DOCUMENT RESUME

ED 063 512 VT 015 721

TITLE	Switzerland--The Education, Training and Functions of Technicians. Scientific and Technical Personnel.
INSTITUTION	Organisation for Economic Cooperation and Development, Paris (France). Directorate for Scientific Affairs.
PUB DATE	May 68
NOTE	151p.
EDRS PRICE	MF-$0.65 HC-$6.58
DESCRIPTORS	Articulation (Program); Economic Development; *Foreign Countries; Job Analysis; *Job Training; Manpower Development; *Manpower Utilization; *National Surveys; Tables (Data); Teacher Education; *Technical Education; Vocational Education
IDENTIFIERS	Switzerland

ABSTRACT

To identify problems regarding economic development, the Committee for Scientific and Technical Personnel conducted an educational and occupational survey of each member country of the Organisation for Economic Cooperation and Development (OECD). The specific purpose of the surveys was to gather comparative data on the training and utilization of technicians in each member country. Major sections of each survey are: (1) The Structure of the Educational System, (2) Training of Technicians and Other Technical Manpower, and (3) Functions of Technicians. Related surveys for each of the following countries, Canada, Denmark, Spain, France, Netherlands, Yugoslavia, United Kingdom, Portugal, and Italy, are available in this issue as VT 015 716-VT 015 720, VT 015 722-VT 015 725 respectively. (JS)

OCDE
OECD

THE EDUCATION, TRAINING AND FUNCTIONS OF TECHNICIANS

SWITZERLAND

DIRECTORATE FOR SCIENTIFIC AFFAIRS

ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

SCIENTIFIC AND TECHNICAL PERSONNEL

THE EDUCATION, TRAINING AND FUNCTIONS OF TECHNICIANS

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PREFACE

The OECD Committee for Scientific and Technical Personnel has given considerable attention to the question of technician training and utilisation which is a key problem in the economic development of Member countries, and has on several occasions drawn attention to the need for an adequate supply of and proper training for skills at this level.

To clarify the situation as far as possible and to establish a solid base for discussion, the Committee has instituted a series of surveys in Member countries describing and analysing training conditions.

The material obtained is classified according to a standard pattern throughout, so that comparisons can be drawn between countries. The completed surveys were used as basic working documents for "Confrontation Meetings" between two or more countries. These meetings were held under a neutral chairman and were attended by teams of specialists from the participating countries. Delegates discussed each other's training systems and the various problems which arise and endeavoured to reach conclusions on questions of policy and to find solutions to technical difficulties.

The present publication, the eighth of a series, is a revised version of the working document used at the confrontation meeting between the Netherlands, Spain, Switzerland and Yugoslavia, held in Paris in Decemoer, 1965. The conclusions of this meeting and of the previous one between Canada and Denmark, are given in Appendix VIII.

The report was prepared by the OECD Secretariat the responsibility being with Mr. S. Syrimis, Consultant to the Directorate for Scientific Affairs. It incorporates information already available at OECD and in particular in the original survey carried out by a joint FEANI/EUSEC (1) Committee, supplemented by on-the-spot investigation.

The Secretariat wishes to acknowledge its indebtedness to the Swiss Authorities for their help and co-operation in the preparation of this report.

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(1) FEANI: European Federation of National Associations of Engineers.

EUSEC: Conference of Engineering Societies of Western Europe and the United States of America.

Part One

THE STRUCTURE OF THE EDUCATIONAL SYSTEM

I. GENERAL DATA - THE PLACE OF TECHNICAL EDUCATION IN THE EDUCATIONAL SYSTEM

1. A main feature of the Swiss educational system is that it is organised on a cantonal basis, the twenty-five cantons and semi-cantons being autonomous in this field. There is no national system of education, nor a central office or agency whose primary function is in education. Furthermore, the cantons themselves are made up of local units known as "Gemeinden" (Communities) many of which had an independent status before the canton governments were formed. Each "Gemeinde" evolved its own social and cultural life and many of them had developed strong educational traditions before universal education was made a matter of cantonal concern. Therefore, in many cases, the role of the "Gemeinden" in education is still primary and exceedingly important.

2. The role of the Federal government in the field of education is limited by the Federal constitution, according to which the organisation, administration and inspection of the schools and other educational institutions are the responsibility of the cantonal authorities.

Each authority has the obligation to provide for a "sufficient compulsory primary education for its citizens, regardless of origin or faith". The Confederation contributes financially to this effort.

3. Cantonal autonomy within the educational field has resulted in considerable differences in the educational system such as the duration of compulsory schooling, which varies from 8 to 9 years,(1) entrance requirements to several courses, curricula and time-tables. However, the centrally controlled final examinations for the secondary education certificate (Maturité) introduced in 1925, helped to maintain a more or less uniform standard, at least at this level of education.

4. Federal interest is more direct in technical and vocational education. Expansion of industry during the second half of the 19th century and after the second world war, especially in building construction, metallurgy, and electrotechnology, urged the government to take particular interest in the development of technical and other vocational education as a whole.

5. The Federal Act of 26th June 1930, on vocational training, which was put into force in 1933 and revised in 1963, deals in a general way with the organisation of vocational orientation, and with training and up-grading at craftsman and technician levels, in the following fields: industry, handicrafts, commerce, housing, insurance, transport and communications, hotel and catering, and several other services. Training in agricultural trades is regulated by the Federal Act on Agricultural Training. (para. 75).

6. A main feature of the Swiss structure of technical education is that apprenticeship training is considered as a prerequisite for technician training. Therefore technician courses proper start fairly late, that is after the age of 20, and the total time required for training at this level is scarcely less than that required for university studies.

7. Appendix I on page 81 illustrates by means of a simplified diagram the existing technical and vocational courses within the

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(1) In two cantons it is still 7.

framework of the educational system as a whole, a brief description of which is attempted below. Technical and vocational courses are further analysed under the appropriate headings in the text.

a) Primary Level

8. Primary education comprises the following:

i) Infant Schools

Infant education lasts 2 or 3 years (age 4 to 6 or 7), depending on the canton, and is given in private or public infant schools. It is not compulsory, with the exception of the canton of Geneva, where six-year-old children are obliged to attend school (Kindergartens).

ii) Primary schools - Compulsory Schooling Period

Primary schools cover the compulsory schooling period, which starts at the age of 6 or 7 and lasts 7 to 9 years, depending on the canton. After the 3rd, 4th 5th or 6th year of schooling, pupils are divided into two or three groups and attend one of the following alternatives - (1) the extended primary course, which prepares them mainly for country life and simple craftsmanship; (2) the lower secondary course, which is introductory to vocational, commercial, or teacher training; (3) the pro-gymnasium course, which is preparatory to general higher secondary school (gymnasium) courses. The lower secondary and pro-gymnasium courses are held either by special sections of the primary schools or by separate units, the lower secondary schools, and the pro-gymnasia respectively.

b) Secondary and post-secondary levels

9. Secondary education comprises the lower cycle, which covers part of the compulsory schooling period and runs parallel to the extended primary cycle (see 8, (ii) above), and the upper cycle consisting of general and specialised education, as described below.

(i) General Higher Secondary Schooling - "Maturité" federal certificate

The general higher secondary schools (called also gymnasia lycées or colleges) absorb about 5 or 6 per cent of the compulsory school leavers. Studies are of four years' duration and lead through final examinations at federal level to the federal certificate of "Maturité" which is of three types, i.e. "Classical", with Latin and Greek, "Modern" with Latin and a modern language and "Scientific" with sciences and mathematics. The "Maturité" federal certificate opens the way to higher education.

Similar examinations are also held by several cantonal authorities and lead to the "Maturité cantonale" certificate.

(ii) Primary teacher training

With the exception of Basle and Geneva, where a "maturité" certificate is necessary to enter a training institution, teacher-training colleges are secondary-level institutions, accepting lower secondary school leavers (age 15 to 16). The programme lasts 4 to 5 years and professional training is integrated with cultural disciplines. Graduates have access to certain university faculties.

(iii) Complementary Schools

The complementary schools offer a general cultural education, not necessarily leading to higher studies. The programme lasts 2 to 4 years and, in certain cases, has an agricultural or home-economics bias. In 18 cantons, complementary school attendance is compulsory for those not attending other types of secondary school. It is estimated that this programme absorbs 30 to 35 per cent of the compulsory school leavers.

(iv) Apprenticeship

Apprenticeship in industry is combined with compulsory day release attendance and constitutes the basis of technical and vocational training. It absorbs 35-40 percent of the compulsory school leavers, lasts from 1 to 4-1/2 years (depending on the trade) and leads to the "Federal Certificate of Proficiency in Apprenticeship" (para. 61).

(v) Vocational Schools

Full-time vocational schools for industrial, commercial and agricultural trades provide courses for the same federal certificate as apprenticeship training but absorb only 5 to 10 per cent of the total population in this sector.

Special types of vocational schools normally offer advanced vocational training in several trades leading to the "Brevet fédéral", "Maîtrise" (Mastership) or other certificates qualifying holders as skilled workers, foremen, etc. (para. 29). Certain commercial schools offer courses leading to the "Maturité" commercial certificate (para. 72).

(vi) "Technicums"

The "Technicums", also called Higher Technical Schools, (Ecoles Techniques Supérieures) provide for the training of upper-level technicians (non university engineers). Length of studies is 3 to 4 years and a completed apprenticeship is a pre-requisite for admission. All technicums hold entrance examinations in mother language, mathematics and technical training at a level comparable to that of the final year of a higher secondary school. "Technicum" courses may therefore be considered as being at post-secondary level. These courses lead to a diploma which qualifies holders as "Technician-engineers, ETS"(1) (Ingénieur-techniciens ETS).

c) Higher Education

10. Higher Education comprises the Polytechnical Schools and the Universities.

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(1) ETS = Ecoles Techniques Supérieures

(i) Polytechnical Schools

Technical courses at university level are held by the polytechnical schools (Ecoles polytechniques). A "Maturité" federal certificate is normally required for admission but, under certain conditions specified by the individual schools, holders of the "Technician - engineer ETS" diploma (para.9, (vi) above) may be accepted. Studies last 4 to 5 years and lead to a university degree - the "Diploma in Engineering or Architecture".

(ii) Universities

All universities normally demand a "Maturité" federal certificate for admission. However, under specified conditions, certain economics, pedagogical, and science faculties are open to holders of higher commercial, teacher training or technician engineer certificates respectively. The formal length of university studies is 4 to 5 years.

II. EDUCATIONAL AND VOCATIONAL ORIENTATION AND GUIDANCE

11. Vocational orientation and guidance are organised on a cantonal basis, with a central office called "office central de l'orientation professionnelle" in each canton. Cantonal activities are guided and co-ordinated by the Swiss Association for Vocational Guidance and the Protection of Apprentices and are financially supported, to the extent of 25 per cent of the salaries of full-time staff, by the Confederation. Apart from the official services there are several semi-official and private services which, if formally recognised, may also be subsidised by the Confederation. The Federal Act on vocational training, as revised in 1963, provides for the expansion of vocational guidance and for the inclusion of adult population. The application of the Act continues to be the responsibility of the cantons.

12. Vocational guidance generally starts at the eighth year of schooling or at the age of 14 or 15, when pupils are examined and given advice on the type of employment most suited to their abilities. It is more pronounced in the extended primary and lower secondary schools where the vast majority of the pupils are headed towards vocational training. Vocational guidance is not compulsory, but estimates show that about 50 per cent of the extended primary and the lower secondary school population take advantage of the services available.

13. The vocational guidance centres issue bulletins and leaflets describing various jobs, and organise lectures, visits to industry and ability tests. Each central office normally also includes a service for the placement of apprentices and a scholarship service. The latter handles the grants for apprenticeship and technician training courses; these come from several sources such as the local authorities, professional associations, employers' organisations etc. and are supplemented by federal contributions within the framework of an intercantonal scholarship scheme.

14. In 1964 there were 308 offices of vocational guidance centres staffed with 339 advisers not including administrative staff; of these, 95 were full-time employees, 77 were also working for another youth service, and 167 were employed as part-time advisers only. These figures do not include approximately 50 private advisers employed by various schools.

15. Staff is normally recruited from among teachers; previous special training is not required but the Swiss Association for Vocational Guidance recommends that cantonal authorities should appoint to positions as vocational advisers only those applicants who, at the expense of the public authorities, agree to take a four-week course, where possible before starting guidance work and a second course of the same length by the end of their first year of service. Advisers are normally trained at the Universities of Fribourg and Geneva and the Institute of Applied Psychology in Zurich, but training courses at other institutions are also organised by the Association of Vocational Guidance and the cantonal authorities. At federal level the advisers are brought together through conferences.

