Int. J. Engng Ed. Vol. 9, No. 1, pp. 20–28, 1993
Printed in Great Britain.

0742–0269/91 $3.00+0.00

German Engineering Education from a Fachhochschule Perspective

R. TAURIT
Fachhochschule Lübeck, Stephensonstraße 3, 2400 *Lübeck, Germany*

The system of higher engineering education in Germany is characterized by the symbiosis of universities and Fachhochschulen and a comparably close co-operation with industry. The system and its status is shown and the profile of Fachhochschulen is explained with their impact on practice-oriented education. Some special aspects are illustrated using the example of Fachhochschule Lübeck.

INTRODUCTION

FACHHOCHSCHULEN are part of the higher education system in Germany. Therefore this system will be discussed first. A profile and criteria of Fachhochschulen will then be looked at with special attention to their engineering education aspects. Some details will be given from the example of Fachhochschule Lübeck.

THE SYSTEM OF HIGHER EDUCATION IN GERMANY

Within the federal system of Germany the federal parliament determines the legal framework for higher education and the federal government (Ministry of Education and Science/BMBW) takes responsibility to finance 50% of new contructions, including equipment. The other 50%, as well as the normal budget including expenses for all personnel, depends on the 16 state parliaments and their state governments/ministries of science.

A number of organisations deal with recommendations or coordination, or are engaged in additional research, are:

- Kultusministerkonferenz/KMK: Conference of the Ministers of Education & Science;
- Wissenschaftsrat: Scientific Council;
- Hochschulrektorenkonferenz/HRK: Conference of Rectors/Presidents of Universities and Fachhochschulen;
- Deutsche Forschungsgemeinschaft/DFG: Funding of Research
- Max-Planck-Gesellschaft/MPG: Society for Basic Research;
- Fraunhofer Gesellschaft/FhG: Society for Applied Research;
- Arbeitsgemeinschaft der Großforschungseinrichtungen (AGF): Association of Large Research Centres;.

In 1992, there are a total of 267 institutions [1, 2] as shown in Fig. 1. This number includes institutions that already exist in West Germany or are currently being established in the former East Germany. Of 82 universities, about 20 offer engineering degree courses the same as do 89 Fachhochschulen (FH).

The number of students totals (1 630 000 + 130 000) which is an increase of more than 75% compared to 1977, when it was agreed to keep the schools open in spite of the large students increase expected. However the scientific personnel increased by only 2% (U) and 8% (FH). Thus the ratio of students/professors increased from 11/1 to 16/1 (U) and from 18/1 to 37/1 (FH) respectively [3]. As a consequence, a heavy load has to be carried which causes many kinds of problems.

Figure 2 gives the number of available study places in East and West Germany, which shows a deficit of about 50%. Whereas the ratio of available study places between University and Fachhochschule in West Germany is 80% to 18%, the ratio of beginners has changed to 71% to 27%. The trend of this ratio can be seen in Fig. 3 which also shows the relative increase of students between 1977 and 1992. While 31% of an age group began studying in 1992 this percentage is expected to increase to about 34% in 2000 and to about 40% later on (equivalent to about 300 000 beginners per year) [3]. Consequently, a significant increase of place capacities, of the order of 24%, is needed for a total of 1 325 000 places, primarily for Fachhochschulen, as an immediate action [3].

Looking at the graduates, 65% graduated from Universities, and 35% from Fachhochschulen. Comparing engineering degrees however, more than 70% are granted by FH. In business administration and data engineering this ratio is about 50%.

Items of concern are first, the low rate (less than 3%) of female students in engineering in West Germany [1] (in East Germany it is slightly above

	West	East	Total
Universities	70	12	82
Other (U)	25	-	25
Music/Arts	31	16	41
Fachhochschulen	69	20	89
Other (FH)	30	-	30
			267

Fig. 1. Number of institutions of higher education.

