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Engineer 2000—An Anthropocentric 'Europe-ready' Engineering Education

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High-tech and humanity must not be allowed to develop into two diverging disparities, but must be integrated into a unified whole in a complementary and penetrating way. 'Europe-ready' training for engineers, therefore, not only involves the fulfillment of the conditions of the Council of Europe, as specified in the 'General Guideline' on 21 December 1988, concerning the mutual recognition of university diplomas. It also must take into account the evolution of a human awareness which reflects the responsibility of engineers and the importance of interaction between society, environment and technology.

FOREWORD

THE competition between national economies has become a competition of the national education systems. The decline of the eastern economic system, as we have witnessed in the recent past, will reinforce this trend. Therefore, we should not only avoid making the mistake of misjudging the signs of the times through fatal overestimation of ourselves, which would hinder any reform of the well-established educational system, but also make sure that we are not lacking in the necessary courage to start work on this sensitive and delicate task.

INTRODUCTION

The development in engineering over the last two decades, and its increasing interaction with the environment and society, has changed and expanded the demands on the engineering profession in many areas. With these considerations in mind, most European countries have reconsidered and modified the educational system for engineers, in order to adjust to the requirements of the industrial society of the present and of the future. In accordance with the demands placed by technology and the economy, two different educational paths, each with different objectives, have evolved for engineers, especially in the German-speaking countries. One of the paths can be described as production–practical training and the other is a more research-oriented scientific–theoretical training. These two types of demands on education also exist in other educational systems. In Austria, the research-oriented scientific education for engineers is carried out by the universities. Completion of the course is rewarded with the academic title of 'Diplom Ingenieur' ((Dipl.Ing.). The practical and production-oriented training takes place in the first instance at the Höheren Technischen Lehranstalten (HTL—technical institutes of higher education). This first step in training must be followed by a practical period in which higher technical knowledge is acquired, at a state-run or state-approved place (ministry or organization). Then the candidate can apply for permission to carry the official title of 'Ingenieur' (Ing.).

This separation of tasks in the training institutions does not however cover the differences which Austrian—and also Swiss and German—firms carry out when advertising jobs, as has been demonstrated recently by a study of the Austrian Institute für Bildungsforschung der Wirtschaft (IBW) [1]. Accordingly, a high rate of overlap between Dipl.Ing. and Ing. is encountered, which is only partially explainable through the lack of Dipl.Ings. on the job market (Fig. 1).

Principally, it has also been determined that all engineering educational institutions in Europe are found in the post-secondary—that is, the tertiary or quasi-tertiary—sector, where the admission requirements for the practice-oriented training include either a specific pre-training in the secondary sector or a demonstrable practice. Awareness of the implication of the engineers' training for our future has led to the formation of various international societies and institutions to hold yearly symposia on the vast subject of education, for example: IGIP (Internationale Gesselschaft für Ingenieur-Pädagogik—International Society for Engineering Education), SEFI (Fédération Européenne pour la Formation d'Ingénieurs—European Federation for the Training of Engineers), and the registration commission of the FEANI (Fédération Européenne d'Associations Nationales d'Ingénieurs—European Federation of National Associations of Engineers). The latter

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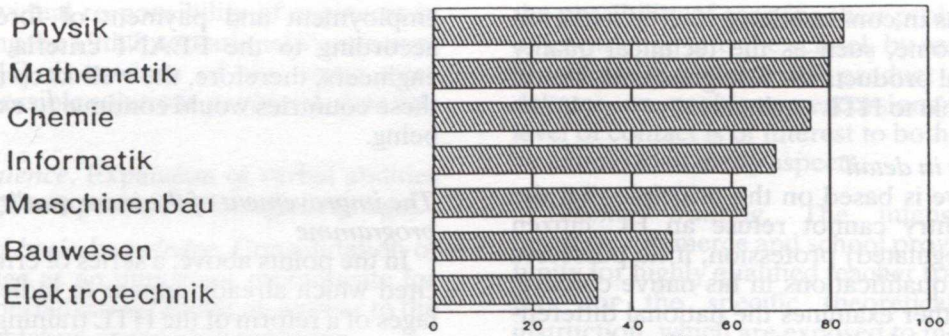

Fig. 1. Exclusiveness and interchangeability betwen Dipl. Ing. and HTL Ing.

has also proposed a set of minimal guidelines for the education of engineers in Europe ('Europa-Ingenieur').