16. Educational guidance is general in character and takes place mainly during the final two or three years (age 12 to 15) of compulsory education, when the class teacher, taking into consideration the inclinations and potentialities of the pupils, advises the parents on the possibilities which exist for the further advancement of their children. From the age of 10, 11 or 12, pupils may be divided into several groups according to ability, and may subsequently change from one group to another if their development warrants it.

17. Apart from the few general secondary schools which have an educational psychologist on their staff, it is the headmaster and teachers in these schools who interview the parents and advise them about the choice of courses and subsequent university studies for their children. For the latter, activities are coordinated by the Association for the Educational Orientation of Future University Students (AGAB - Arbeits-Gemeinschaft für Akademische Berufsberatung).

In the lower classes of general secondary schools a form of school guidance is now being introduced, based mainly on the pupil's performance during a special course offering a wide range of options; the most advanced experiments in this field are in the Canton of Vaud.

III. AUTHORITIES IN CHARGE OF EDUCATION

18. As stated previously (para. 1) the role of the federal government in education is limited, for responsibility in this field is left to the cantonal authorities. For technical and vocational education, however, there is a certain degree of centralisation, with the confederation exercising a general supervisory role. In this respect, the "Department of Public Economy" which is one of the seven Federal Departments of the Confederation through its Office of Industry, Arts and Crafts, and Labour (OFIAMT - Office Fédéral de l'Industrie, des Arts et Métiers et du Travail) acts as the executive agent for matters relating to technical and vocational training. Its Division of Agriculture similarly covers training in agriculture.

At the cantonal level, educational activities are the responsibility of the cantonal educational authorities or, for the industrialised cantons, of the cantonal Departments of Public Economy.

19. The activities of OFIAMT (para. 18 above) may be outlined as follows: (i) promulgation of general rules and regulations for apprenticeship training, and the preparation of the final examinations for the certificate of proficiency in apprenticeship; (ii) preparation of basic curricula for the theoretical part of apprenticeship training; (iii) organisation for special courses for experts employed as members of examination commissions; (iv) organisation of courses for in-service training of technical teachers; (v) supervision of the examinations for the "Maîtrise fédérale" certificate; (vi) allocation of funds voted annually by the Confederation for technical and other vocational training.

Part Two

TRAINING OF TECHNICIANS AND OTHER TECHNICAL MANPOWER

IV. DEFINITION AND GRADING OF THE TECHNICIAN - STANDARDISED QUALIFICATIONS

20. In Switzerland the role of upper-level technicians or engineers is well appreciated and precisely defined. The technical force which belongs to this level are graduates of post-secondary technical colleges (Technicums) and bear the title "Technician-Engineer ETS"[1] (Ecoles Techniques Supérieures), which is protected by a federal act. Upper-level technicians are organised under a central professional association, the "Swiss Technical Union".

21. For lower-level technicians, however, the situation is not so clear. Between the craftsman (proficiency in apprenticeship) and the upper-technician level there are no formal courses for the training of an intermediate technical force with combined practical and theoretical knowledge. As a matter of fact the "Evening Technicums" do hold courses at this intermediary level, but their standard is very

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(1) (Ingénieur-technicien ETS)

near that of the higher level and there is also a tendency for it to become even nearer.

On the other hand, the main objective of further training for craftsmen to the level of "Brevet fédéral", "Maîtrise" federal or equivalent certificates (para. 29), is for foremanship or special industrial techniques. In actual practice, however, the functions of the lower-level technicians in industry are carried out mainly by craftsmen with such additional qualifications as mentioned above.

a) <u>Content of courses.</u>

22. According to the Federal Act on Professional Education (1963 revision) the training programmes of the vocational schools (apprenticeship and maîtrise courses) are drawn up by the OFIAMT in consultation with the cantonal authorities and the appropriate professional and educational associations. A considerable degree of uniformity is therefore secured at this level. For higher technician courses, however, the Act is less specific, simply stating that the Confederation may co-operate with interested cantonal authorities in fixing minimum programme and examination requirements. This results in diversity in both the content and duration of the courses, as the individual cantons base their training programmes mainly on their particular views, or their own requirements.

b) <u>Final examinations - diplomas and certificates</u>

23. Most of the technical and other vocational courses at craftsman and lower technician levels terminate with a federal examination as described below. Courses at upper-technician level lead to an examination controlled by the cantonal authorities.

(i) Apprenticeship examinations are organised by the cantonal authorities, under the supervision of OFIAMT, as described in para. 60. Successful candidates are awarded the "Certificate of Proficiency in 'Apprenticeship'", a federal certificate qualifying them as skilled workers.

(ii) The "Brevet fédéral" certificate is a professional aptitude federal certificate awarded to successful candidates on the completion of the respective course (para. 29).

Relevant examinations are organised by the professional associations under the supervision of OFIAMT. Similar arrangements are in force for the "Maîtrise" federal (Federal Mastership) diploma which qualifies holders as suitable for a foreman's post. A "Brevet" certificate is a prerequisite for the "Maîtrise" examinations.

(iii) Final examinations for upper-level technician courses are organised by special commissions appointed by the appropriate cantonal authority as described in para. 41. Diplomas qualify holders as Technician Engineers ETS (Ecoles techniques supérieures) and have an intercantonal reputation provided the schools are recognised by the Confederation.

(iv) Several other certificates, such as certificate for "Agents techniques" etc. are awarded by industrial cantonal or private schools on the completion of any of a variety of courses at professional aptitude or supervisory level. These certificates, although sometimes highly appreciated by industry, are not yet officially recognised by the State.

V. LOWER-LEVEL TECHNICIAN COURSES

24. In Switzerland the main sources for providing lower-level technicians are the advanced vocational courses based on industrial experience with attendance at nearby special schools under a variety of governmental or private organisation (Appendix II). The geographical distribution of these schools is considered to be satisfactory as they are within easy reach of the population as a whole. Most schools hold apprenticeship courses (part-time and/or full-time), parallel with 'maîtrise' and special short courses in related fields; all are adequately equipped with practical facilities to meet curricula requirements. The total number of schools is given in table 1, page 29. A short description of the main courses available is given below.

a) "Evening Technicum" courses

25. These are held by special evening technical colleges, called 'Evening Technicums' and are designed for persons already working in industry. A full apprenticeship, relevant to the course to be followed, is normally required for admission. The length of the courses varies from eight to ten semesters, 16-20 hours per week.

26. The content of the courses differs from one canton to another but in all cases it is theoretical in nature with a strong mathematical and scientific background. The Geneva canton course of mechanical engineering, for instance, comprises 46 per cent scientific and mathematical subjects (mathematics, physics, chemistry); 35 per cent technological subjects (metallurgy, elements of machines, servo-mechanics, hydraulics, combustion engines, technical drawing etc.); 8 per cent laboratory work (physics, metallurgy, electro-technology, hydraulics, etc.) and 8 per cent of general subjects (civics, economics, works organisation,etc.). In Appendix II are given the timetables for four evening courses (two for Geneva and two for Berne).

27. Final examinations are organised by the school authorities in collaboration with the appropriate professional associations. Candidates who have not attended the course may be admitted to the same examinations. The level, although comparable to that of the day technicum courses in certain subjects, is definitely lower on the whole, although there is a general tendency towards raising the standards and establishing complete equivalency with the day-courses.

28. The diploma awarded by the Evening Technicums is not yet recognised as a federal qualification. The professional association (Swiss Technical Union) (paragraph 89)recognises in only one case (Evening Technicum of Zurich) the diploma as equivalent to the Technicum Engineer ETS diploma and grants membership to graduates of this school. In actual practice, graduates of the Evening Technicums are mainly occupied in lower-level technician jobs but several have been assimilated with Technician-Engineers.

b) "Maîtrise" and "Brevet federal" (Federal Brevet and Mastership) courses

29. The "Maîtrise" federal courses are held by full-time vocational schools, for the training of foremen in various trades. Courses for each trade comprise several subjects which may be taken either as isolated subjects, or as a whole. The length varies from a few weeks to over a year, depending on the trade and the number of subjects taken. The courses and final examinations are controlled by the Confederation. Until recently, requirements for admission to "Maîtrise" courses were an apprenticeship certificate, plus a minimum of three years' practical experience after the completion of the apprenticeship. It was observed, however, that in the majority of cases further formal professional aptitude training was indispensable. The recent introduction of the "Brevet federal" certificate (revised Act on vocational education) is an attempt to correct this deficiency. The "Brevet" is a professional aptitude certificate obtained through special advanced vocational courses in various trades and is now a prerequisite for admission to Maîtrise courses. An apprenticeship certificate plus a minimum of two years' practical experience are required for entry to Brevet courses. The final programme for the "Brevet" courses are still under consideration.

30. Courses for foremen in the building construction and civil engineering trades, are a special type of "Maîtrise" course. These are held by special schools and are intended for persons already possessing the necessary technical qualifications. (Full apprenticeship plus several years of practical experience). The curricula comprise an average of 75 per cent theory related to the trade (including industrial drawing); 8% per cent mathematical and 17 per cent general cultural subjects (languages, religion, civics, etc.) and the programme lasts five semesters. The courses are interrupted by actual work in industry, as indicated in Appendix III and lead to the "Maîtrise" federal certificate in building construction and civil engineering trades, awarded on the completion of the course and after successful oral and written examinations jointly organised by the schools and the professional associations of building constructors, under the supervision of OFIAMT.[1]

(1) See footnote on page 17.

c) Courses for "Agents Techniques" (Technical Agents)

31. These are designed mainly for the skilled labour force in the mechanical, chemical, metallurgical and textile industries and are held by special schools. A completed apprenticeship is normally required for admission, but some schools demand further practical experience. For those candidates whose knowledge of language and mathematics is insufficient, special preparatory courses are available. The length of the training courses varies considerably with the trade, but on an average 240 hours of instruction are required on a part-time basis. The final examinations are not yet organised at federal level. The certificates attributed to successful candidates indicate the length and the nature of the course attended.

VI. UPPER LEVEL TECHNICIAN COURSES

32. Upper level technician courses are based on apprenticeship which, for industrial trades, lasts four years and are held by special technical colleges called "Ecoles Techniques Supérieures", (Higher Technical Schools), or "Technicums". However, the term 'Technicum' may be used to define a school comprising several sections, such as "Technical" (technician training) "Vocational" (craftsman training), "Maîtrise" (courses for the Maîtrise). The Technicum of Fribourg is such an example.

33. Technicums, with the exception of that in Lucerne, are governmental institutions organised on a contonal basis. The Technicum of Lucerne, which was established in 1958, is intercantonal; seven cantons participate whose representatives form a joint administrative commission. Twelve technicums (Table 1) exist at present.

Table 1

Institutions for technician and craftsman training

(1965)

Branch	Govern-mental (cantonal)	Private	Jointly adminis-tered (govt. + private)	Total
1. Technicums	12	-	-	12
2. Evening technicums	1	7	-	8
3. Special schools for building construction and civil engineering trades.	3	2	-	5
4. Schools for Federal Foreman Certificates (Maîtrise)	4	7	1	12
5. Schools for "agents techniques"	1	6	1	8
Total	21	22	2	45

34. Courses are available in mechanical engineering, electrical engineering, electronics, chemical engineering auto-mechanics, ventilation, and air conditioning, watchmaking, architecture and civil engineering, distributed as shown in Appendix IV.

35. Entrance requirements, length and nature of studies, final examinations, etc. have been revised recently by the schools in collaboration with the "Confederation" so as to reduce existing differences to a minimum. The general picture of the situation as a whole is given below; further details may be found in Appendix IV.

a) Entrance requirements

36. In general, candidates for admission to the first year of a Technicum must pass an entrance examination and have completed an apprenticeship in the trade concerned. Entrance examinations are based on the knowledge which must be acquired at the vocational school during apprenticeship while the level of general knowledge required is comparable to that of full secondary education. Candidates who have not completed higher secondary education therefore usually find themselves inadequately equipped to enter a Technicum without prior private tuition.