		University	Music/Arts	FH	Total
Study places referred to area	West East	652 000 (80 %) 50 000 (62 %)	17 000 (2 %) 30 000 (38 %)	141 000 (18 %) -	810 000 80 000
Students	West East	1 240 000 (76 %) 80 000 (62 %)	40 000 (2 %) 50 000 (38 %)	350 000 (22 %) -	1 630 000 130 000
Loading of room capacity		175 %	140 %	220 %	
Beginners	West East	195 000 (71 %) 19 500 (66 %)	5 000 (2 %) 10 000 (34 %)	73 500 (27 %) -	272 000 29 500

Fig. 2. Available study places compared to students.

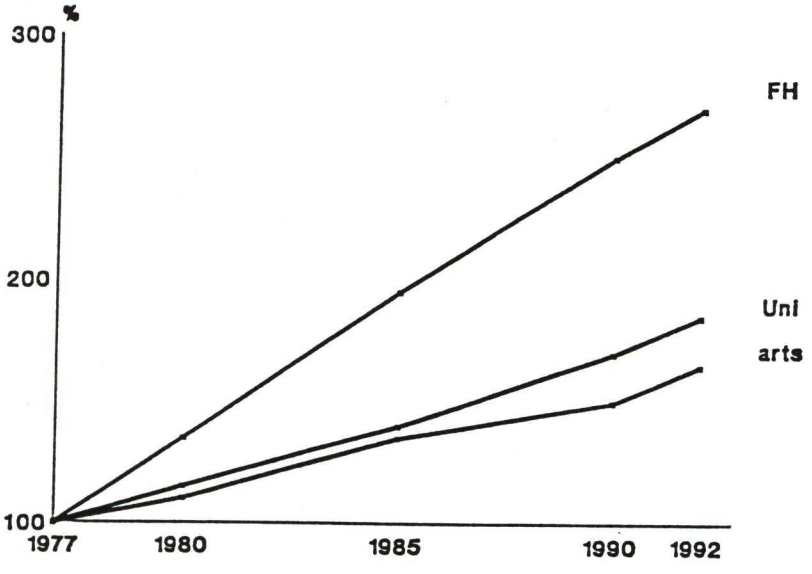

Fig. 3. Relative increase of number of students in West Germany between 1977 and 1992.

7%) and, second, an effective length of study significantly above the standard length of time for degree completion [4]. Figure 4 shows some examples. There are a number of recommendations for decreasing the length of study, such as the establishment of a better advisory system for the students, the reduction of the number of subjects and level of examinations, no penalties for a failed degree examination when attempted within the standard length of time, the evaluation and improvement of teaching quality, and the installation of short-term basic courses plus follow-up courses [5].

The procedure for to becoming a student and a

	University	FH
Standard length [sem.]	10 (14 weeks/sem.)	8 (19 weeks/sem.)
Effective length [sem.]		
– Architecture	14	10
– Civil engineering	13	9
– Mechanical engineering	12	9
– Electrical engineering	12	9

Fig. 4. Examples of average length of time for degree completion.

