Int. J. Appl. Engng Ed. Vol. 7, No. 6, pp. 434–437, 1991
Printed in Great Britain.

0742–0269/91 $3.00+0.00

Towards a Reform of the Swiss Schools of Engineering

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The Swiss Schools of Engineering have existed for more than a century. Their future development is handicapped by the unique Swiss education system. The paper gives an outlay of the present and the future situations and deals with a reformed study structure developed by the Winterthur Polytechnic, School of Engineering.

THE SWISS SCHOOLS OF ENGINEERING TODAY

IN THE second half of the 19th century a Mr Autenheimer used all his influence to forward the idea of creating, in addition to the already existing academic engineering education, an alternative training for skilled workers. His idea was to enable practically oriented skilled workers to become 'technicians of intermediate level'. The idea was taken up, and the first engineering school of Switzerland was opened as the 'Technikum Winterthur' in 1874. There were six day schools and one evening school until the end of World War II in which thousands of technicians were educated for Swiss industry.

The early fifties saw an increase in furthering higher levels of education in Switzerland. Not only the academic path profited (by creations of new and extension of existing universities). Based on a highly developed system of vocational education a tertiary level was opened for young people willing to educate themselves by developing existing and creation of new institutions. Through this a wide range of institutions in the fields of industry, commerce and the service sector was created under the heading 'higher vocational education', known in Great Britain as 'Polytechnics', and in Germany as 'Fachhochschulen'.

The already existing Swiss 'technical schools' followed the fast development in industry and industrial sciences and became known as Swiss Engineering Schools (in German still called 'Höhere Technische Lehranstalten' (HTL), a term we have never liked). It was no big surprise that, following the rapid technical development, there was a boom in the creation of new engineering schools. Today there is a total of 29 schools, i.e. 17 full-time day schools and eight evening schools, both offering studies in the fields of technology. In addition to these 25 technically oriented schools there are four institutions in the field of agriculture. Their common basis is their entry requirements consisting of an adequate, practically oriented apprenticeship of 4 years ending with a Swiss certificate and an entry examination. Holders of an 'abitur' (a large range of A levels) do not have to sit for the entry examination, but have to serve a 1-year training in industry.

The structure of the Swiss Engineering Schools is presented in Appendices 1 and 2. The average age of students starting their studies is about 20. The duration of the full-time study is 3 years with academic years of 40 weeks and a total number of lessons of 4200. The average classroom week for a student is 36–40 lessons. The teaching load of the full-time teaching staff is 22 lessons a week. There is no research at Swiss Engineering Schools, but they have created a considerable number of possibilities of technological transfer to industry due to their highly qualified staff and very well-equipped laboratories.

The Swiss Engineering Schools are organized in a federalistic way. The older schools are usually run by individual cantons; the later foundations belong to a group of several cantons each. All the schools are accredited and subsidized by the Swiss Federal Government under the Federal Law of Professional Education.

It is a unique aspect of the Swiss educational system that the academic and practically oriented streams are not housed in the same ministry. While the universities and the Swiss Federal Institutes of Technology are clearly institutions in their own right, all the remaining tertiary institutions of non-academic status are traditionally still ranged under the heading of 'higher vocational education'. This leads, no doubt, to discrimination abroad. There is an average of about 20% of grammar school leavers in Switzerland. Two thirds of all young people in Switzerland make their way through an apprenticeship, of which there are more than 200

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types in Switzerland. So it is not surprising that there are more than twice as many Swiss Engineering School leavers per year than students graduating from the two Swiss Federal Institutes of Technology. In addition to that there is a very high demand for HTL engineers; their practically oriented education proves to be a sound basis for a wide variety of occupations.

A VIEW INTO EUROPE: ACCEPTANCE OF THE SWISS HTL ABROAD

The curricula of the Swiss Engineering Schools aim at a very high level of competence, and their aims compare very well with their equivalents in Europe and the rest of the world. However HTL engineers at present are not accredited equal status abroad due to the Swiss structure. Swiss HTL engineers are formally neither accepted as being equal to a chartered engineer of a German 'Fachhochschule' nor to a Bachelor of a British polytechnic or a university on the American continent, let alone to a graduate from a French 'École d'Ingénieurs'. The main reasons for this situation have already been given. As long as the Engineering schools are considered as 'higher vocational training' by Swiss law instead of being recognized as institutions in their own right in tertiary education, their graduates will not get international accreditation. Their entry requirements of a completed 4-year apprenticeship plus an entry examination cannot really compare with a German abitur or a French Baccalauréat. However, after 3 years' full-time study the gap is filled and an internationally comparable standard is reached. Unfortunately it is not the final product that is judged and compared, but the entry requirements to the institutions.

The conclusion of this state of affairs is that the only way to European recognition of Swiss diplomas is an up-to-date Swiss education system. The educational institutions would have to be equipped and situated accordingly. This would mean that institutions such as Engineering Schools or Schools of Trade and Commerce on the same level would have to be transferred from the field of higher vocational education to being independent institutions in the field of tertiary education.