37. The conditions of admission to the Ecole Technique Supérieure in Geneva differ radically from those of other technicums in Switzerland. This institution does not demand any practical experience before entrance, and no entrance examination is required for those candidates who possess a "maturity" certificate, or evidence of an education comparable to that of general higher secondary school.

b) Nature and content of courses - final examinations

38. Upper-level technician courses are theoretical in nature and include mathematics, natural sciences, technological subjects, laboratory work and general cultural disciplines (mainly languages). Some examples of time-tables are given in Appendix IV - B.

39. In general, educational authorities maintain close contact with industry, and adapt their training programmes to current needs. Furthermore, most of the teachers of engineering subjects have previous experience in industry and maintain their link with it.

40. The length of studies in the technicums is normally three years, although two colleges have a four-year programme.

41. Final examinations are organised by special committees appointed by the appropriate cantonal authorities, and are carried out by the schools. Candidates should have passed two preliminary examinations, namely, on the completion of the third and the fourth (or fifth) semester respectively and have been promoted to the final year. The examination includes original work (thesis) carried out under a tutor's supervision, during the final semester, as well as written and oral tests.

42. Successful candidates are awarded a diploma equivalent to that of the "Schools of Engineering" in other European countries and which certifies that holders are eligible to take up technical or administrative jobs in industry; they receive the title of "Technician-Engineer ETS" which is legally protected.

43. Appendix IV-C gives: (i) an example of a curriculum outline in mechanical engineering; (ii) specimens of final examination projects in mechanical engineering; (iii) specimens of final examination projects in electrical engineering.

VII. VOCATIONAL COURSES AT CRAFTSMAN LEVEL WITHIN THE EDUCATIONAL SYSTEM

44. The main source for vocational training at craftsman level in Switzerland is apprenticeship, based either on training within industry combined with compulsory day-release school attendance, or on institutional training held by the several types of vocational schools. Although the latter may be considered as falling within the educational system, apprenticeship is examined as a whole in paragraphs 56 to 62.

VIII. TECHNICAL COURSES AT UNIVERSITY LEVEL

45. Technical courses at University level are run by the Polytechnical schools (Ecoles Polytechniques). There are four such schools, combined with other University faculties, and holding courses in several technical fields at "Diploma" and "Doctorate" levels as indicated in Table 2. The total number of universities in Switzerland is nine.

Table 2

Polytechnical Schools

Branch	Zurich (Federal Institute of Technology)	Geneva	Lausanne	Neuchâtel
1. Architecture	Dipl.-Dr.	Dipl.	Dipl.-Dr.	-
2. Civil Engineering	Dipl.-Dr.	-	Dipl.-Dr.	-
3. Mechanical engineering	Dipl.-Dr.	-	Dipl.-Dr.	-
4. Electrical engineering	Dipl.-Dr.	-	Dipl.-Dr.	-
5. Watch-engineering	-	-	-	Dipl.
6. Forestry	Dipl.-Dr.	-	-	-
7. Agronomy	Dipl.-Dr.	-	-	-
8. Rural science and topography	Dipl.-Dr.	-	-	-

46. A "Maturité" federal certificate (full secondary education), or equivalent, in the case of foreign students, is required for admission to polytechnical school courses.

47. The normal length of studies for the diploma course is eight to eight-and-a-half semesters, including the time necessary for the preparation of the diploma work. Additional practical experience (6-13 months) is normally required of graduates in mechanical engineering, electrical engineering, architecture and forestry. For the Doctorate degree two to three years of complementary studies and the completion of a thesis are necessary.

48. Graduates of the Polytechnical schools (diploma course) bear the title of "Diploma Engineer" (Ingénieur diplomé) and are organised under a central association, the "Swiss Engineers and Architects Association".

Zurich Polytechnical School, (Federal Institute of Technology) established in 1955, is a Federal institution;(1) it comprises a technical section with branches as indicated in Table 2, and a science section with branches in mathematics, physics, chemistry, geology and pharmacy. The total enrolment in 1965 was over 4,000 students, 20 per cent of whom were from abroad. The school also includes several research institutes and other Federal services.

49. The Polytechnical School of Lausanne was founded in 1853 as a special school but was later (1869) incorporated with the University of Lausanne.

IX. TECHNICAL TEACHING STAFF

a) Recruitment

50. The teaching profession in Switzerland enjoys a high reputation; the teacher is expected by the community to exercise a leadership role.

51. Technical teachers are recruited among the University-Engineer and Technician force and, for cantonal schools, are Civil Servants appointed by the cantonal authorities.

52. A University degree or higher technician diploma - (ETS) is normally required for technical teachers at technicums, but a "Maîtrise" certificate is considered satisfactory for workshop instructors at vocational schools. Industrial experience is considered an additional qualification and special increments are usually granted for this.

b) Pupil/teacher ratios

53. Because of the high degree of decentralisation, data on pupil/

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(1) This school and the Federal School of Sports at Macolin, near Bienne, are the only Federal institutions.

teacher ratios and similar matters are not readily available. However, Table 3, based on information supplied by the Swiss Educational Documentation Centre (l'Enseignement en Suisse, Dec. 1963) is indicative of the situation, which appears "satisfactory" at least for the types of schools included in the table. In addition these ratios have been practically constant since 1951.

Table 3

Pupil/Teacher Ratios - 1963

Type of Schools	Excluding Auxiliary Teachers	Including Auxiliary Teachers
Primary schools	26.5	24.5
Lower secondary schools	24.5	22.2
Gymnasia	-	11.1
Commercial High Schools	24.2	16.4
Technicums	12.0	6.1

c) Training courses for technical teachers

54. The only official training courses for technical teachers are those for vocational school teachers organised by OFIAMT (para.18). two types are available:

(i) One-year course on pedagogical subjects and teaching techniques. This is compulsory for technical teachers without professional qualifications, but only twenty to twenty-five are admitted each year.

(ii) Short courses (one to two weeks) organised in vacation periods and dealing with special developments and techniques in industrial and educational fields.

Teachers attending these courses receive a subsistence allowance from the Confederation to cover their travelling and residence expenses during the course; about 100 attend each year. Similar activities are organised by various professional associations (paragraph 64 (ii)).

d) Teachers' salaries

55. Teacher salary scales vary from one canton to another. In general, the average income of a technical teacher compares favourably with that of a person with equivalent qualifications employed in industry. Teachers at technicums are better remunerated than teachers in higher secondary schools (gymnasia). Some technical teachers secure additional income by acting as consultants to industrial firms, or by undertaking private work. This connection with industry is normally appreciated by school authorities and in certain cases is encouraged. Although it has not been possible to reach final State-wide valid conclusions concerning teacher salaries, Table 4 gives an illustration of the existing situation by using an example from the canton of Berne. Needless to say, teachers - as do all other citizens of Switzerland - enjoy many benefits from social security schemes.

Table 4

Teacher Salary Scales, 1965

(Basic annual income in round figures in Swiss francs)(1)

Class	Minimum qualification required	Minimum	Maximum
2	Teachers with University degree in science or engineering	20,000	25,000
3	Teachers with higher technician (ETS) diploma and industrial experience	18,900	23,900
4	Language and commercial teachers with University degree	17,700	22,500
5	Language and commercial teachers without University degree	16,600	21,200

(1) One USA dollar = 4.32 Swiss francs

Note: a) Maximum salary is generally reached after eight years.

b) Several allowances increase the basic salary by 15 to 20 per cent.

c) Teachers with special additional qualifications or experience may be classified in a higher grade.

X. TRAINING OUTSIDE THE FORMAL SYSTEM

a) Apprenticeship

56. Apprenticeship is the main form of craftsman training and constitutes the base for technician training. It is organised on a Federal basis and is covered by the law on vocational education. The Federal Department of Public Economy through OFIAMT[1] supervises the application of the law and promulgates, in collaboration with cantonal authorities and the appropriate professional associations, rules and

(1) See para 18.

regulations for each trade. Cantonal authorities are responsible for the organisation and running of the courses.

57. Apprenticeship training may be effected in two ways: either by training in industry combined with compulsory day-release schooling normally not exceeding one day per week, or by full-time institutional training provided by special vocational schools possessing necessary practical facilities. The great majority of apprentices (over 90 per cent) are trained within industry.

58. The length of apprenticeship in industry varies from one to four years, depending on the trade. In schools, it lasts three or four years. The minimum age of admission is fifteen years, i.e., after compulsory schooling.

59. The training programmes are drawn up by OFIAMT(1) in consultation with the cantonal authorities and the appropriate professional and educational associations. In principle, they consist of 80 per cent workshop practice and 20 per cent related theory and general subjects.

60. Apprentices, at the completion of their training, sit for final examinations which are held by the cantonal authorities within the framework of general rules and regulations established by the Federal Act. Cantonal authorities, however, may authorise interested professional associations to take over. Furthermore, OFIAMT reserves the right to ask the professional associations concerned directly to organise and carry out apprenticeship examinations in a particular trade or trades for the whole of the country or for certain specified cantons. (Act on Vocational Education, 20th September 1963).

61. Successful candidates are awarded a "Federal Certificate of Proficiency in Apprenticeship" in their particular trade, which qualifies them as semi-skilled workers.

62. Apprenticeship training is greatly encouraged by the cantons through the granting of scholarships and the provision of appropriate

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(1) See para.18

facilities. At present the Act covers nearly 250 trades, classified in twenty-one groups. In 1965, a total of 41,701 proficiency certificates were issued, as against 28,532 in 1959.

b) Courses held by non-governmental organisations

63. Co-operation between private organisations and the State is developed to such an extent that in the majority of cases governmental and non-governmental technical and vocational training activities are thoroughly integrated. Many vocational schools are owned and administered by professional associations or other private organisations but the majority of these are approved by the government and conform to the Federal Act on Vocational Training.

64. Courses covering special topics in fields not necessarily covered by the Act are organised and held by several professional or other organisations. A brief account of representative examples is given below.

(i) The Swiss Federation of Metal and Watch Industry Workers, a trade union with over 136,000 members, classified in trade groups, organises and holds (a) courses for training supervisors; (b) short courses dealing with special industrial techniques, productivity problems, organisation of work, prevention of accidents, etc.; (c) preparatory courses to assist skilled workers to enter colleges of technology; and (d) courses for the "Maîtrise" federal certificate.

Most of the courses are held in collaboration with vocational schools and in certain cases the union contributes financially to the running of such schools. A monthly bulletin "l'Equipe technique" issued by the union in two languages (German and French) helps to keep members adequately informed on developments in their particular field.

(ii) The Central Union of Swiss Employers' Associations, established in 1908, is a central organisation co-ordinating the activities of the member-organisations. It comprises (1964) thirty-one central, and twenty-two regional employers' associations representing a total of approximately 750,000 manpower. Several member-associations have embarked on large-scale activities connected with technical and vocational training in their particular field; that of the "Swiss Employers' Association of Machine Constructors and Metallurgical Industries" may be considered a typical example. This association is one of the largest member-organisations of the central union[1]. In 1946, a school was set up at Winterthur (Ecole de Contremaîtres) to train foremen for skilled workers in the machine construction and metallurgical industries.

The main courses last thirteen weeks (340 hours of instruction) and cover several topics, as indicated in Appendix V). A two-week course for training supervisors is also available. Students are designated by the enterprises from among the members of their labour force. Full apprenticeship followed by several years of experience is a prerequisite for entering the course, on the successful completion of which a certificate is awarded. In 1964, 180 students completed this course.

The school also organises short courses and seminars for teachers of vocational schools; these last two weeks and include psychology and teaching methods and techniques (see Appendix V). Twenty-four teachers took these courses in 1964.

(iii) The ASET (Association Suisse pour l'Etude du Travail) started the "School of Work Study" (l'Ecole d'étude du travail) in 1946. This association today operates twenty centres, scattered all over the country and offering basic courses for skilled workers in fields related to work organisation and productivity. The courses are normally evening or day release and last at least three semesters (total of 240 hours of instruction). Requirements for admission are a full apprenticeship (or equivalent) plus a (lower) secondary school certificate, or successful completion of the school's preparatory course (see below), or satisfactory results in entry examinations.

On completion of the course a certificate is awarded to those passing the schools' final examinations. A preparatory part-time course of one semester is available for candidates whose knowledge of mathematics is inadequate. A full apprenticeship, or equivalent, is sufficient for entrance to this course.

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(1) In 1964, membership amounted to 496 enterprises occupying a total of 241,000 employees.

Industry collaborates closely with the Association and assists financially in the organisation and running of the courses, which in many cases are considered a basic requirement for technical personnel in charge of small groups of workers or those who are assigned with other limited responsibilities in production and management work.