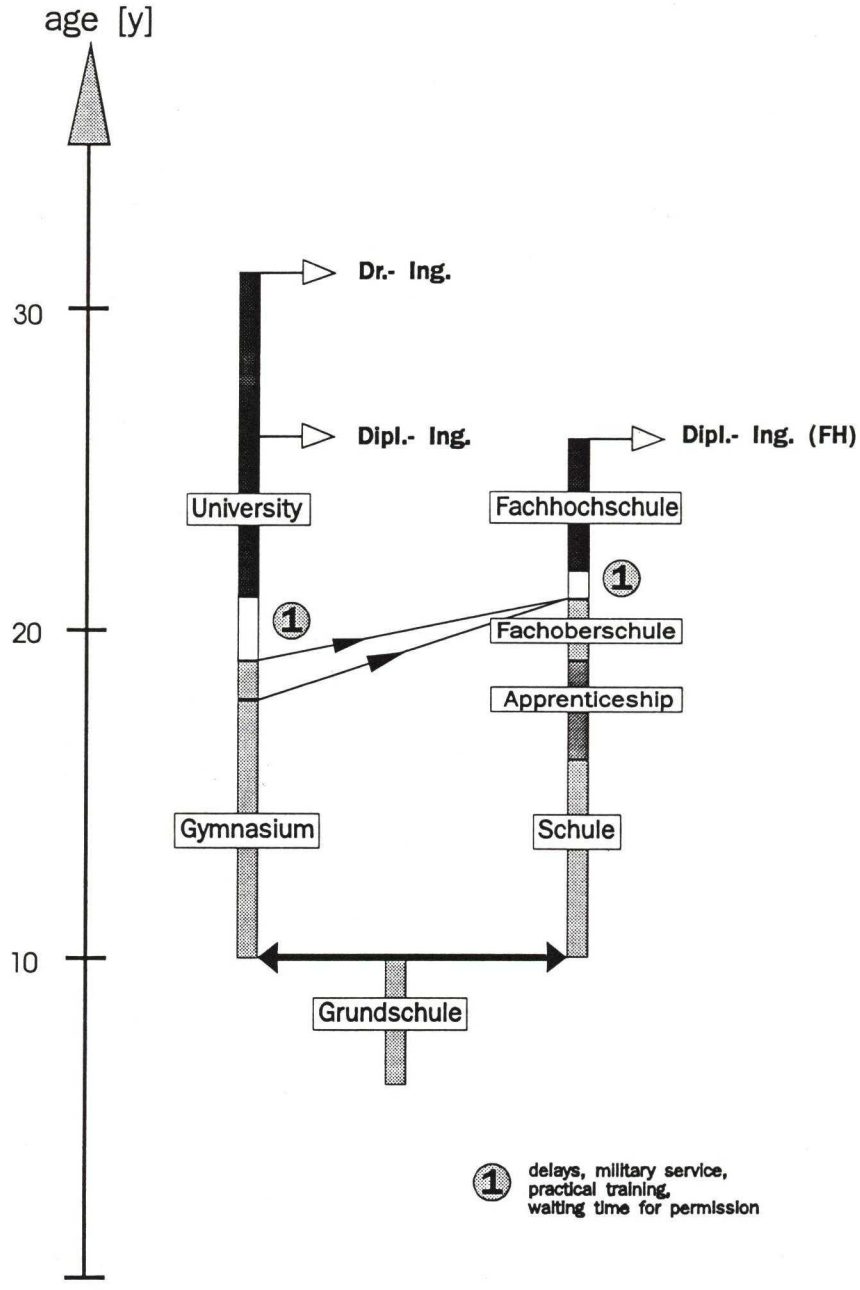

Fig. 5. Main ways to become a student and a professionally qualified engineer.

professionally qualified engineer is shown in Fig. 5. About 45% of the students at Fachhochschulen get there via a Gymnasium plus half a year of practical training. The others typically have extensive practical experience by way of a three-year apprenticeship.

UNIVERSITIES AND FACHHOCHSCHULEN

Universities and Fachhochschulen complement each other with respect to their education of engineers and the professional qualifications of their graduates. Typical structural elements of universities are:

- unity of science, variety of disciplines, independence;
- unity and equivalence of research and teaching, education of the future scientific generation, community of professors and students;
- right to grant a Doctoral degree.

Research in universities is focused on fundamentals (applied research also in engineering) and is funded by external sources.

Overall, 14% of research is performed in universities, with the rest done by industry (70%), other research institutions (15%), and Fachhochschulen (1%).

Fachhochschulen are described by the Wissenschaftsrat (Scientific Council) as a distinct and indispensable element of a differentiated system of higher education, as well as an alternative to universities, with a teaching emphasis and a particular profile with features such as:

- practical orientation;
- short courses of study, using seminars.
- courses harmonized with the labour market;
- applied development and research.

The underlying concept is that: 'Fachhochschulen are different but equivalent.'

FACHHOCHSCHULEN

The practical orientation of Fachhochschule education is accomplished by requiring professors to have 3 to 5 years of practical experience in industry after their Doctoral degrees, by about one year of students' practical experience in addition to extensive laboratory work (20–30%). Theoretical study, which is based on scientific and technological fundamentals, is concentrated on practical examples and is clearly structured. Most of the diploma projects are done in industry. These characteristics show the traditional close relationship with industry.

Figure 6 shows the scope of degree courses currently offered by Fachhochschulen, as well as indicating new courses, the installation of which has been proposed by the Wissenschaftsrat [6].

