4 years, including industrial placements
DENMARK
There two pathways for engineering higher education beside long-term university studies: short-cycle and medium-cycle programmes; short-cycle courses take 1.5 to 3.5 years; medium-cycle courses take 3.5 years including industrial placements
GERMANY
Starting about 1970 the former Ingenieurschulen have been transformed into a whole new sector, the Fachhochschule sector, which qualifies the majority of engineering graduates in Germany. Most programmes include industrial placements and have a nominal duration of 3 to 4 years, but the actual time needed is longer.
NETHERLANDS
Since the 1980s HPE has provided engineering programmes beside universities, which actually take 4 years including industrial placement periods. Transfer to university after graduation is quite frequent.
PORTUGAL
Polytechnic Education provides 3-year programmes of engineering education and was growing fast during the 1980s and 90s. There are public and private institutions; transfer to university after graduation is possible.
UNITED KINGDOM
The educational basis is usually a period of three years of university or college education and/or industrial placement. To get professional status, students have to undergo a registration process under employment (about 2 to 3 years): Chartered Engineer, Incorporated Engineer and Engineer Technician can be obtained.

Source: ENGENUS-project

Experiences made in the Netherlands show that funding can be a mechanism for enhancing the responsiveness of educational institutes concerning labour markets demands. On the other hand the example of Denmark and also Austria (concerning the newly established Fachhochschule sector) shows that the social partners' involvement and the use of other labour market expertise can also facilitate the matching between supply and demand.

The company survey carried out by the Portuguese partner has shown that polytechnics engineers are considered to have a more practical training which facilitates integration into industry. University engineers are considered to have a better background for management functions.

This differentiation is also true for the Austrian SCE engineering education as compared to university education. The domains of engineering graduates from universities (Diplomingenieure) are (basic) research, management functions, and positions that require a very detailed technological knowledge. Graduates from SCEs can be employed for a much broader range of tasks and positions.

The newly established Fachhochschulen are strong competitors for university graduates outside research functions due to their mostly better additional skills in commercial respect and in foreign languages as well as the general focus on soft skills in Fachhochschulen rather than purely academic research-orientation. Within a few years the share of new entrants in university-level engineering education including information technology reached 29 per cent, which is about the same as in Portugal (see Table S/C-2). In Germany, Denmark and the Netherlands the quantitative importance of the alternatives to old universities in terms of students' enrolment amounts to 55 to 70 per cent. This percentage is even higher when comparing graduate numbers by sector, due to the shorter duration of the NUS-programmes in most countries.

TABLE S/C-3.

Quantitative importance of engineering education in the NUS*

Country	Students		Graduates	
	NUS	Universities	NUS	Universities
Germany	55 %	45 %	61 %	39 %
Denmark**	10 % + 55 %	36 %	-	-
Netherlands	70 %	30 %	-	-
Austria***	29 %	71 %	-	-
Portugal****	26 %	74 %	-	-
United Kingdom*****	-	-	19 % + 6%	75 %

* or vocational/technical oriented tertiary programmes

** NUS: short-cycle and medium-cycle; all fields of study, not only engineering

*** new entrants at Fachhochschulen (developed since 1994) as a percentage of all new entrants at university-level education in engineering (including IT)

**** referring to all fields of study

**** the U.K. has abolished the binary system; 75 per cent of those getting registered professional status obtain C.Eng., 19 per cent I.Eng. and 6 per cent Eng.Tech.

Diversification broadens the occupational advantages of graduates by opening up to them more than just the traditional routes of higher education into the labour market. It is a one-eyed view of higher education and employment to stress only the needs of the economy for qualifications as an important context of post-secondary education. The higher education systems do not only have to meet the increasing and changing needs of the economy, but also to respond to "the substantially greater social pressures"[54]. A further increase "in social de-

[54] OECD: From Higher Education to Employment. Synthesis Report, Paris, 1993, p. 142.

mand must be expected"[55]. It is of utmost importance to get a wider view of the economic and social demands of higher education. Public debate far too often focuses on university education and top-level qualifications.

The country reports indicate not only advantages for engineering graduates over fields of study not oriented to the private sector. There is also evidence of advantages of vertical diversification of higher education and a need for short training courses. High-level employment is increasingly growing at intermediate or "upper-medium level" jobs and can be located not only at traditional high-level positions.[56]

Funding and quality assurance as increasingly relevant issues

In Austria, Germany and Denmark it is the State that takes care of the funding of the whole area of engineering education at tertiary level as well as of higher education in general. So far private universities have played a marginal role in Austria and Germany. In the Netherlands and the United Kingdom students in general have to pay tuition fees, in Portugal only at the private institutions of higher education.