Approximately an average of 2,000 students complete the basic courses each year.

The Association recently set up in Zurich a new series of courses covering special techniques in several industrial fields (cours de perfectionnement). This Association has established close co-operation with the corresponding German Association and International Labour Office; this contributes greatly to the realisation of the ultimate objective, i.e. the promotion of work organisation and productivity in industry. The monthly bulletin "l'Agent d'Exploitation" issued by the Association in two languages (German and French) has a wide circulation and is of great practical value.

c) Correspondence courses

65. Correspondence courses in Switzerland have up to now contributed very little to technical and vocational education.

XI. COMMERCIAL EDUCATION

66. The structure of commercial education is similar to that of technical education. Four levels may be distinguished, as follows:

a) Commercial apprenticeship

67. This may be regarded as corresponding to craftsman level and is covered by the Federal Act on Professional Training.

Courses are held by the Vocational Commercial Schools, start after compulsory education (eight to nine years of schooling), and last three years. The programme includes practical training in enterprises combined with "day release" compulsory school attendance of an average of eight hours per week. The courses lead to the

Federal examinations in commercial apprenticeship, and successful candidates are awarded a "Proficiency Certificate". In 1964, 7,710 such certificates were issued. In 1965 over 120 schools were holding courses for apprentices on a day release basis. However, there are also several full-time vocational commercial schools where practical training is given in the school together with related theory and general cultural disciplines. Graduates of these schools are eligible for the same Federal examinations in commercial apprenticeship.

68. Most of the vocational commercial schools were primarily established by a private association - the "Swiss Society of Commercial Employees". Today they are all under cantonal or communal control and the supervision of the Confederation.

b) <u>Lower technician level (Commercial Diploma)</u>

69. Commercial training at this level may be acquired through the "special commercial courses" which are normally part-time day release or evening courses of varying duration (four to ten semesters) run by the vocational commercial schools.

70. Several branches, such as accountancy, banking, correspondence, insurance, secretarial, travelling agency, foreign languages, etc., are covered by the Federal Act and examinations for a "diploma" (e.g. diploma in banking) are organised each year in collaboration with the appropriate professional associations. The certificate of proficiency in commercial apprenticeship is a prerequisite for entering a diploma course.

71. In 1962/63, 184 vocational commercial schools (35,423 apprentices and 45,673 attending diploma courses) were in operation in twenty-three cantons or semi-cantons.

c) <u>Upper-technician level (Maturité Commerciale)</u>

72. This level is represented by the holders of the "Maturité Commerciale" certificate, which is a cantonal certificate equivalent to those for full secondary education (Maturité) in other disciplines and opens the way to a university education. "Maturity" courses

are held by the "Higher Commercial Schools". In 1961/62 forty-six such schools, providing courses for 9,516 students (4,864 boys, 4,652 girls), were in operation in nineteen cantons.

d) University level

73. The economic and commercial faculties are open to holders of "Maturité" certificates, although in certain branches holders of commercial diplomas (see b) above) may also be admitted.

XII. AGRICULTURAL EDUCATION

74. The first proposals to introduce agricultural education into Switzerland may be traced back to the 18th Century. Only during the second half of the 19th century however, were agricultural schools established, from which subsequently developed the so-called "agricultural winter-schools".

75. Following the provision in the 1930 Federal Act concerning vocational training, practical training for rural pupils intending to become farmers became a reality with the introduction of agricultural vocational education. Furthermore, the Federal Act of 3rd October 1953, and the annexed ordinances of the Federal Council provided for the furtherance of agricultural education and experimentation.

76. The cantons have made regulations to ensure that the Federal Act is duly applied. The Federal Department of Public Economy, through its "Division of Agriculture" is charged with high-level supervisory duties, as is OFIAMT for technical education.

77. The basis for vocational agricultural education today is compulsory schooling (eight or nine years) followed by practical training. The following courses are now available:

a) Apprenticeship in Agriculture (craftsman level)

78. This starts at the age of sixteen and lasts from two to four years depending on the special field selected and is covered by the

Federal Act on vocational training. Apprentices have their practical training on farms and attend school courses (mostly evening courses) on related theory. At the completion of their training they take the final examinations as laid down by the Act. Successful candidates are awarded the "Federal Certificate of Proficiency" in their particular field of training. It is estimated that about 20 per cent of the future farmers are today trained through apprenticeship. In dairying the percentage is practically 100. Table 5 below indicates the number of certificates awarded in 1955, 1960 and 1963.

Table 5

Certificates of proficiency in vocational agriculture (apprenticeship)

Sectors	1955	1960	1963
1. General agriculture	510	664	759
2. Dairying	235	284	337
3. Rural domestic economy . . .	416	615	716
4. Other special branches . . .	14	15	21
Total.	1175	1578	1833

b) Vocational agricultural schools (craftsman level)

79. Vocational agricultural schools are full-time schools, or classes, normally incorporated into rural lower secondary schools. They provide for practical training in agriculture and agricultural mechanics for young future farmers (normal age 16-18 years) on lines similar to those for apprenticeship training but in conjunction with general educational disciplines. Teachers of practical subjects are normally recruited as part-time teachers among agricultural engineers or experienced farmers possessing a mastership diploma (Maîtrise).

In 1963, vocational agricultural classes which cater for a total of 9,258 pupils were functioning in nineteen cantons

c) Technical agricultural schools (lower technician level).

80. Technical agricultural schools may be regarded as institutions providing for agricultural training at lower-technician level.

There are three types of such schools -

(i) Full-time schools: These are schools at lower secondary level (age group 16-18) with a two-year programme covering theoretical and practical training in agriculture.

(ii) Winter schools: Winter schools held courses for young farmers on technical and economic farm problems. The normal length of the courses is two terms of seventeen weeks each. The content of the courses is adapted to local farming and production conditions.Teachers are mostly agricultural engineers with special training in vocational guidance.

Many winter schools possess farms and boarding facilities. These schools run special short courses in the summer for farmers, and organise demonstrations, inspection of farming processes, etc., maintaining thus a close contact with the rural population of the area.

A special type of winter school is the so-called "Alpine school", where the programme is adapted to the conditions prevailing in the Alps.

(iii) Special agricultural schools: These specialise in different types of agriculture - e.g. dairying, horticulture, poultry breeding, fruit cultivation and wine production.

d) Training for Agriculture at University level

81. The "Federal Institute of Technology" (para. 48) in Zurich has a faculty of agriculture. The programme lasts four years and covers general agriculture with the possibility of further specialisation in cultivation, animal-breeding, farm economics, dairy farming and technico-agronomic sciences. Future agricultural teachers receive

an introductory course in pedagogy and methodology after the first two years.

The number of agricultural students is around thirty.

XIII. HOTEL, CATERING AND TOURISM COURSES

82. Hotel, catering and tourism courses are organised by schools established and run by professional associations. Some of the schools are recognised and subsidised by the Federal government.

83. At the basic vocational level general and special one-year courses are available. Four of these (for male cooks, female cooks, butlers and waitresses) are covered by the Federal Act on Apprenticeship. Requirements for entering the basic courses consist of eight to nine years of basic education (compulsory schooling). In 1964, 1076 certificates of proficiency in hotel and catering trades were issued, as compared with 394 in 1954.

84. At the middle (lower technician) level training possibilities are limited to two types of courses (hotel and tourism) held by the International Centre for Training in Hotel and Tourism Trades, and to special short courses intended for experienced personnel. A brief account of the main training facilities so far available is given below:

(i) A private school in Lausanne, established in 1893 by the "Swiss Association of Hotel Keepers" provides basic vocational courses in several hotel trades. The courses last twenty weeks and are followed by five months' practical training in hotels. The same association has two similar schools (at Davos and Lenk) attached to hotels.

(ii) "The Swiss Society of Coffee Shop and Restaurant Keepers" runs two schools (at Zurich and Vieux-Bois), providing basic training in several branches of the profession. The courses last one semester; practical training is acquired at restaurants attached to the schools. Both schools are recognised and subsidised by the Confederation.

(iii) The "General Swiss Society of Hotel Employees" (Union Helvetia) operates a school in Lucerne, established in 1909, providing: (a) apprenticeship courses; (b) basic general and specialised courses in trades not covered by apprenticeship; (c) special courses for experienced personnel. The length of these courses varies from one week to three months depending on the type and nature of the course. The school, which is attached to a hotel where students have their practical training, is approved and subsidised by the Confederation.

(iv) The SET (Société d'Expansion Touristique), a private international organisation, set up in 1961 in Berne, established an "International Centre for Training in Hotel and Tourism Trades". This centre today operates three institutes as follows:

a) International Institute for Hotel Trades

This is situated in Leysin (Vaud) and is attached to a hotel. It holds vocational courses in several trades, including those covered by apprenticeship. The courses last two years. Eight months (four each year) are devoted to theoretical and practical training in the school hotel while the rest of the time is spent in supervised practical training in other hotels and restaurants. Candidates must have a sound basic education and be at least 16 years old.

b) International Institute for the Training of Higher Personnel for Hotel and Tourism Trades

This Institute which is attached to a hotel at Glions/ Montreux holds one-year courses for the training of: assistant directors for hotels, personnel managers for hotels and restaurants, teaching staff for vocational schools, staff officers for tourism offices and transport companies, etc. Requirements for admission are a full apprenticeship or equivalent training in a trade relevant to the one chosen for study, plus a minimum of two years' experience. Candidates are normally required to sit an entry examination in arithmetic, accountancy and French. Preparatory courses of four weeks' duration are organised for candidates whose knowledge of the French language is inadequate. The minimum age of admission is 22 years. All courses lead to a diploma awarded after final examinations. Ten to fifteen students are admitted each year to each course.

c) International Institute for the Organisation of Special Courses in Hotels and Tourism Trades

This Institute, functioning in Berne, holds advanced courses in such special topics as: market study and advertising, accountancy methods and expenses control, personnel problems, etc. The length of the courses varies from a few days to a few weeks depending on the topic. Admission requirements also depend on the nature of the course. Several years of practical experience is indispensable.

Part Three

FUNCTIONS OF TECHNICIANS

XIV. TECHNICIANS AND THEIR OCCUPATIONS

a) General remarks

85. Upper-level technicians are occupied in industry and the public services. In industry they are concerned with development and research projects, construction and quantity surveying in sales and purchases departments. In the public services they are occupied in administration, technical services, public works and education. Technicians are often assimilated with university engineers, the more competent of them being promoted to high technical or administrative posts in industry or the public services. Many upper-level technicians have set up as independent consultants, or run their own firms as architects, civil engineers, machine constructors, etc.

86. Graduates of the "Evening Technicums" have functions similar to the above in both industry and the public services and, in many cases, are assimilated with graduates of Institutes of Technology. Holders of a "Maîtrise" federal certificate generally occupy positions as foremen and superintendents while "Agents techniques" are used in technical jobs as executives although, in certain cases, they may be assigned with limited activities to planning departments.

b) <u>Summary of a survey on the functions of technicians in industry</u>.

87. A special survey on the functions of technicians in industry was carried out by OECD in 1963. The survey covered only the production and distribution of electricity. Three enterprises, varying greatly in size, were chosen among the many Swiss generating and distributing undertakings, and fifteen "formal" interviews were conducted with technicians occupied in several fields. Each establishment visited may be considered as a representative example of its own particular category. The different posts held by the technicians in industry may be grouped as follows:

(i) Power station superintendent and his deputy;

(ii) Head of section on the technical side (distribution, drawing office, publishing department);

(iii) Workshop superintendent and foreman;

(iv) Chief erector and chief electrician;

(v) Installation inspector.

88. The main findings of the survey are given in Tables 6 and 7.

Table 6

Functions of technicians - Breakdown of the labour force by category of skill in the firms visited

	E1	E2	E3	Total
1. Professional engineers (or equivalent)	21	5	-	26
2. Upper-level technicians	112	29	2	143
3. Lower-level technicians and others doing equivalent work	90	47	5	142
4. Total technicians (2+3)	(202)	(76)	(7)	(285)
5. Skilled workers	599	229	16	844
6. Unskilled workers	28	49	5	82
7. Total, technical personnel	850	359	28	1237
8. Total technicians (4) as a percentage of total technical personnel (7)	24%	21%	25%	23%
9. Technician/engineer ratio	10/1	15/1	-	11/1
10. Technician/skilled worker ratio.	1/3	1/3	1/2.3	1/3

Table 7.