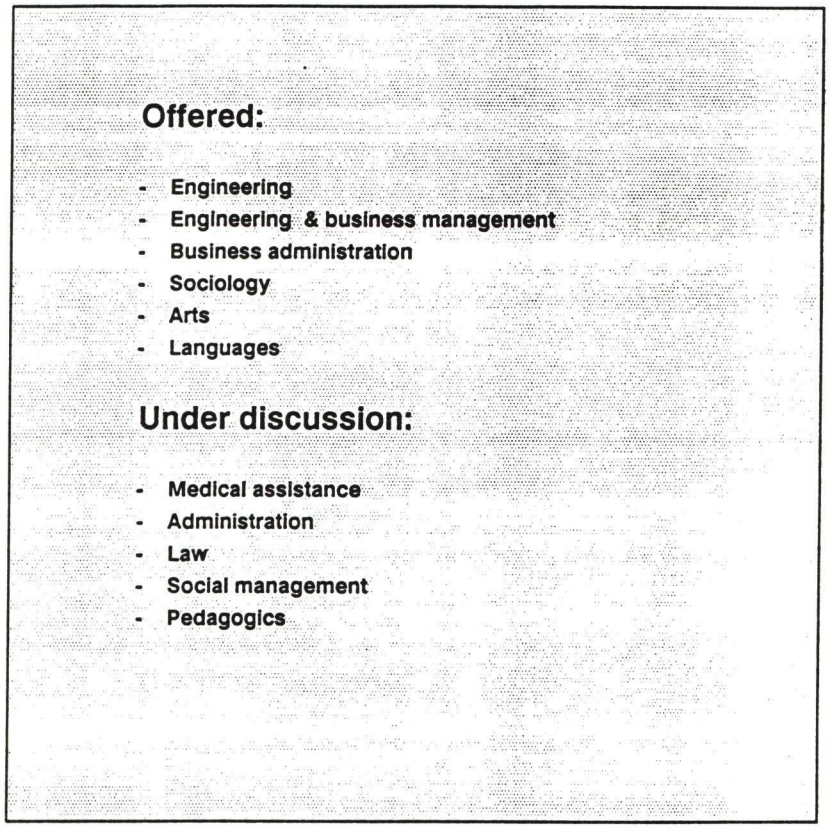

Fig. 6. Scope of degree courses.

Figure 7 lists the main degree courses in engineering [7, 8, 9].

Even highly respected Fachhochschulen suffer certain deficits besides the lack of space and teaching personnel. Assistant laboratory engineers can be employed only at a rate of one for every two professors. On the other hand, laboratories are usually very well equipped. The teaching load of professors (18 hours per week) is far too high. Because of intensive student class and laboratory work (30 hours per week) there is not enough time for additional courses in liberal arts. Usually, such courses are restricted to some business administration, ergonomics, technical English, and similar subjects. Special topics such as the responsibility of engineers to society with respect to environmental problems, global resources, or working within a complex system are sometimes covered in philosophical seminars. Most important, however is the example given by the professor. The current need for a high number of professors throughout Germany makes the recruiting procedure especially difficult, given the level of direct competition with industry.

Fachhochschulen have developed international relations rapidly during the last ten years. The trend is to establish integrated degree courses with partner institutions within the Common Market. Also, the obligation to assist underdeveloped countries and the need to participate in the reorganisation of the systems of higher education in East European countries, has made additional efforts necessary. The practical-oriented Fachhochschulen are seen as a special model for those countries. European Community programs such as ERASMUS and COMETT are helpful as are international exchange programs, such as the Deutscher Akademischer Austauschdienst (DAAD).