In the *United Kingdom* mandatory tuition fees have to be paid at all tertiary educational institutes. HE Colleges, the new universities (the former polytechnics) and the old universities charge the same tuition fee. The tuition fee is not decisive for the applicants' acceptance at higher education institutions. There is no general entitlement for A-level holders to be accepted by a university like in Austria or, slightly different, in Germany (there is a central procedure for allocation of study places but generally based on the "Abitur" as a prerequisite).

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[55] OECD, 1993, op. cit., p. 142.

[56] OECD, 1993, op. cit., pp. 141.

TABLE S/C-4.

Funding of higher engineering education

Country	State	Private tuition fees
Germany	Yes	No
Denmark	Yes	No
Austria	Yes	No
Netherlands	Yes	Yes
Portugal	Yes	yes*
United Kingdom	Yes	Yes

* only at private institutions

Source: ENGENUS-project

In countries with fully state-funded higher education, quality assurance plays a different role than in countries with private tuition fees or in countries with a high degree of institutional diversity in higher education. It is stipulated and assumed in state-funded higher education systems that all respective institutions provide the same quality of teaching because they are all based on curricula which have the legal status of ordinances. Thus the question of "university ranking" does not have the same importance as in market-oriented higher education systems with accepted marketing tasks of institutions.

But also in the state-run higher education system, devices of quality control are increasingly connected with funding and important for the further evolution of the study systems. In Denmark e.g. funding for teaching in medium-cycle programmes in Colleges of Engineering is provided *according to the success of student in year-end examinations*. Funding for short-cycle programmes in Technical Colleges/Schools is provided according to full-time enrolment, but not for students repeating a year. This funding approach is called the "taximeter" system.

In *Austria* there is open admission to all universities but not to the newly established Fachhochschulen which have limited numbers of study places due to a different funding. The state refunds Fachhochschulen about ATS 100,000 for each study programme enrolled. But this funding is based on previous skill requirement studies and acceptance of a restricted number of places by the public authorities. This means that the sector of Fachhochschulen has become a kind "closed educational sector" compared to the fully open old universities. This has consequences on funding, on the quality and on the student-teacher ratios of the institutions.

Labour market advantages for engineering graduates from all routes

The sector of information-technology is a decisive field to prove this hypothesis. The growing IT-skill gap requires, among other measures, the widening of access for additional groups to post-secondary education and training: DATAMONITOR gives as final conclusion the recommendation to IT-companies (among other recommendations) to tap into "non-traditional labour pools", to partner universities/training organisations[57]. Furthermore a recommendation is given to governments to support recruitment from ‘non-traditional’ sectors of the labour pool through mentoring programmes.[58] This is a strong indication that we need a high degree of diversification of pathways leading to IT-skills and its horizontally and vertically differentiated jobs.

Skill inflation and underemployment as a consequence of higher education expansion can be avoided to a high degree in spite of an ongoing growing social participation in post-secondary education by diversification of programmes, short- and medium-term courses provision and strong links to the industry.

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[57] Datamonitor: The economic impact of an IT skills gap in Western Europe, London, 2000, p. 9f.

[58] Datamonitor, 2000, op.cit., p. 9f.

All participating countries experience a shortage of engineers to fulfil the needs of industry. Although there are severe problems of older engineers in some regions and mismatches between supply and demand by engineering subjects, the labour market positions of engineering graduates are better than the employment prospects for most other fields of study.

Due to demographic decreases and other factors the number of new graduates in engineering is declining in most countries. There appears to be a significant difference in the attractiveness of classical engineering versus computer-related studies. However, there are national variations. For example, in Denmark and the Netherlands the shortages of graduates appear to be caused to a certain extent by a lack of attractiveness of the 'classical' engineering studies, whereas in Austria this shortage is probably more related to the downward demographic trends of the respective age cohort. Another related point is the low participation rates of females in engineering studies.

The U.K. experience: Despite the large increase in the number of engineering graduates entering the labour market over the past 10 years, evidence suggests that there are both quantitative and qualitative shortages. In certain sectors, such as electronic engineering, over one third of enterprises experience severe difficulties in recruiting graduates.

Another reason for shortages of engineering graduates is that a large number opt for a career in business or financial services rather than manufacturing. This reflects the fact that the financial services sector can offer graduates much higher salaries than they would receive in the manufacturing sector. Figures from the Institute of Chartered Accountants, the professional body responsible for accountants, revealed that about a quarter of its entrants have a degree in engineering or a science-based subject.