Posts occupied by the technicians interviewed

Firm	Title	Immediate Superior	Education[1] and Training possessed	Diplomas and Certificates	Age	Training desired by firm
EI (Total output in 1962, 2,769 million KWh.)	1. Depute power station superintendent.	Engineer	P5y - S4y- SC. PE 5y	Apprent.	58	Appr.SC PE 3-4y
	2. Foreman	Engineer	P6y - S3y Appr. SC	Apprent.	37	Appr.SC PE 5y
	3. Assistant foreman	Engineer	P6y - S3y- Appr. SC	Apprent.	44	Appr.SC PE 6-8y
	4. Statistician	Head of Tariffs Office	P6y - S3y- Appr. SC- PE 6y	Apprent.	52	Appr.SC PE 3-4y
	5. Site Superintendent	Head of the Design Dept.	P6y - S3y- Appr.SC- PE12y	Apprent.	46	Appr.SC PE 5-10y
	6. Designer	Head of Dept.	P6y - S3y- Appr. SC- PE 10y	Apprent.	44	Appr.SC PE 5-6y
	7. Chief erector/ chief linesman	Operator or district engineer	P6y - S3y- Appr.SC- PF 5y	Apprent.	42	Appr.SC PE 5y
E2 (Total output in 1962 1,228 million KWh.)	8. Power station Superintendent	Engineer	P6y - S3y-	Apprent.	62	Appr.SC PE 3-4y

Firm	Title	Immediate Superior	Education and training possessed	Diplomas and certs.	Age	Training desired by firm
	9. Dispatcher (of electricity)	Engineer	P6y - S3y- Appr. SC - PE 8y	Apprent.	31	Appr. SC PE 4y
	10. Chief erector	Operation Engineer	P6y - S3y- Appr. SC - PE 10y	Apprent.	52	Appr. SC PE 4y
	11. Site superintendent	Engineer	P6y - S3y- Appr. SC - PE 8y	Apprent.	35	Appr. SC PE 4-5y
	12. Chief designer	Engineer	P6y - S3y Appr. SC. PE 6y	Apprent.	39	Appr. SC PE 6-8y
	13. Workshop Superintendent	Operation Engineer	16y - S 3y- Appr. SC - PE 6y	Apprent.	53	Appr. SC PE 2-3y
E.3. (Total power distributed in 1962: 38 million KWh.	14. Inspector		P4y - S5y - Appr. SC PE 8y	Apprent.	48	Appr. SC PE
	15. Chief electrician-house wiring		P5y - S4y - Appr. SC. PE 10y	Apprent.	45	Appr. SC PE 5y

(1) P = Primary education (P5y = 5 years of primary education)
S = Secondary education (S4y = 4 years of secondary education)
Appr. = Apprenticeship
SC = Special courses, on the job training
PE = Previous practical experience

XV. CAREERS AND STATUS OF TECHNICIANS

a) The "Swiss Technical Union"

89. Upper-level technicians are organised under a professional association, the "Swiss Technical Union", which is one of the founding members of the federal association "Swiss Register of Engineers, Architects and Technicians"(para. 91). According to the Constitutional Act, the main objectives of the union are: (i) to increase the prestige of the members and (ii) to participate in the study of technical and economic problems contributing thus to technical progress, to the benefit of members and society as a whole. Members should be holders of "Technician - Engineer ETS diploma; exceptionally, graduates of the Evening Technicum of Zurich are also accepted. About 90 per cent of the technician force, which is estimated at approximately 24,000 including nearly 2,000 non-Swiss, are organised. The union is mainly concerned with professional matters, its activity in the educational field being somewhat limited. Lower-level technicians do not constitute a professional group of their own, and are therefore found among skilled labour, organised under several trade unions, such as the "Swiss Federation of Metal and Watch Industry Workers" which has developed an immense educational activity.

b) Prospects for higher studies and promotion

90. Advancement in industry largely depends on the personal qualities of the individual, although promotion through higher studies appears almost impossible because of the peculiar structure of the educational system. Despite the fact that higher technician courses run parallel to university technical courses, technicians are rarely accepted for enrolment, even in the first year of a polytechnical school course,as the majority of them do not possess the necessary "Maturité" certificate.

91. However, an alternative way is now open to competent technicians to register and be recognised as professional engineers: four professional associations, namely (i) The Swiss Association of Engineers and Architects; (ii) The Federation of Swiss Architects; (iii) The Association of Swiss Consultant-Engineers; and (iv) The Swiss Technical Union, established in 1951 a Federal association, the "Swiss Register of Engineers, Architects and Technicians". Under its

constitution, upper-level technicians (Technician- engineers ETS) may register as professional engineers equivalent to "successful" industrial experience and after passing special examination organised by the Association as specified in the appropriate regulations.

c) Earnings of technicians

92. Sufficient statistical data are not available on which to base accurate general conclusions concerning the earnings of technicians. However, data summarised in Tables 8, 9 and 10 (pages 56 , 57 and 59) are indicative of the situation. As shown in Table 9, the average income of a technician-engineer is, in general, not less than 80 per cent of that of a university engineer. In certain cases, of course, where technicians have high technical or administrative posts, their remuneration may be well above that of a university engineer.

Table 8

Average monthly income of skilled manpower in industrial and commercial fields (in Swiss francs)(1)

Field of activity	Category 1(2)		Category 2(3)	
	Commercial	Technical	Commercial	Technical
1. Textile industry	1558	1473	1186	1179
2. Shoe and clothing	1509	1407	1120	1173
3. Food, beverage and tobacco industry	1597	1487	1113	1182
4. Chemical industry	1712	1699	1289	1250
5. Paper and leather industry	1551	1601	1163	1235
6. Wood industry	1476	1411	1029	1182
7. Petrol and machine construction industry (3)	1417	1393		
8. Watchmaking and jewellery	1562	1496	1050	1180
9. Stone and cement industry	1512	1580	1092	1238
10. Cottage industries	1401	1442	995	1071
11. Commerce	1477	1439	1006	1065
12. Banks and insurance	1559	1599	988	1256
13. Private transport companies	1307	1353	1072	1106

(1) 1 US $ = 4.32 Swiss Francs.

(2) Category 1 comprises the upper-technician level while Category 2 covers that between the skilled worker and the upper technician.

(3) Differentiation is not possible in this field.

Source: OFIAMT (Enquête sur les salaires et traitements, Octobre, 1964).

Table 9

Salary scales in the public service of the Canton of Zurich, 1964

Class	(in Swiss Francs/year) Min.		Max.	Technical qualifications normally required
1	10,512	-	13,080	Proficiency in apprenticeship
2	11,172	-	14,100	
3	11,856	-	15,120	
4	12,564	-	16,140	"Agent technique" certificate
5	13,320	-	17,280	
6	14,160	-	18,480	
7	15,084	-	19,740	Maîtrise Fédéral
8	16,128	-	21,000	Evening Technicum diploma
9	17,184	-	22,320	Technician (Engineer ETS) diploma
10	18,312	-	23,640	
11	19,464	-	25,080	
12	20,628	-	26,580	University Engineer degree
13	21,876	-	28,140	
14	23,256	-	29,760	
15	24,780	-	31,500	University degree (Higher administrative posts)
16	26,472	-	33,720	
17	28,212	-	36,300	
18	29,964	-	38,940	
19	31,944	-	41,880	
20	34,656	-	45,000	

Source: Zurich cantonal authorities' bulletin

Table 10

"Directives"[1] on technician-engineer salaries, Sept. 1966
(in Swiss francs per month)

Age	Classification			
	Group A	Group B	Group C	Group D
- 24 years	1,185-1,285	-	-	-
25 - 29 years	1,285-1,630	1,555-1,780		
30 - 34 years	1,465-1,800	1,700-2,020	1,975-2,405	
35 - 39 years	1,605-2,020	1,860-2,215	2,115-2,580	2,205-2,770
40 - 44 years	-	2,015-2,370	2,250-2,730	2,315-3,135
45 -	-	2,175-2,520	2,385-2,855	2,450-3,300

Group A: Technicians working in a group or section of a firm but not independently.

Group B: Technicians working independently (chiefs of small groups, offices, etc.)

Group C: Technicians in administrative posts such as chiefs of services in medium size enterprises, etc.

Group D: Technicians in high administrative posts such as technical managers of medium size enterprises, etc.

(1) These directives are issued by the Secretariat of the Swiss Technical Union and serve to keep members informed.

Part Four

GENERAL INFORMATION - STATISTICAL DATA

XVI. THE FINANCIAL SITUATION

a) National Income

93. Since 1958, the Swiss economy has been expanding rapidly with Gross National Product rising at an average annual rate of about 6 per cent - a rate exceeded only by Italy and Japan among OECD countries.

94. The net national product of the Swiss people amounted to S.F. 45.6 thousand million(1) in 1963, of which approximately 58% correspond to the earned income of persons working on their own account and living on the proceeds of their work. Compared with 1939, the National Income has roughly quadrupled and, in view of the fall in the value of money,(2) the intrinsic value of this increase has easily doubled. The contribution of the main productive sectors to the National Income for the years 1930, 1950 and 1960 is given in Table 11. In 1963, the Gross National Product was S.F. 50.5 thousand million and the GNP per capita was U.S. $2,024. Figures indicating Swiss living standards are given in Table 12.

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(1) Swiss francs per U S dollar = 4.32.

(2) Cost of living index = August 1959 = 100, August 1964 = 208

95. In the past few years, however, economic expansion has been accompanied by strong inflationary pressures, with rising prices and large external current deficits. Deflationary measures began to be taken by the government as early as 1960 but were based entirely on voluntary agreements and appeals for restraint in employment, investment, price and wage decisions. In the Spring of 1964, a new programme of direct action had to be adopted (OECD, Economic Surveys, Switzerland, 1965).

b) Industry

96. Despite the lack of raw materials and the lack of direct access to the sea, early in the last century Switzerland had already developed a modern industry to produce competitively with other industrialised countries. Industrial plants grew out of various trades and crafts, the so-called "cottage industries" playing an important role during the transitional period; some may be still found in the watchmaking industry in parts of the country. Besides Swiss watches, which are exported to all continents, many products from the textile, machine construction, and chemical industries find their way abroad. The machine industry specialises predominantly in machine-tools; the chemical industry produces mainly dye-stuffs, pharmaceutical products and pesticides. Nearly 6,000 factories were in operation in 1960 (Table 13).

97. The firms employing the largest numbers, i.e., with staff exceeding 1000 persons are found mainly in the mechanical industry (iron and steel) and in 1962 accounted for 35 out of the 53 large-scale undertakings; of the others 7 produce chemicals, 7 textiles and 3 watches, while food-stuffs, shoes, paper-making, printing and fine mechanical and optical apparatus, each counts one firm with more than 1000 employees.

c) Agriculture

98. The agricultural products are as varied as the land and the soil. The possibility of importing cheap grain from countries where natural conditions are more favourable, caused the Swiss to turn to cattle-breeding and to convert their land into pasture. However, the two world wars and the consequent difficulties of importation brought crop farming into the foreground again and led to the

decision to keep 741,000 acres permanently under cultivation. Large estates are unknown in Switzerland, approximately 98.5 per cent of the holdings being under 14 acres.

d) Foreign Trade

99. Even though the larger industrial establishments produce mainly for export, in terms of value imports considerably exceed exports. In 1963, the value of exports amounted to 28.5 per cent of GNP, while that of imports reached 31 per cent (Table 14). Apart from raw materials for industry, food products and various types of machinery are the most important items imported.

e) Expenditure for education

100. Data on education - expenditure in the budgets of the individual cantons - give the general picture shown in Table 15. Expenditure on education increased from approximately F.456.2 million in 1948/49 to F.1,906.8 million in 1962/63. According to the Federal Bureau of Statistics, GNP in 1962 was about F.40,000 million which means that expenditure for education then amounted to approximately 5 per cent of the GNP; taking into consideration the amount devoted to scientific research and scholarships (Tables 16 and 17) and the private school budget which is not included here, this percentage goes up to 5.5. As compared with the national budget (communes, cantons, Confederation), which in 1963 amounted to 11.5 billion francs, expenditure for education was approximately 17.4 per cent.

101. Furthermore, in 1951 the Confederation established the "National Fund for Scientific Research" (Fond National de la Recherche Scientifique) to promote scientific research by providing financial assistance to cantonal universities. This Fund had, in 1962/63, an annual budget of approximately 23 million francs.

Table 11

Percentage contribution of the main production sectors to National Income.