Last but not least, Fachhochschulen are considered to be important partners for smaller and middle-sized companies in the region. In addition to the traditional ties to industry an active role is

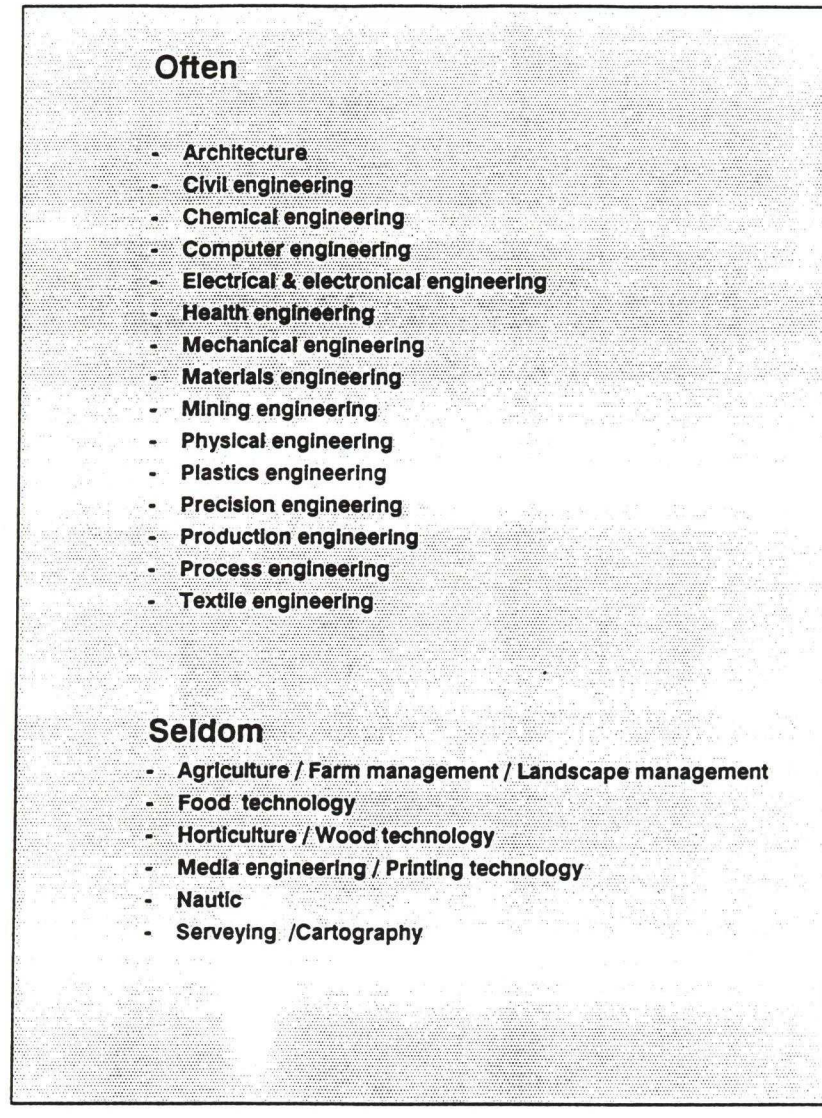

Fig. 7. The main degree courses in engineering.

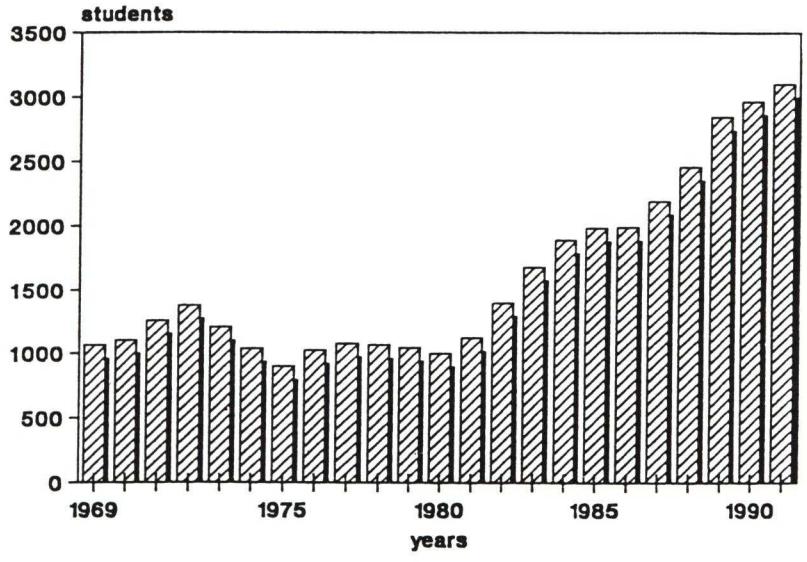

Fig. 8. Changes in student numbers at FH Lübeck.