The circumstances for engineers in the UK labour market will probably become worse in the near future, particularly if we enter a period of high growth and the supply of graduates is unable to keep pace with demand. Furthermore, this will also exacerbate what many academics call '*latent or concealed labour market shortage*s'.

In the Netherlands every year a survey is conducted among graduates from higher professional education (*HBO monitor*); this survey takes place one and a half years after they have left school. In 1998 the proportion of unemployed among HPE graduates in engineering was 2 per cent, whereas for all HPE students it was 3 per cent. In particular the period 1993-1995 showed a sharp decline in graduate unemployment. Due to the flourishing economy in the Netherlands at the moment, unemployment in general has reached its lowest levels for decades. There are only slight differences in unemployment between the various engineering courses in HPE.

Significant earning advantages of engineering graduates can be stated. Of all HPE or Fachhochschule graduates the graduates engineering fields earn the highest incomes. This situation is probably an answer to the strong need for engineering qualifications on the labour market. There are, however, some differences in income between graduates from various engineering courses. For instance, the income of graduates in computer and information science, (technical) business administration, and operational technology is above average, whereas the income of graduates in architecture and construction engineering as well as environmental science is clearly below average.

At the beginning of the nineties German labour market prospects for engineering graduates showed some problems not known for decades. In 1997 (compared to 1993) the situation has significantly changed for new graduates entering the labour market.[59] Although there are still striking differences by age, region or field of study have remained. However the employment prospects of young engineering graduates are one of the best when comparing the different study fields – this is true for university graduates[60] and Fachhochschule graduates as well. For Germany we have to take into account very diverse employment conditions for graduates from higher education between the old and the new Länder, and this also applies to engineering graduates.

In Austria both the graduates from SCEs and those from the newly established Fachhochschulen have better employment prospects than most of the other fields of higher education. Similar results can be reported from Denmark. In both countries the shaping of programmes is supported by intensive efforts on the part of experts of the social partners and other labour market-related organisations.

In Denmark, unemployment among medium- and long-cycle educated engineers has dropped dramatically over the last 4 or 5 years and is still decreasing. Today's Danish unemployment problems are related to structural issues and short-term frictional unemployment and do not depend on the actual cyclical movement of the Danish economy.

In spite of the fact that the main part of the short-cycle engineers have shown that they are able to adapt to new conditions and can react flexibly to changing working conditions, some parts of the engineers have experienced an increasing mismatch between their real competence and the qualifications needed to handle the new conditions.

The challenge facing the labour market today is that it is becoming more and more tight. The demand of the Danish industry for more and more people with a short-, medium- or long-cycle education in the engineering field is growing fast, but fewer and fewer students are choosing related studies. Therefore the unemployment rate is decreasing fast and the labour market is experiencing more

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[59] See: Karl Heinz Minks, Rolf Holtkamp, Petra Koller: Der Übergang von Fachhochschulabsolventen in den Beruf. Vergleich der Absolventen 1989, 1993 und 1997, Hannover, 2000, p. 2.

[60] See: Minks, Holtkamp, Koller, op.cit., 2000, pp. 5.

and more examples of mismatch problems and bottlenecks. One way of solving this mismatch between the demand for and supply of technical skills is by substitution of both geographical and vertical terms. But that is not enough. It is urgently necessary to have greater numbers of graduates leaving the educational systems in the coming years to match the growing demand. Another issue is to give graduates the possibility to continue training on the labour market.

Employability skills and project learning as educational answers

In all countries there are established traditions of close links between engineering departments and industry. However, technological pressures, movements towards a service-orientated economy, as well as changes to the way in which work is organised, are influencing the nature and type of links. Nevertheless, there is the possibility of a gap emerging between changes in occupational tasks for engineering, and the inability of curricula/training methods in the colleges to keep pace with such changes.

A key aspect to be considered is the *differentiation of occupational tasks* in engineering, particularly with regard to the following aspects:

- design;
- construction;
- marketing, selling and client relations.

Across the participating countries there has been strong evidence that technological skills are not enough for graduates entering today’s labour market. Indeed, no longer can graduates rely on their technical knowledge to find a job in the modern workplace. Employers are increasingly looking beyond engineering knowledge and whether graduates have what is commonly known as *employability skills*.

Employability skills can be defined as:

- traditional intellectual skills;
- the new core or key skills;
- those personal attributes deemed to have a market value;
- knowledge about how organisations work and people in them do their jobs.