	1930	1950	1960
1. Agriculture	16.4	12.5	8.2
2. Industry	42.5	45.8	50.6
(i) Watch industry	9.2	11.6	14.2
(ii) Other industry and handicrafts	33.3	34.2	36.4
3. Services	41.1	41.7	41.2
(i) Transport and communi-cations	6.0	5.9	7.0
(ii) Trade, banks and insurance	9.0	6.4	5.1
(iii) Public administration, liberal professions	7.4	9.4	10.1
(iv) Domestic services, hotels and establishments with boarders	18.7	20.0	19.0
Total	100.0	100.0	100.0

Source: Federal Office of Statistics

Table 12

Living standards

1. Calories per head, per day in 1962 - 1963	3,163.
2. Food expenditure in 1963 (in per cent of total expenditure in worker families).	25.
3. Average hourly earnings of unskilled workers in 1963 (S. francs).	4.13
4. Number of passenger cars in 1963 (per 1,000 inhabitants)	121
5. Number of telephones in 1962 (per 1,000 inh.). . .	346
6. Number of radio sets in 1962 (per 1,000 inh.). . .	277

Source: Economic surveys by the OECD. Switzerland, February, 1965.

Table 13

Number of factories in selected branches, 1960

1. Food and beverages	796
2. Textiles	969
3. Chemical products	411
4. Machine construction.	2,122
5. Watchmaking	1,272
6. Electric power plants	232
Total	5,802

Source: 1960 Census

Table 14

Foreign Trade and its relation to GNP

Imports		Exports	
1. Imports of goods and services as a percentage of GNP. (1963).	31.0	1. Exports of goods and services as a percentage of GNP. (1963). .	28.5
2. Main imports in 1963 (percentage of total imports):		2. Main exports in 1963 (percentage of total exports)	
- Food products . . .	75.0	- Manufactured goods	90.0
- Machinery	16.0	of which:	
- Fuels	8.0	(i) Machinery. .	29.0
		(ii) Watches. . .	15.0

Source: Economic Surveys by the OECD., Switzerland, February, 1965

Table 15

Total expenditure on Education by type of School
1948/49, 1956/57, 1962/63.
(in Swiss francs)

	1948/49	1956/57	1962/63	% of Total (1962/63)
1. Primary schools	251,102,831	513,140,394	1,100,000,000	52.4
2. Lower secondary schools. . . .	63,891,195	124,418,050	300,000,000	15.6
3. Technical and vocational schools . . .	33,635,915	57,571,116	94,196,788	4.9
4. Commercial schools . . .	15,700,050	23,911,382	40,099,507	2.1
5. Agricultural schools . . .	5,810,895	11,241,620	25,000,000	1.3
6. Complementary schools . . .	494,232	515,035	700,000	0.3
7. Home economics schools . . .	13,639,391	20,631,645	34,825,711	1.8
8. Higher secondary schools . . .	33,655,997	76,555,623	200,000,000	10.5
9. Universities. .	38,258,101	80,758,623	211,933,000	11.1
Total. .	456,188,607	908,743,488	2,006,755,006	100.0

Source: Centre d'informations en matière d'enseignement et d'éducation -1965).

Table 16

Financial contribution of the Confederation to Cultural and Educational Activities (1962-1965)

	1962	1963	1964	1965 Budget
1. Sciences, arts and culture	23,561,301	44,350,364	34,074,500	34,875,182
2. Atomic research	19,549,393	5,000,000	3,212,385	6,000,000
3. Education	6,347,030	7,729,853	8,567,889	8,833,520
4. Vocational training	34,181,457	39,860,500	47,753,966	54,877,500
Total	83,639,181	96,940,717	93,608,740	104,586,202

Table 17

Scholarships and loans for Studies
(in Swiss francs)

	Scholarships		Loan for Studies	
	1962	1963	1962	1963
1. Universities	3,658,594	5,452,779	1,079,740	1,817,766
2. Secondary schools	2,548,371	3,656,302	122,700	156,500
3. Teacher-training colleges	2,457,098	3,015,861	576,732	510,440
4. Technical and vocational schools	4,784,592	5,269,958	289,025	505,495
Total:	13,448,655	17,394,900	2,068,197	2,990,201

Source: Centre d'informations en matière d'enseignement et d'éducation (1965).

XVII. EDUCATIONAL STATISTICS

102. Switzerland has reached a high standard of education. There is a widespread network of schools subsidised by the state and under the control of the cantons; every child must attend primary and lower secondary schools for 8 or 9 years. At secondary and post-secondary levels participation in education is high with plenty of opportunities for technical or other vocational training. The number of universities and other institutions available for higher education is indicative of the high demand at this level.

103. According to a sample check of the 1960 census 78.0 per cent of the non-attending school population had completed a primary or lower secondary school, 5.8 per cent a general higher secondary or technical school, 2.3 per cent a higher education institution, the rest declared as non-identified (Table 18); illiteracy has been practically stamped out (0.18 per cent of the non-attending school population).

104. One indication of the high level of education in Switzerland is the large number of libraries and publications. Public libraries have acquired well over 1,500,000 volumes annually in recent years, while over 8,000,000 books are taken out every year.

105. Enrolments for each level of education for the period 1951 - 1962 and percentage change (Tables 19 and 20) show that emphasis has been placed mainly on general secondary and middle-level technical education with an absolute increase of 40 and 98 per cent respectively. However, middle-level technical personnel still appears to be scarce in many fields and a further increase in the number of graduates from technical and vocational schools is necessary.

106. Total student enrolment at university faculties was 24,659 in 1962-1963 (Table 21) of which 18 per cent were in natural sciences, 15.5 per cent in economic and social sciences and 1.4 per cent in agriculture. Almost one-third of the students were foreigners.

107. A total of 2,730 engineering and architecture diplomas were delivered during the period 1955-1961 (Table 22) which corresponds to an average of 391 diplomas per year. Taking into consideration the

future technical manpower needs of the country (Table 23) at this level, the average output of those attending university level technical courses should at least double during the decade 1960 - 1970.

108. A general picture of technical and other vocational education for the school-years 1956-1957 and 1962-1963 is given in Table 24; further details of vocational courses and the output of "maturité" courses for the period 1951-1961 are given in Tables 25 to 28.

109. Technician courses during the period 1955/61 had a total output of 4,072 i.e., an average of approximately 580 graduates per year (Table 25). According to the research carried out by a special committee, the "Commission pour l'Etude de la Relève des Cadres scientifiques et techniques" in 1959, a considerable increase in the output of these courses was necessary to meet industry's requirements, particularly in machine construction and metallurgy. The necessary steps were in fact taken and output was brought up to nearly 900 in 1963.

110. Evening technicums had an average output of 219 during the period 1955 - 1961 (Table 26) which helped to meet urgent technician requirements in mechanical, electrical and civil engineering.

Table 18

Breakdown of the population no longer attending school, by educational level attained
(1960)

	Actual number	Percentage of total non-attending school population
1. Illiterates	7,346	0.2
2. Primary level (total)	3,114,560	78.0
(i) Primary schools	2,255,616	
(ii) Lower secondary schools	858,944	
3. Secondary and post-secondary levels (total)	232,687	5.8
(i) General higher secondary schools	199,975	
(ii) Technicums	32,712	
4. Higher level (total)	91,302	2.3
5. Non-identified	555,938	

Source: 1960 Census-Federal Office of Statistics.

Table 19

Enrolment for each level of education and percentage change
(School years 1951/52 - 1961/62)

Level and Type of Education	Years			% Change in round figures 1951/62
	1951/52	1956/57	1961/62	
1. Primary (total)	556,538	667,926	695,205	25
(i) Primary schools	476,331	557,406	577,055	21
(ii) Lower secondary schools (incl. pre-gymnasia)	80,207	110,520	118,150	47
2. Secondary and Post-Secondary (total)	95,523	105,991	157,420	65
(i) General higher secondary schools	7,997	11,353	24,837	210
(ii) Commercial schools	7,222	7,682	9,516	32
(iii) Apprenticeship	78,471	84,760	119,450	52
(iv) Technicums	1,833	2,196	3,617	98
3. Higher (total) (Universities, Swiss School of High Economic & Administrative studies, Federal Polytechnical School of Zurich)	16,032	16,455	23,384	46
Totals	668,093	790,372	876,009	31

Source: Federal Office of Statistics

Table 20

Enrolment for each type of secondary and post-secondary school as a percentage of total enrolment (School years 1951/52 - 1961-62)

Type of education	Enrolment as a % of total			% Change 1951-62
	1951/52	1956/57	1961/62	
1. Higher secondary schools	8.4	10.7	15.7	7.3
2. Commercial schools	7.6	7.2	6.0	-1.6
3. Apprenticeship	82.0	80.0	76.0	-6.0
4. Technicums	2.0	2.1	2.3	0.3
Totals	100.0	100.0	100.0	-

Table 21

University courses, - Enrolment. 1952/56-1962/63

Faculty	1952/53	1956/57	1960/61	1962/63	% Change 1952-63
1. Natural sciences	2,503	2,545	3,816	4,631	85
2. Engineering and architecture	2,414	2,677	3,495	3,978	65
3. Economic and social sciences	1,961	2,069	2,957	3,927	100
4. Agricultural sciences	242	209	257	367	52
5. Other faculties	8,504	8,965	10,756	12,756	50
Total	15,624	16,465	21,281	25,659	64
of which:					
Foreigners	3,985	4,579	6,978	8,207	106
Swiss	11,639	11,886	14,303	17,452	50

Source: Rapport de la Commission fédérale d'experts pour l'étude d'une aide aux universités, 1964.

Table 22

University courses: output, 1955 - 1961
(Bachelor degrees)

Year	Technical courses	Natural sciences	Economic & political sciences	Agricul-tural sciences	Other
1955	286	151	243	31	271
1956	414	144	249	37	278
1957	296	141	251	39	236
1958	398	174	313	41	318
1959	428	212	364	41	320
1960	464	191	345	23	322
1961	452	258	342	17	374

Source : Federal Office of Statistics (extrait de l'Annuaire Statistique de la Suisse, 1962)

Table 23

Engineers and Architects - Estimated needs
(1960 - 1970)

1.	Mechanical engineering	2,000
2.	Electrical engineering	2,000
3.	Chemical engineering	1,600
4.	Nuclear energy engineering	500-1,000
5.	Topography	40
6.	Civil and rural engineering	850-1,000
7.	Architecture	400 - 500
	Total	7,350-8,140

Source: Rapport final de la Commission pour l'étude de la relève des cadres scientifiques et techniques, 1959

Table 24

Technical, Commercial, Agricultural, Home Economics and other Vocational schools and courses. (school years 1956/57, 1962/63).

Type of schools	Number of schools/courses 1962/63	Enrolment 1956/57 Total	Enrolment 1956/57 Apprents	Enrolment 1962/63 Total	Enrolment 1962/63 Apprents.
1. Technical and other vocational	83	20,865	4,835	26,369	6,156
(i) Technicums (1)	18	3,641	-	7,676	1,303
(ii) Schools for apprenticeship training	41	4,915	2,034	7,489	2,981
(iii) Other vocational schools. (2)	24	12,309	2,801	11,204	1,872
2. Commercial	168	49,573	22,518	81,096	35,423
(i) with diploma courses only	22			2,397	
(ii) for traffic and post-office jobs	4			469	
(iii) with diploma + "maturité comm." courses	22	8,778		8,084	
(iv) with "maturité comm." courses	2			306	
(v) vocational (for apprent. training)	118	40,795	22,518	69,840	35,423
3. Agricultural	621	12,817		12,781	
(i) vocational (basic training)	41	2,879		3,229	
(ii) other (further training)	580	9,938		9,552	
4. Home-economics	90	118,805		147,756	
(i) Seminars (3)	13	485		629	
(ii) Boarding-schools	52	2,466		3,641	
(iii) Other (4)	25	115,854		143,486	

(1) Including evening technicums - four have workshops attached for apprenticeship training. (2) Include several vocational schools, e.g. for building trades, hairdressing, hotel trades, textile trades etc. (3) Millinary courses for home-economics teachers; (4) Courses at primary school level, advance courses in home economics, mainly courses for house-holding personnel etc.