NECESSITY FOR REFORM IN THE HTL TRAINING COURSE

Fundamentally, there are two different components that require reform:

- the competitiveness of the Austrian HTL engineers in an integrated Europe
- the improvement of the inner quality of the HTL-training course.

The determining technical factors in the competitiveness of the Austrian HTL engineers in an integrated Europe will now be examined.

The European Community (EC) guidelines

The guidelines for the mutual recognition of university degrees as introduced by the Council of the EC [2] have stimulated an intensive discussion concerning the reform of the HTL training course. According to the guidelines, only those diplomas would be recognized which comprise a minimum of 3 years of *university* or *university-comparable* training. Since the Austrian technical institutes of higher education belong to the secondary sector, it is to be assumed that the European recognition of about 70% of Austrian engineers will create difficulties.

Whether the Austrian economy on the whole can, without detectable detriment, manage when only about 25% of the engineers are recognized, is a question to be addressed—the comparison with Germany can be seen in Table 1.

Other economic discriminations raised by the EC guidelines

In the event of Austria entering the EC, German FH engineers would be able to set up offices in Austria and take over jobs. A movement of Austrian technical offices in the opposite direction would only be possible if the proprietors passed through a lengthy adaptation process. With respect to the taking over of greater tasks—the public commission system should also be internationalized witin the EC—and the associated proof of capacity and performance of a company, Austrian businesses would also be discriminated against, because their employed HTL engineers would not be recognized as engineers but only as technicians. Further, the taking charge of engineering tasks

Table 1. Comparison of the numbers of engineers in Austria and Germany, following the EC guidelines [2]

	Austria		With EC recognition							
	HTL		TU		TU		FH		Total	
	number	ppm	number	ppm	number	ppm	number	ppm	number	ppm
Engineering	4217	557.1	783	103	7815	127.9	19251	315.1	27066	443
Information technology	40	5.3	136	18	1130	18.5	1038	17	2168	35.5
Technology of the arts			49	6.5						
Chemical engineering technology	90	11.9	9	1.2	1125	18.4	440	7.2	1565	25.6
Engineering physics			50	6.6	1087	17.8	111	1.8	1198	19.6
Total	4347	574.2	1027	135.1	11157	182.6	20840	341.1	31997	523.7

Source: Austria: Österreichische Schulstatistik, BM-UKS 87/88. Germany: Bildung im Zahlenspiegel (1988).
(ppm = parts (persons) per million)

abroad, such as in construction projects, and even contracts at home, such as the technical quality control of local products for foreign clients, would not be accessible to HTL engineers.

The guidelines in detail

The directive is based on the principle that the receiving country cannot refuse an EC citizen access to a (regulated) profession, if he possesses the necessary qualifications in his native country. The paper further examines the national differences in the educational system and professional structure. In the event that the admission requirement for the profession in question is stricter in the host country than in the native country, compensatory and adjusting mechanisms such as aptitude tests and additional courses have been proposed. The receiving country can also demand a certain period of professional experience to compensate for a shorter training course. All of these adjusting mechanisms, however, enable such an EC member state with an interest in this regard to behave in a very restrictive way with respect to a real freedom of movement. That is why the majority of the member associations of the FEANI believe that, just as for the architects, physicians and lawyers, a 'special guideline' should be established for engineers. It is the opinion of many European associations of engineers that only such a move would do justice to the engineering profession.

The EC has also approached the FEANI to process recommendations for a 'special guideline', but the member associations have not been able to reach consensus up to now, and it does not seem to be likely in the near future, if at all.

The title 'Europa Ingenieur' (EUR ING)

The title EUR ING (Europa Ingenieur—European Engineer) would be awarded by the FEANI, the European umbrella organization for national engineer associations. It is not a distinction or an honour given to a deserving European Engineer, but a confirmation based on satisfying the European standards on technical education and experience. The minimal training criteria have been laid down in the 'Guide to the FEANI Register' [3]. They start out from the minimal qualification of a 3-year university training, as proposed by the 'General Guideline' [2] of the EC, and include additional and secondary qualifications. Austrian HTL engineers do not fulfil these requirements and would therefore not be able to apply for the EUR ING title.