The experience of participating countries illustrated that these skills can be developed using innovative learning methods and situations, including:

- project approaches to learning;
- work based project learning;
- the involvement of industrialists in these learning processes;
- changes to the role of the teacher in engineering education, such as the use of mentoring and coaching techniques.

In all countries involved in the European project-based assignments play a central role in the engineering education system. All of these systems stress learning in a complex situation, including working in teams, the development of effective communication skills, negotiation and other soft skills.

The best way to improve not only technical skills but also employability skills as a whole are programmes of company placements for students with structured contents and follow-up reflection in the colleges. Therefore it is one of the most important measures to maintain and to foster education-industry links at a national and European level in order to improve engineering education and thereby the technology-oriented human capital.

There has been consensus in the working group that short study programmes with a high degree of transferability between different educational pathways and institutions can expand employment opportunities of youth. This implies various combinations of engineering design, construction and marketing aspects. It has been stressed by all partners that a high degree of transparency of educational programmes and the connections between education and employment has a key function in informing, guiding and orientating youths towards future employment opportunities.

Improving mobility by more transparency and ECTS

There is a lot of occupational mobility in Europe especially in the fields of scientific professional work, technician and management.[61] Graduates from engineering education pathways are usually employed in all of the above-mentioned fields. In many countries of the European Union the share of technicians coming from other EU-member states is higher than the share of citizens from other countries (see Table 4). This is especially true for the Netherlands, Denmark, Austria, Belgium, Italy and Greece.

The combinations of technology and business-related jobs are growing and therefore also the respective studies and the need for foreign language skills and at least a basic understanding of cross-cultural interactions. Subject-related English has become very important for technologist, engineers and management for many countries. This is the reason why most engineering programmes offer foreign languages as additional skills.

The trend towards globalisation and the need for broad-based competencies are met by employment possibilities abroad. However, due to national differences in economic orientation and differences in labour market situations there are variations in the extent that graduates work abroad after completing their studies.

[61] Melanie Kiehl / Heinz Werner: Die Arbeitsmarktsituation von EU-Bürgern und Angehörigen von Drittstaaten in der EU, September 1997, pp. 44.

In all countries there is the possibility to follow engineering courses in English. Students exchange, international co-operation and educational joint ventures with institutes abroad are practice in most countries. Different structures of engineering education can be obstacles to mobility.

Due to the historical differences of higher education in Europe there are also deep cultural specialities in engineering education which function as obstacles to comparison. The legal possibility to establish the Anglo-Saxon three-tier university study systems since the end of the 90s in Germany and also in Austria might be a chance in the long run for a higher degree of comparability of engineering education at tertiary level.

It takes some time for persons from European mainland countries to understand the basics of the UK system of becoming an incorporated or chartered engineer. Whereas in professional degrees are awarded by educational institutions this is not true for the U.K. Although the college or university education plays an important role, the comparable qualifications are awarded – after professional work experience – only through *registration by a professional body*.

Whereas the British system differentiates between three-year undergraduate studies leading to a Bachelor's degree and post-graduate studies leading to a Master's degree, in Germany, the Netherlands and Austria – until now[62] - university degrees are attained within a single course of study (duration about 4 to 7 years), which in view of the qualification level are mostly equivalent to the Master's degree.

About three quarters of registered engineers in the UK are Chartered Engineers. About a fifth falls to the Incorporated Engineers, and 6 per cent to the Engineer Technicians. It is a significant difference to most European mainland countries that the formal top level (C.Eng.) of engineering professionals has by

[62] There have been new regulations allowing Bachelor's and Master's for Germany (1998) and Austria (1999) but their implementation is just at the very beginning.

far the highest share among all registered engineers. In contrast to that, graduates from the alternatives to long-term university studies in the European mainland countries make up the majority of diploma holders in the field of engineering. Due to the quantitative importance of the I.Eng. it is very difficult to establish a convincing correlation between the Incorporated Engineer and the graduates from Fachhochschule (Germany, Austria) or the Dutch HPE. Fachhochschule award diplomas which might be more equivalent to a Master's degree than to a first degree in the UK.

In the short-time perspective the use of the *European Credit Transfer System (ECTS)* is one of the most important devices to improve the mobility of students and later on of technicians, scientists, technologists and other highly skilled personnel. This will require a restructuring of engineering subjects in a modular way that can in used in future European engineering curricula with academic and practical content-orientation. Within a framework of European engineering studies there should be enough space for different kinds of programmes: from the pure sciences to the applied sciences and the implementation of technology with various combinations of engineering and commercial subjects.

TABLE S/C-5.