Source: Die Organisation des Schulwesens in der Schweiz (Dr.Eugen Egger; 1964)

Table 25

Upper-level technician courses: Enrolments and output, 1955-1963
(Technicums)

Year	Output by field of specialisation					Total Output	Total Enrol-ments
	Mech. Eng.	Elec. Eng.	Chem. Eng.	Archit. & Civil Eng.	Others (1)		
1955	147	138	31	128	8	452	1,929
1956	132	156	33	166	7	494	2,196
1957	151	161	33	164	2	511	2,369
1958	172	163	39	188	3	565	2,725
1959	-	-	-	-	-	611	2,984
1960	212	200	41	201	12	666	3,367
1961	242	248	50	186	47	773	3,617
1962	-	-	-	-	-	811	3,884
1963	-	-	-	-	-	892	4,109

(1) Watchmaking, auto-mechanics, electronics, heating and air-conditioning.

Source: OFIAMT and Federal Office of Statistics.

Table 26

Evening Technicums: Enrolments and output, 1955-1963

Year	Output by field of specialisation				Total Output	Total Enrol-ments
	Mech. Eng.	Elect. Eng.	Archit. & Civil Eng.	Industrial management		
1955	75	34	54	-	163	997
1956	70	54	43	-	167	1,087
1957	96	83	61	-	240	1,272
1958	91	71	50	-	212	1,425
1959	-	-	-	-	189	1,611
1960	134	81	58	-	273	2,085
1961	141	98	45	5	289	2,338
1962	-	-	-	-	330	2,406
1963	-	-	-	-	464	2,627

Source: OFIAMT and Federal Office of Statistics

Table 27

Selected vocational courses: enrolment and output
(1950, 1961)

Courses	Enrolment			Output		
	1950	1956	1961	1950	1956	1961
1. Special schools for building construction and civil engineering trades	145	471	476	37	388	458
2. "Maîtrise" federal exams	-	-	-	458	460	545
3. "Agents techniques" courses	1,569	1,620	4,450	-	-	-
4. Apprenticeship	77,211	110,442	119,450	25,029	26,362	33,114

Source: Federal Office of Statistics, 1962

Table 28

"Maturité" certificates, 1951-1961

Year	"Maturité" federal	"Maturité" Commercial (Cantonal)
1951	1,867	397
1953	1,891	416
1955	1,966	400
1957	2,123	458
1959	2,326	440
1961	3,147	526

Source: Federal Office of Statistics, 1962

XVIII. POPULATION AND MANPOWER STATISTICS

a) The land and the people

111. Switzerland, with an area of 15,941 sq. miles, only three quarters of which is productive, contains 1.04 thousand sq. miles of cultivated area, 7.4 thousand sq. miles of grassland and pasture and 3.3 thousand sq. miles of forest.

112. It is a Federation of member states (cantons) which under the Constitution, are sovereign insofar as their rights suffer no limitation by the Federal Constitution; they are genuine States, each with its own constitution and its own legislative and executive bodies. Each canton consists of several communes (para. 1); 3095 such communes comprise the Swiss State.

113. Population increased by some 74 per cent during the period 1870-1963 (Table 29) with an average annual growth rate of 8.1 per thousand inhabitants during the period 1955-1963.

114. According to the 1960 census of the Swiss population, 69.3 per cent were German speaking, 18.9 per cent French-speaking, 9.5 per cent Italian-speaking, 0.9 per cent Romansh - speaking, the remaining 1.4 per cent speaking other languages. German, French and Italian are official State languages and may be used in the transacting of official business.

115. The different languages and cultures and the variety of religions have been powerful factors in encouraging tolerance and in helping to build up the Confederation on the basis of respect for the rights of others. According to the 1960 census, 52.7 per cent of the population were Protestants, 45.4 per cent Catholics, 0.5 per cent Christian Catholics, 0.4 per cent Israelites and 1.0 per cent of several other religions.

116. The active population in 1960 was 2,515,600 i.e., 46.3 per cent of the total, occupied as shown in Table 30.

117. Today more people are employed in industry and manual trades than in any other sector of the economy; according to a sample check

of the 1960 census results, 45.8 per cent of the gainfully employed were working in these sectors. The same data show that in 1960 only 10.7 per cent of the active population were engaged in agriculture and forestry, which, apart from Belgium and England, is the lowest percentage in Europe. The distribution of the rest of the working population is also typical of an industrial and touristic country with a highly differentiated economic structure. As compared with the situation in 1950, a considerable amount of manpower was transferred from the low to the higher productivity sectors (Table 30) and particularly to manufacturing.

118. The need for both skilled and unskilled manpower, due to the rapid expansion of industry during the past few years, has been so acute that recourse was had to the recruiting of workers from abroad. In 1965, 561,018 workers were employed in Swiss industry (137,326 in metal industry and 423,692 in other industries and crafts) as compared with 95,393 in 1951.

119. A breakdown of highly qualified technical manpower in 1960 showed 18,937 university engineers and architects, and 23,845 technician - engineers, i.e. 0.76 and 0.96 per cent of the total active population respectively, distributed by specialisation and economic activity as shown in Tables 31 and 32. As stated previously, the strengthening of this sector of manpower appears indispensable.

Table 29

Total Population (1870-1963)

Years	Population	Years	Population
1870	2,655,001	1941	4,265,703
1900	3,315,443	1950	4,714,992
1910	3,753,293	1960	5,429,061
1920	3,880,320	1963	5,770,000 (1)
1930	4,066,400		

Source: Annuaire Statistique de la Suisse, 1964

(1) Approximate figure (Economic Surveys by OECD, Switzerland, 1965)

Table 30

Active Population by field of activity
(1950, 1960)

Field of activity	Persons in thousands (1960)	Percentages	
		(1960)	(1950)
1. Agriculture and forestry	292.0	11.6	16.5
2. Industry and trades	1,245.6	49.4	45.0
(1) metal and machine construction	403.0		
(ii) building construction	239.5		
(iii) textile, shoe, clothing	171.9		
(iv) food, beverage, tobacco	107.2		
(v) wood, cork and paper	81.7		
(vi) watch and jewellery	79.5		
(vii) other industry	162.8		
3. Services	978.0	39.0	38.5
(i) trade,banks, insurance	338.0		
(ii) domestic services (1)	163.5		
(iii) transport and communications	135.1		
(iv) hotel and catering	113.6		
(v) other services	227.8		
Totals	2,515.6	100.0	100.0

(1) Including welfare establishments

Source: Federal Office of Statistics

Table 31

Breakdown of University engineers and technician-engineers (ETS) by specialisation (1960)

Field	University engineers	Technician engineers ETS	Ratio
1. Architecture	5,885	-	-
2. Civil engineering	3,020	4,586	1/1.5
3. Mechanical engineering	2,697	5,426	1/2.0
4. Electrical engineering	2,506	5,532	1/2.2
5. Chemical engineering	-	1,121	-
6. Watch engineering	-	358	-
7. Ventilation and air-conditioning	-	1,000	-
8. Forestry	341	-	-
9. Agronomy	458	-	-
10. Topography	290	-	-
11. Quantity surveying	412	-	-
12. Others	3,328	5,831	-

Source: Federal Office of Statistics.

Table 32

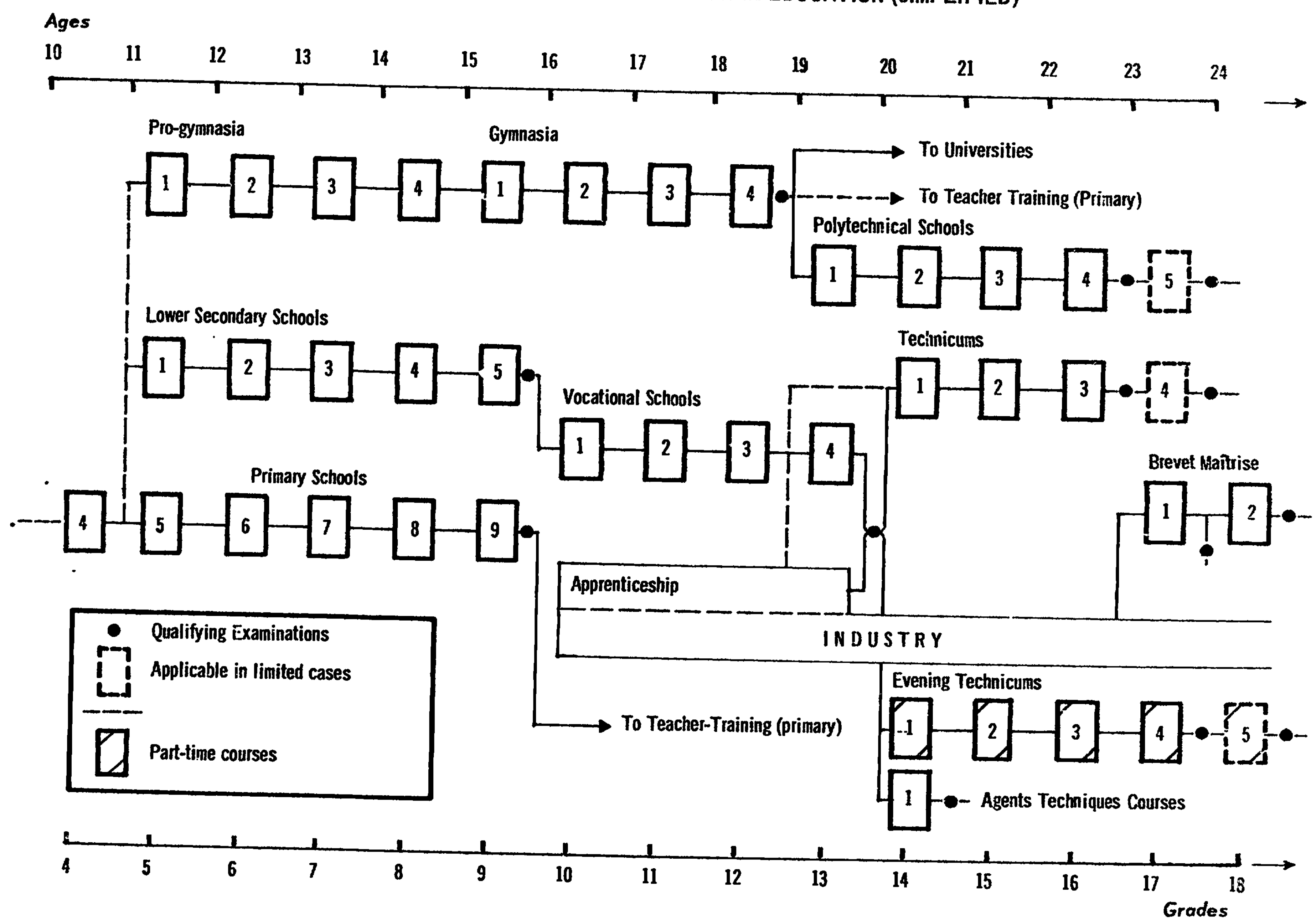
Breakdown of University engineers and technician engineers by division of economic activity (1960)

Field	University engineers	Technicians	Other skilled labour
1. Agriculture (total) (including forestry and fishing)	210	51	24
2. Industry (total)	15,202	19,595	39,892
(i) Mining and quarrying	11	22	174
(ii) Food, beverages, tobacco	127	204	818
(iii) Textiles, shoes, clothing	164	837	1,436
(iv) Wood, cork, paper	86	269	907
(v) Graphic arts	21	91	217
(vi) Leather and rubber	15	60	135
(vii) Chemical	285	1,066	5,549
(viii) Stone and cement	171	205	620
(ix) Metal and machine construction	5,628	11,016	15,889
(x) Watch and jewellery	73	539	404
(xi) Construction	8,145	4,283	9,189
(xii) Electricity, gas, water	435	923	4,395
(xiii) Other industry	41	80	159
3. Services (total)	3,525	4,168	6,551
(i) Commerce	621	1,264	1,100
(ii) Banks, insurance, agencies	721	365	402
(iii) Transport and communications	440	1,197	1,144
(iv) Hotel and catering	-	2	50
(v) Public administration, defense, etc.	658	490	565
(vi) Education and sciences	1,027	708	2,158
(vii) Domestic services (incl. welfare establishments)	42	40	264
(viii) Hospitals and health services	4	13	151
(ix) Other services	12	89	717
Total	18,937	23,814	46,467

Source: Federal Office of Statistics

Appendix I

STRUCTURE OF TECHNICAL AND VOCATIONAL EDUCATION (SIMPLIFIED)