TOWARDS REFORM OF THE SWISS SCHOOLS OF ENGINEERING

It is not only the lack of European recognition that necessitates a reform of the Swiss Schools of Engineering. Of much more importance is the fact that they can no longer fulfil their given task in their given structures. These structures are more than a century old, and it has become less and less possible to educate engineers adapted to the needs of a modern and pulsating industry. The duties of a practically oriented engineer of the present day differ greatly from those of a technician just before World War II. A 3-year study during which the basics of mathematics and natural sciences have to be taught is not long enough any more. The very high number of contact hours (38 a week) is also very unsatisfactory. These lessons are taught frontally, in small forms of only about 20 students , and at present are mainly subject-oriented. The numerous lessons for laboratory and construction exercises are arranged in such a way that they have to be done within limited time and as a result there is very little time left for any creative work.

This situation has led to a proposition for reform worked out by the General Assembly of the Professors of Winterthur Polytechnic, now generally known as the 'Winterthurer Modell' (see Appendix 3). It was accepted both by the Government and the Parliament of the Canton of Zurich in 1990. The first term following the new structure will start in November 1993. Its aims are the following:

- The main aim will be meeting the long-term demands of the economy and its future development; i.e. the engineering school will offer a high standard engineering education.
- The basic concept is that the future engineer has to be prepared for more autonomy, responsibility and creativity.
- In order to reach such objectives new teaching and learning methods will have to be introduced.
- There will be a high degree of interweaving of classroom activities and self study; the teachers will have to transform themselves from being instructors to guiding their students through their studies.
- The curriculum will not be extended compared with the present state, but the weekly number of student contact hours will be reduced by one third. The students will be expected to spend as much study time as spent in the classroom.
- A good deal of time will be spent on, and great importance will be given to, project work and seminar papers.

Based on these criteria the total duration of study will be extended from 3 to 4 years; at the same time its temporal structure will be improved as follows:

1. *Basic introductory course*: 30 weeks of not more than 28 lessons per week, the same programme for all the departments. Content: laying the mathematical and scientific basic as a sound foundation for entering the actual engineering education. Final examination comparable to a German 'Fachhochschulreife'.
2. *Main course*: three years of 40 weeks each of not more than 28 lessons per week.
3. *Final examination period:* 10 weeks, in which the practical diploma (thesis) is included.

There is an additional goal of the reform project, i.e. the working conditions of the teaching staff will be adapted within the still existing, but nevertheless

high teaching load of 22 lessons a week to the needs of the new task of the engineering school.

The director must have sufficient means to allocate teachers to specific assignments such as developing the new syllabus, installation of new laboratories, continuous education, or technology transfer which will be offset against an adequate amount of teaching assignment. The 'Winterthurer Modell' has set in motion quite a number of things among Swiss Engineering Schools. Not only are other schools now thinking about reforms but also the Conference of Directors of Swiss Engineering Schools (DIS) has had discussions and reached conclusions on a reorganization of their schools. They are at present trying to make clear, especially to the Swiss authorities, that reform of the Swiss Engineering Schools has to be given the highest possible priority. They are working towards politicians recognizing the fact that tertiary level education in Switzerland is in urgent need of reform and reorganization. When doing that the international context regarding the mutual recognition of diplomas has to be considered.

APPENDIX I: SWISS EDUCATIONAL SYSTEM

Sector	Grade	Academic Path	Practically oriented path	
Tertiary	18			
	17			
	16	University	Higher vocational education	
	15	FIT (Federal Institute of Technology)	Schools of Engineering	3 years
Secondary	13			
	12	Grammar school	Vocational education	
	11		apprenticeship	3–4 years
	10			
Secondary	9			
	8	Grammar school	Secondary school	3 years
	7			
Primary	6			
	5			
	4	Primary school		
	3			
	2	6 years		
	1			

APPENDIX II: CURRENT STRUCTURE OF STUDIES

Admittance: Entry examination on having completed an apprenticeship of 3–4 years duration with Federal Certificate.

Duration: 3 academic years, 40 weeks each; 38 contact lessons per week

Terms 1–4	Intermediate exam[b]	Terms 5 and 6	Final exam[c]
Mathematics, calculus, sciences, languages basic engineering subjects[a]		Applied mathematics Subject-oriented Engineering	
Cultural aspects		Cultural aspects and languages	

[a] 25% of the syllabus should be covered in the level of previous education.
[b] Intermediate examination at the end of the second academic year.
[c] Final examination at the end of the third academic year. Final thesis within a 5-week period following the end of the third academic year.

APPENDIX III: REFORM STRUCTURE OF STUDIES

1. Basic introductory course	30 W	840 L
2. Main course	3 Y	3360 L
3. Final examinations	10 W	280 L
Total	4 Y	4480 L

	10 W	Final examinations, thesis work
3rd Y	40 W	Main course (Part II): Subject-oriented eng. studies

Intermediate examination

2nd Y	40 W	Main course (Part I):
1st Y	40 W	Basic engineering subjects, calculus, languages

Admittance to main course: Examination
or Matura plus one year industrial practical experience

	30 W	Basic introductory course: Mathematics, sciences, languages

Admittance: Entry examination after completed apprenticeship (Federal Certificate)

W = weeks, Y = academic years, L = lessons, 1 academic year = 40 weeks, 1 lesson = 45 minutes.