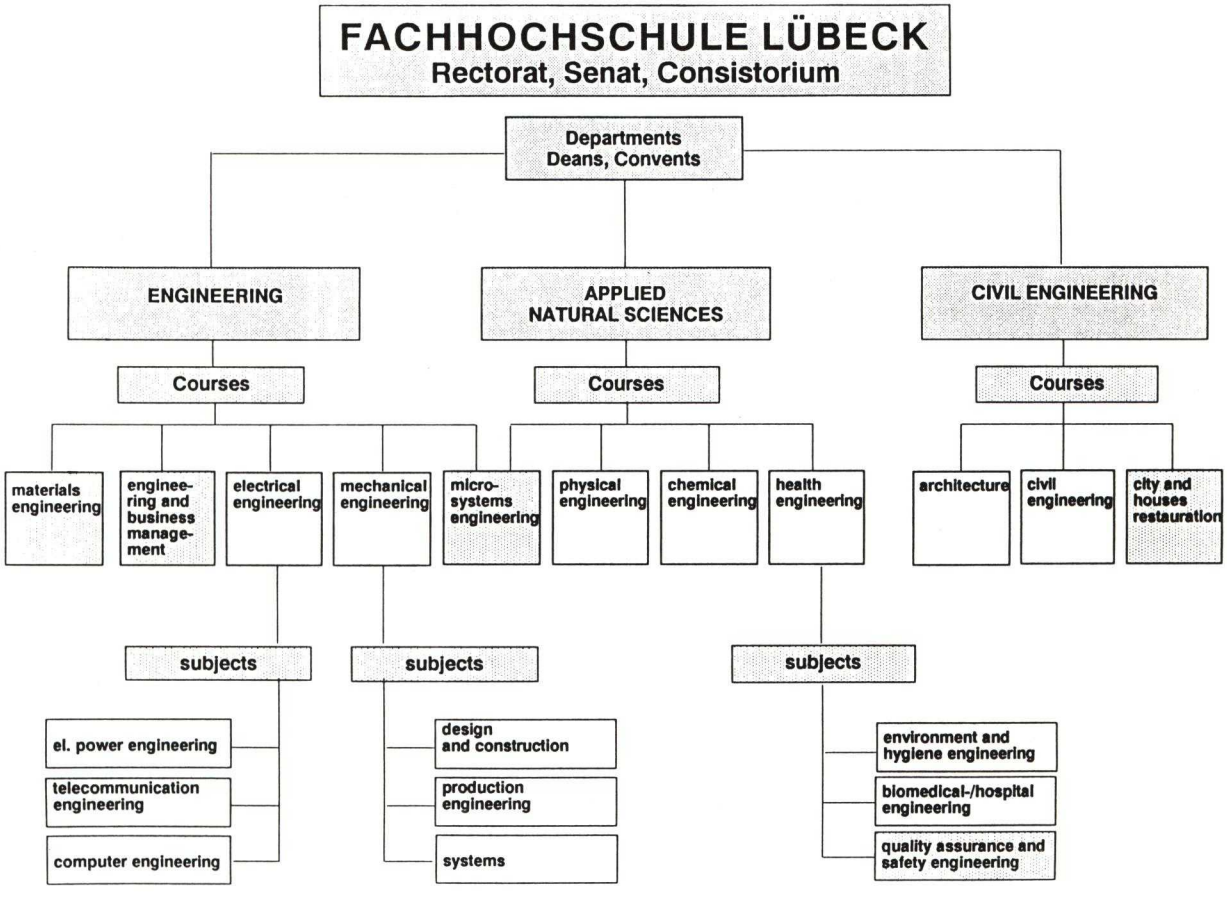

Fig. 9. Organisational structure at FH Lübeck.

taken in transferring knowlege and technology. This activity helps industry and also assures that the experience of professors is current in modern technologies. Unfortunately, relatively few lectures for continuing training of practising engineers can be offered because of the faculty overload situation.