Employment of Technicians in EU-Member Countries by Citizenship, 1995

In per cent (basis in thousands)

Country	Citizens of the country	Citizens of EU-Countries	Citizens of NON-EU-Member-Countries	*Difference: column 1 minus column 2*	*Difference: column 2 minus column 3*
Austria	13.8 N=3330.3	21.4 N=42.4	5.5 N=300.2	*-7.6*	*+15.9*
Germany	19.7 N=32790.8	11.4 N=1002.4	8.1 N=1988.8	*+8.3*	*+3.3*
Denmark	16.8 N=2556.2	20.6 N=22.0	11.2 N=22.5	*-3.8*	*+9.4*
Netherlands	18.2 N=6319.5	16.1 N=106.0	7.9 N=96.4	*+2.1*	*+8.2*
Portugal	10.7 N=4376.9	6.5 N=9.6	13.8 N=8.8	*+4.2*	*-7.3*
United Kingdom	8.3 N=24934.7	6.8 N=402.8	6.9 N=463.1	*+1.5*	*-0.1*
Belgium	10.2 N=3538.3	10.0 N=186.2	3.5 N=65.0	*+0.2*	*+6.5*
France	17.4 N=20801.1	6.3 N=565.0	5.0 N=664.0	*+11.1*	*+1.3*
Spain	7.3 N=11933.3	7.4 N=35.7	7.0 N=58.5	*-0.1*	*+0.4*
Greece	5.7 N=3758.8	11.4 N=8.5	3.4 N=53.2	*-5.7*	*+8.0*
Italy	13.8 N=19151.1	13.2 N=18.6	5.4 N=65.6	*+0.6*	*+7.8*
Luxembourg	16.6 N=99.3	9.5 N=58.2	6.8 N=4.4	*+7.1*	*+2.7*
Ireland	4.0 N=1224.7	5.5 N=27.3	7.2 N=7.6	*-1.5*	*-1.7*

Source: Melanie Kiehl / Heinz Werner: Die Arbeitsmarktsituation von EU-Bürgern und Angehörigen von Drittstaaten in der EU. September 1997. Tab. 3.15 and own calculations

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PARTICIPATING INSTITUTIONS AND EXPERTS

ibw-Institute for Research on Qualification and Training
of the Austrian Economy
A-1050 Vienna, Rainergasse 38
Phone: +43 1/545 16 71-17 Fax: +43 1/545 16 71-22
homepage: http://www.ibw.at

Dr. Arthur Schneeberger
E-mail: schneeberger@ibw.at
Ing. Mag. Bernd Kastenhuber
e-mail: kastenhuber@ibw.at

Mag. Petra Wimmer (ibw)
Dr. Herwig Höllinger (Austrian Federal Economic Chamber)

Teknisk Landsforbund (TL)
Nørre Voldgade 12
DK - 1358 København K

Phone: +45 / 33 / 12 22 218 Fax: +45 / 33 / 12 23 17
E-mail: erik.jensen.tl@net.dialog.dk

Erik Jensen
Henrik Rothman

Netherlands Economic Institute (NEI)
P.O. Box 4175
N L-3006 A D Rotterdam
Phone: +31 / 10 / 453 88 12 Fax: +31 / 10 / 453 07 68
E-mail: aa@nei.nl

Ruud van der AA

Institut für Wirtschaftsanalyse, Personalentwicklung
und Unternehmensberatung (IWPU)
Thalheimer Str. 59
D - 06766 Wolfen
Deutschland

Phone: +49 / 3494 / 331 21 Fax: +49 / 3493 / 767 79
E-mail: project-group@tpnet.de

Dipl.-Ing. Birgit Bauer
Dr. Wolfram Pfeiffer

Sociedade Portuguesa de Inovação (SPI)
Edifício „Les Palaces“
Rua Júlio Dinis, 242 - Piso 2 - 208 - 4050
Porto
Portugal
Phone: +351 / 2 / 609 91 52 Fax: +351 / 2 / 609 91 64

Paulo Baptista
Prof. Augusto G. Medina
Prof. Fernanda Oliveira
Mark Spinogio
Dr. Rui Tomás
E-mail: spi@mail.telepac.pt

Centre for Labour Market Studies (CLMS)
7-9 Salisbury Road
Leicester LE1 7QR
United Kingdom
Phone: +44 / 116 / 252 / 59 50 or +44 / 116 / 252 / 59 57
Fax: +44 / 116 / 252 / 59 53

Dr. Marcus Powell
Prof. David Ashton
E-mail: map5@le.ac.uk