This situation is, however, without any implication for the status at home, because the FEANI is a private association whose propositions are not legally binding. But a certain idealistic value remains for engineers who would like to measure their training and position according to European standards. The situation is different for the engineers who strive for an occupation abroad. Until now, it has been such that predominantly the English-speaking countries have carried out the employment and payment of foreign engineers according to the FEANI criteria. For Austrian engineers, therefore, the well-known difficulties in these countries would continue to exist for the time being.

The improvement of the inner quality of the HTL programme

In the points above, a series of criteria have been cited which already appear to indicate the advantages of a reform of the HTL training course, based on economic considerations. The opinion of the author, however, subscribes a greater priority to the second component of the necessary reform, that is, to the improvement of the HTL training course.

Ethics as an indispensable prerequisite for a meaningful engineering vocation. For this, an alteration of the present predominantly technocentric training profile into an anthropocentric one is necessary, through the expansion of the sociopolitical competence of the HTL engineer and the consolidation of a general education including the subjects of ecology, biology, sociology, philosophy and other informative sciences; that is, the dismantling of the social deficits of the present HTL course. The engineer who finds himself at the intersection between technology and society has to be responsible to both, especially in terms of the search for possible solutions which will prevent 'that through the magnitude and complexity of the technical systems we lose track of the risks for Nature and therefore for man, that technological changes break up social structures and interhuman relationships are destroyed, and that economically efficient solutions are not compatible with our value system' [4].

Despite these accurate insights, it must be emphasized that only an engineer of unquestionable engineering scientific competence can best serve mankind. However, it must also be stated that this competence cannot be put to use in an amoral manner, otherwise the abilities can be converted from servant of mankind to ruler or destroyer. For this reason, the call for ethics in engineering education is becoming louder, and is often an important part of international symposia [5].

In spite of these international efforts, many questions concerning ethics in engineering education remain unanswered. Up to now, no clear answer has been found as to which institution can formulate and pass forward ethical goals for mankind, or which insitution would supervise and act in case of non-observance of these principles. Even the evaluation of the outcomes of technology [6] has not been approached in a satisfactory manner.

In this context, the question arises for the educators in practice, whether or not *conscience*—the basis of ethical–moralistic behaviour—is educable, and how the call for more ethics in engineering education can form the basis for

accepting individual responsibility of engineers in practice. During the 19th International Symposium of the IGIP [5] discussions of this topic were initiated and possible solutions proposed. (See refs [7–10].)

Verbal eloquence. Expansion of verbal abilities and above all of competence in foreign languages.

Extension of basic knowledge. Consolidation of basic knowledge as an important prerequisite for professional specialization, and as an answer to the fast rate of obsoletion of special knowledge.

Leadership behaviour. Learning of basic management techniques.

Introduction of optimal subjects. Through these, the student would be given the possibility of following tendencies in his subject area, and would also be helped in adjusting to the approaching entry into the profession.

More intensive exchange between theory and practice. Commerce and industry should be given the possibility of carrying their problems and level of knowledge into the school, by arranging school functions (e.g. lectures, product presentations, debates on problems, excursions). The present level of contact is of interest to both sides, and can be extended in many aspects.

Teacher training. The intensified contact between commerce and school provides an opportunity for highly qualified teacher training. Instructors for the specific theoretical subjects of instruction, which are exposed to most pressure in terms of further education, would then be confronted inevitably with the latest developments in technology.

Postgraduate training. At present, an efficient postgraduate training of engineers is lacking. The programmes arranged jointly by the schools, commerce and industry correspond to the presentation of the latest developments in the application of science and research, and constitute an ideal facility for further education. In addition, these