FACHHOCHSCHULE LÜBECK

Fachhochschule Lübeck is averaged sized with 3 100 students, 118 professors, 5 full-time and about 45 part-time lecturers, 73 laboratory engineers or technicians and about 35 other employees. Figure 8 shows the increase of student numbers over time, and Fig. 9 shows the organizational structure.

There are about 70 laboratories with different standards of equipment ranging from merely meeting teaching requirements up to a rather sophisticated level for applied research and development. Special development laboratories are planned to give graduates a chance for further qualification. So far, a laboratory for laser application and optical measurement has been installed and is in co-operation with the neighbouring medical university and its medical laser centre.

A typical student engineering education at FH Lübeck, for example, in Telecommunication Engineering, is shown in Fig. 10.

Closer international relations exist with partner institutions within the Common Market, with those in the sister cities of Lübeck, as well as others who share special programs (Fig. 11).

A number of organisational arrangements have been made for transfer of knowledge and technology with industry. Some examples are listed in Fig. 12.

- Basic practical training in industry (24 weeks)

  (e.g. manual processing of metallic and non-metallic materials, operation of cutting machine tools, joining procedures, thermal treatment of metals, electric workshop, windings, communications)

- 1. - 3. semester (classes and laboratory work incl. tests)

  (mathematics, experim. physics, experim. chemistry, technical mechanics, materials, programming, fundamentals of electrical engineering, fundamentals of telecommunication engineering, measurements, techn. english)

- Pre - diploma - examinations (7 test papers *)

- 4. semester (classes and laboratory work incl. tests)

  (analog and digital technology, sensors and measurements, microprocessor applications, high frequency and control, introduction to el. power engineering)

- 5. semester: Advanced practical training in industry (24 weeks) as an integral part of the study (work in the fields of an engineer)

- 6. - 7. semester (classes and laboratory work incl. tests

  (controls, simulation, microwave communication, networks, software engineering, electro acoustics, seminar, elective subjects)

- Diploma examinations (8 test papers *)

- 8. semester: Diploma work
  Final Colloquium

  → Dipl.-Ing. (FH)

* repetition possible: 2 x

Fig. 10. Typical student engineering education (Telecommunication Engineering) at FH Lübeck.