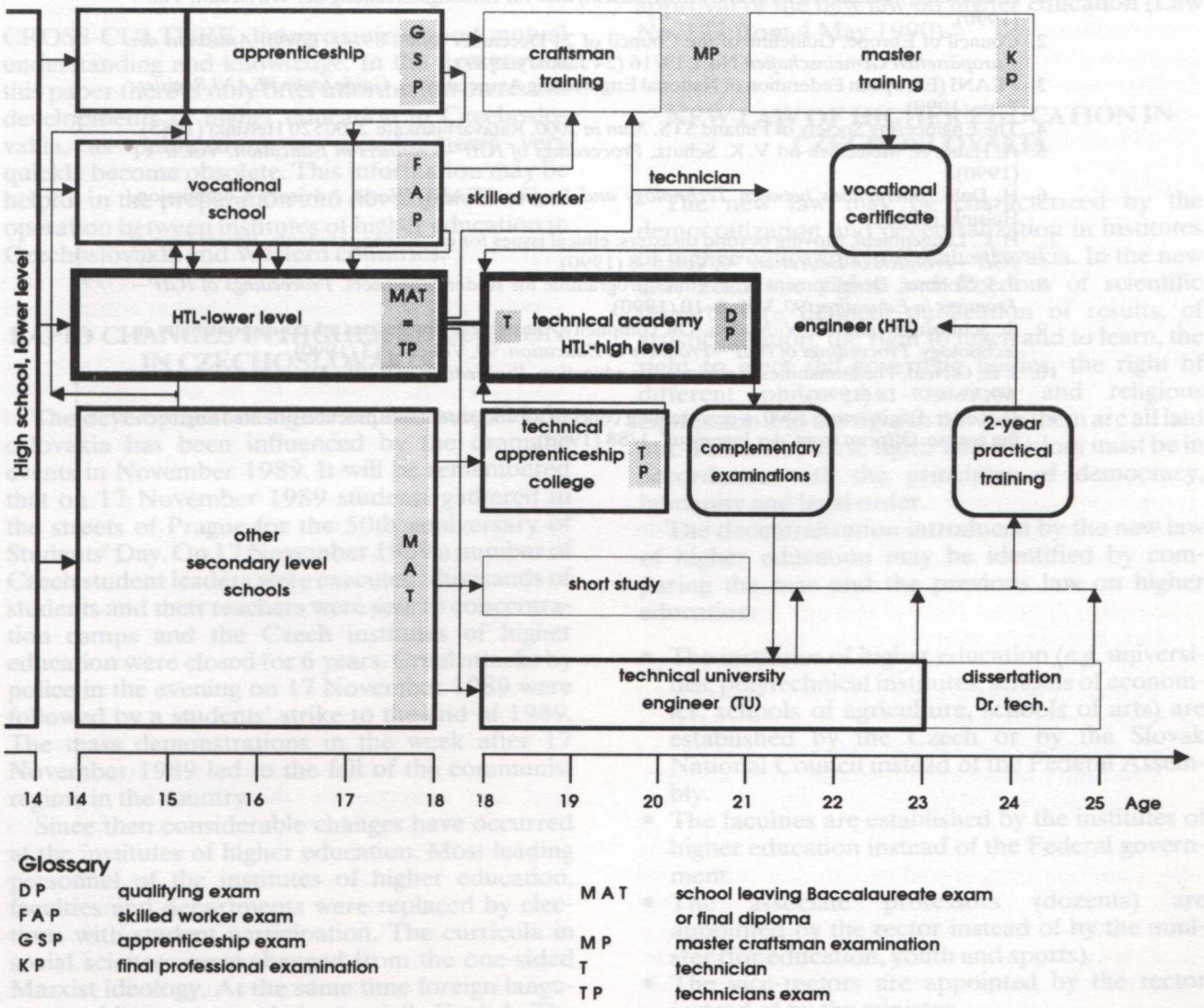

Fig. 2. The new technical academy (HTL upper level) to be introduced into the Austrian educational system.

programmes can help to establish contacts between young engineers and commerce and industry as well as with working professional colleagues.

The realization of the three preceeding points can be made easier by the establishment of a committee in each HTL (e.g. vocational council) consisting of representatives from the local commerce and industry, as well as from the teaching and student body.

Recognition of the HTL course—the Technical University (TU) course. In principle, the frequent demands of HTL engineers that their course be recognized when they enter or transfer to the university programme should be met. The new HTL educational concept, therefore, also includes the idea of a smooth transfer from the HTL to the TU in the same subject. Transfer to another subject, however, would involve passing additional exams.

STRUCTURE AND CONSTRUCTION OF 'ENGINEER 2000'

The new HTL is divided into a 4-year lower level and a 3-year upper level (Fig. 2). The lower level is completed with the Matura (a school-leaving certificate) and the title 'Technician'. Since more than 40% of HTL graduates start a university programme, the bringing forward of the Matura by 1 year is of advantage, not only to the young trainee, but also the national economy. In the upper level, sophisticated engineering knowledge as mentioned above is conveyed, and the reform ideas are realized. The course would be completed with a qualifying exam, which would also confer recognition of the engineering programme in the EC, since a 3-year university-comparable course is involved [11].

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