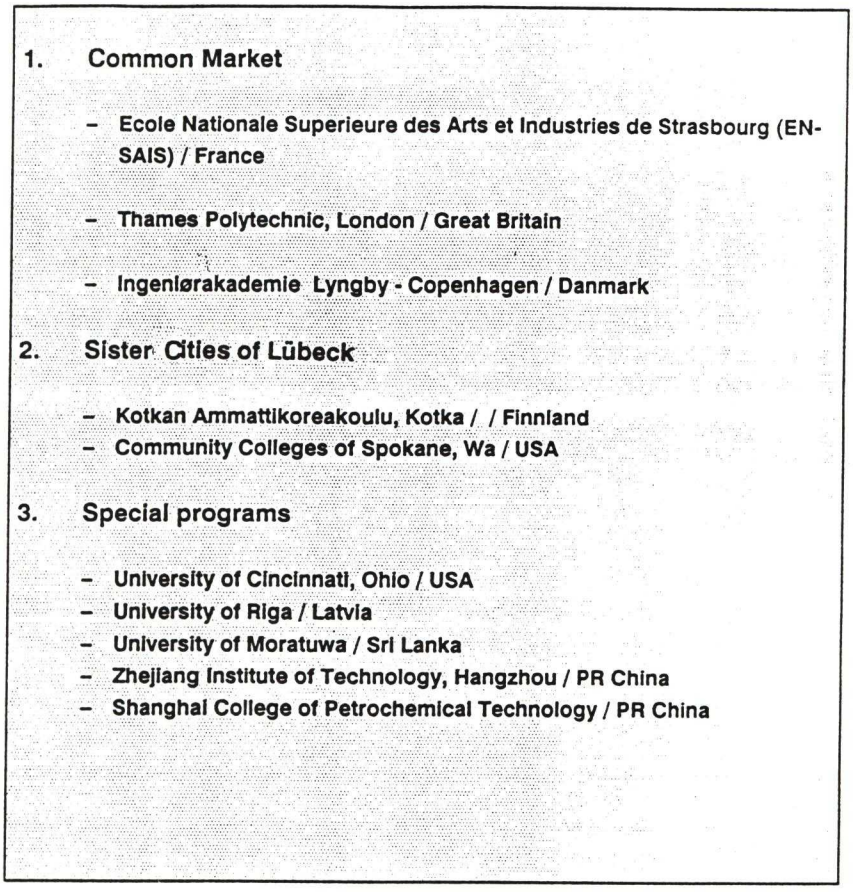

Fig. 11. International cities linked to FH Lübeck.

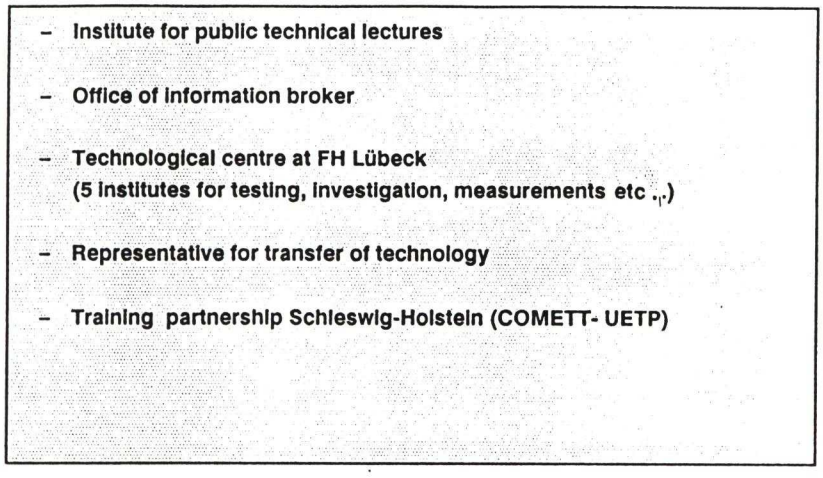

Fig. 12. Co-operation with industry at FH Lübeck.

REFERENCES

1. BMBW, Aktuell, Studenten an Hochschulen 1975–1991, Bonn (7/1992).
2. East: According to recent decisions of state governments.
3. Hochschulrektorenkonferenz (HRK), *Konzept zur Entwicklung der Hochschulen in Deutschland*, Bonn (7/1992).
4. Wissenschaftsrat, *Fachstudiendauer an Universitäten*, Köln (3/1992).

5. Der Bundesminister für Bildung und Wissenschaft, *Thesen zur künftigen Struktur und Reform des Hochschulbereiches*, Bonn (6/1992).
6. Wissenschaftsrat, *Empfehlungen zur Entwicklung der Fachhochschulen in den 90er Jahren*, Köln (1991).
7. K. Henning/J. E. Staufenbiel, *Das Ingenieurstudium*, 4. Auflage, Institut für Berufs- und Ausbildungsplanung, Köln (10/1988).
8. Fachhochschulrektorenkonferenz (FRK), *Handbook of Fachhochschulen*, Campus Verlag, Frankfurt/M. (1990).
9. Bund-Länder-Kommission für Bildungsplanung und Forschungsförderung/Bundesanstalt für Arbeit, *Studien- und Berufswahl 1991/92*, Verlag K. H. Bock, Bad Honnef (1991).
10. Wissenschaftsrat, *Empfehlungen des Wissenschaftsrates zu den Perspektiven der Hochschulen in den 90er Jahren*, Köln (1988).

Rudolf Taurit was born in 1934 and graduated in Electrical Engineering from the University of Hannover in 1960. After serving with EURATOM in the Frascati Research Center in Italy, he obtained an M.S. Degree in Nuclear Engineering from the University of Cincinnati, Ohio,USA in 1963. He served as radiation protection engineer at Indian Point nuclear power station in USA, and as project engineer with AEG in Frankfurt/M. Since 1970, he has been lecturer and professor for Energy and Nuclear Engineering with the Fachhochschule Lübeck. He became the rector in 1987.