Appendix II

EVENING TECHNICUM COURSES

Selected time-tables

1. Mechanical Engineering course (Geneva Evening Technicum)

Subjects	Instruction periods per week									
	Semesters									Total (Units)(1)
	1	2	3	4	5	6	7	8	9	
1. Mathematics										22
(i) Algebra, geometry, trigonometry	6	4	-	-	-	-	-	-	-	10
(ii) Calculus	-	4	2	2	-	-	-	-	-	8
(iii) Applied mathematics	-	-	-	-	2	-	-	2	-	4
2. Science and Technology										103
(i) General physics	3	3	4	5	-	-	-	-	-	15
(ii) General chemistry	-	-	2	2	-	-	-	-	-	4
(iii) Mechanics, resistance of materials	-	-	3	3	-	-	-	-	-	6
(iv) Hydrodynamics, heat	-	-	-	-	4	4	-	-	-	8
(v) Electrotechnology	-	-	-	-	-	3	3	-	-	6
(vi) Electronics	-	-	-	-	-	-	2	2	-	4
(vii) Measurements	-	-	-	2	-	-	-	-	-	2
(viii) Metallurgy	2	2	2	-	-	-	-	-	-	6
(ix) Elements of machines	-	-	2	2	2	2	-	-	-	8
(x) Servo-machanics	-	-	-	-	-	-	-	-	4	4
(xi) Machine-tools	-	-	-	-	3	3	3	3	-	12
(xii) Technical drawing and construction	2	-	-	-	3	3	3	3	3	17
(xiii) Laboratory work	-	-	2	1	2	2	3	1	-	11

(Appendix II)

3. <u>Elective Subjects</u>										<u>8</u>
(i) Hydraulic machines	-	-	-	-	-	-	-	(3)	(5)	
(ii) Combustion engines	-	-	-	-	-	-	-	(3)	(5)	
(iii) Machine tools	-	-	-	-	-	-	-	(3)	(5)	
(iv) Metallurgy	-	-	-	-	-	-	-	(3)	(5)	
(v) Organisation of Production	-	-	-	-	-	-	-	(3)	(5)	
4. <u>General Subjects</u>										<u>12</u>
(i) General economics	1	1	-	-	-	-	-	-	-	2
(ii) Book-keeping, statistics	2	2	-	-	-	-	-	-	-	4
(iii) Psychology of work	-	-	-	-	-	-	-	-	2	2
(iv) Workshop organisation	-	-	-	-	-	-	2	2	-	4
Totals	16	16	17	17	16	17	16	16	14	145

(1) 1 Unit = 16 periods of instruction (approx.)

2. Electrical Engineering course

(Geneva Evening Technicum)

Subjects	Instruction periods per week									
	Semesters									Total (Units)(1)
	1	2	3	4	5	6	7	8	9	
1. Mathematics										22
(i) Algebra, geometry, trigonometry	6	4	-	-	-	-	-	-	-	10
(ii) Calculcus	-	4	2	2	-	-	-	-	-	8
(iii) Applied mathematics	-	-	-	-	2	-	2	-	-	4
2. Science and Technology										88
(i) General physics	3	3	5	4	-	-	-	-	-	15
(ii) General chemistry	-	-	2	2	-	-	-	-	-	4
(iii) Mechanics, resistance of materials	-	-	2	2	2	2	-	-	-	8
(iv) Hydrodynamics, heat	-	-	-	-	-	2	2	-	-	4
(v) Electrotechnology	-	-	3	3	2	4	-	-	-	12
(vi) Electronics	-	-	-	-	2	2	2	2	-	8
(vii) Measurements	-	-	-	-	-	-	-	-	2	2
(viii) Metallurgy	2	2	-	-	-	-	-	-	-	4
(ix) Elements of machines	-	-	2	2	2	2	-	-	-	8
(x) Machine tools	-	-	-	-	-	-	-	4	2	6
(xi) Technical drawing and construction of elect. machines	2	-	-	-	3	4	-	-	-	9
(xii) Laboratory work	-	-	1	1	2	-	2	2	-	8

3. Elective subjects										12
(i) Electrical machines	-	-	-	-	-	-	(4)	(4)	(4)	
(ii) Power stations	-	-	-	-	-	-	(2)	(2)	(2)	
(iii) Electrical installations	-	-	-	-	-	-	-	(2)	-	
(iv) Telephones, low power	-	-	-	-	-	-	-	-	(4)	
(v) Electronics, servo-mechanics	-	-	-	-	-	-	-	-	(4)	
4. General Subjects										12
(i) General economics	1	1	-	-	-	-	-	-	-	2
(ii) Book-keeping, statistics	2	2	-	-	-	-	-	-	-	4
(iii) Psychology of work	-	-	-	-	-	-	-	-	2	2
(iv) Workshop organisation	-	-	-	-	-	-	2	2	-	4
Totals:	16	16	17	16	15	16	14	10	10	134

(1) 1 Unit = 17 periods of instruction (approx).

3. Mechanical Engineering course

(Berne Evening Technicum)

Subjects	Instruction periods per week								
	Semesters								Total (Units)(1)
	1	2	3	4	5	6	7	8	
1. Mathematics									34
(i) Geometry, trigonometry, algebra	8	6	4	-	-	-	-	-	18
(ii) Analytical geometry	-	-	2	2	-	-	-	-	4
(iii) Calculcus	-	-	-	2	2	2	2	-	8
(iv) Descriptive geometry	2	2	-	-	-	-	-	-	4
2. Science and Technology									114
(i) Chemistry	2	2	-	-	-	-	-	-	4
(ii) Physics	-	2	2	2	2	2	-	-	10
(iii) Technology	2	2	-	-	-	-	-	-	4
(iv) Technical drawing	4	4	-	-	-	-	-	-	8
(v) Construction (theory and practice)	-	-	4	4	4	4	-	8	24
(vi) Electrotechnology	-	-	-	2	2	2	2	-	8
(vii) Mechanics	-	-	4	4	2	2	2	-	14
(viii) Resistance of materials	-	-	2	2	2	2	-	-	8
(ix) Elements of machines	-	-	-	2	2	2	2	-	8
(x) Pumps	-	-	-	-	-	-	4	-	4
(xi) Hydraulic machines - turbines	-	-	-	-	2	2	-	-	4
(xii) Heat	-	-	-	-	2	2	4	2	10
(xiii) Machine tools	-	-	-	-	-	-	-	2	2
(xiv) Heating & Ventilation	-	-	-	-	-	-	-	2	2

(Appendix II)

	1	2	3	4	5	6	7	8	
(xv) Checking & regulation techniques	1	-	-	-	-	-	2	2	4
3. <u>General Subjects</u>									<u>12</u>
(i) German	2	2	-	-	-	-	-	-	4
(ii) Civics	-	-	2	-	-	-	-	-	2
(iii) Law and economics	-	-	-	-	-	-	-	2	2
(iv) Work organisation	-	-	-	-	-	-	2	2	4
Totals:	20	20	20	20	20	20	20	20	160

(1) 1 unit = 20 periods of instruction (approx).

4. Electrical Engineering course : Electronics

(Berne Evening Technicum)

Subjects	Lessons per week								
	Semesters								Total (Units)(1)
	1	2	3	4	5	6	7	8	
1. Mathematics									36
(i) Geometry, trigonometry, algebra	8	8	6	2	-	-	-	-	24
(ii) Descriptive geometry	2	2	-	-	-	-	-	-	4
(iii) Calculus	-	-	-	2	2	2	2	-	8
2. Science and Technology									114
(i) Chemistry	2	2	-	-	-	-	-	-	4
(ii) Physics	-	2	2	2	2	2	-	-	10
(iii) Technology	2	-	-	2	-	-	-	-	4
(iv) Mechanics	-	-	2	2	2	-	-	-	6
(v) Resistance of Materials	-	-	-	2	2	2	-	-	6
(vi) Elements of machines	-	-	-	2	2	-	-	-	4
(vii) Technical drawing & construction	4	4	4	2	-	-	-	-	14
(viii) Electrical machines & transformers	-	-	4	4	2	2	2	-	14
(ix) Electrical installations (and plans)	-	-	-	-	4	-	-	-	4
(x) Transmitters and transmission techniques	-	-	-	-	4	8	12	12	36
(xi) Practical work-transmission techniques	-	-	-	-	-	4	4	4	12

3. <u>General Subjects</u>									<u>10</u>
(i) German	2	2	-	-	-	-	-	-	4
(ii) Civics	-	-	2	-	-	-	-	-	2
(iii) Law and economics	-	-	-	-	-	--	-	2	2
(iv) Work organisation	-	-	-	-	-	-	-	2	2
Totals	20	20	20	20	20	20	20	20	160

(1) 1 unit = 20 periods of instruction (approx).

Appendix III

SPECIAL SCHOOLS FOR BUILDING CONSTRUCTION AND CIVIL ENGINEERING TRADES

Example of time table

(Ecole des Arts et Métiers, Fribourg)

Subjects	Instruction periods per week					
	Semesters					Total (Units)(1)
	1 Winter	2 Summer	3 Winter	4 Summer	5 Winter	
1. Mathematics						10
Arithmetic, geometry algebra	6	Practical work in enterprises	4	Practical work in enterprises	-	10
2. Technological subjects						89
(i) Building construction	4		3		3	10
(ii) Drawing	5		5		2	12
(iii) Technical drawing	15		10		9	34
(iv) Technology	-		-		1	1
(v) Statics and resistance of materials	-		3		2	5
(vi) Measurements	2		4		4	10
(vii) Civil Engineering	-		2		4	6
(viii) Reinforced concrete	-		-		2	2
(ix) Heating	-		-		2	2
(x) Modelling	3		-		-	3
(xi) Organisation of the enterprise	-		2		2	4
3. General subjects						21
(i) Religion	1		-		-	1
(ii) Civics and Economics	-		1		1	2
(iii) French	2		2		2	6
(iv) Law	-		-		2	2
(v) Costings	-		2		2	4
(vi) Book-keeping	2		2		2	6
Totals	40	-	40	-	40	120

(1) 1 unit = 20 periods of instruction (approximately)

Appendix IV

UPPER-LEVEL TECHNICIAN COURSES

A. Number and nature of courses available

B. Selected time-tables

C. Curriculum outline - Mechanical engineering

D. Specimens of final examination projects

   1. Mechanical engineering

   2. Electrical engineering

A. NUMBER AND NATURE OF COURSES AVAILABLE - GEOGRAPHICAL DISTRIBUTION (1964) (Appendix IV)

Name of the School	Location (town + canton or state)	Mech. Eng.	Elect. Eng.	Elec-tron-ics	Chem. Eng.	Auto. Mech.	Ventil air-condit-ioning	Watch Eng.	Archi-tec-ture	Civil Eng.
Tecknikum des Kantons Zürich	Winterthur, Zurich	x	x	-	x	x	-	-	x	x
Kantonales Tech-nikum Bienne	Bienne, Berne	x	x	-	-	x	-	x	x	-
Kantonales Tech-nikum Burgdorf	Burgdorf, Berne	x	x	-	x	-	-	-	x	-
Technicum Cant-onal St.-Imier	St-Imier, Berne	x	-	-	-	-	-	x	-	-
Technicum canton-al Fribourg	Fribourg, Fribourg	x	x	-	-	-	-	-	x	x
Scuola technica can-tonale superiore	Lugarno, Ticino	-	-	-	-	-	-	-	x	x
Zentralschweizeris-ches technicum	Luzern, Luzern	x	x	-	-	-	x	-	x	x
Technicum Neuchâte-lois	Le Locle, Locle	x	x	-	-	-	-	x	-	-
Ecole Supérieure technique	Geneva, Geneva	x	x	x	-	x	x	x	x	x
Technicum cantonal vaudois	Lausanne Vaud	-	x	-	-	-	-	-	-	-
Total number of courses available		8	8	1	2	3	2	4	7	5

x = course available

B. SELECTED TIME-TABLES

1. Mechanical Engineering (Technicum of Bienne)

Subjects	Instruction periods per week						
	Semesters						Total (Units)(1)
	1	2	3	4	5	6	
1. Mathematics							40
(i) Arithmetic	2	-	-	-	-	-	2
(ii) Algebra	2	2	-	-	-	-	4
(iii) Geometry	3	1	-	-	-	-	4
(iv) Trigonometry	2	2	-	-	-	-	4
(v) Calculus (differential and integral)	3	3	3	3	-	-	12
(vi) Advanced geometry	-	-	-	-	2	2	4
(vii) Analytical geometry	-	-	2	2	-	-	4
(viii) Descriptive geometry	-	3	2	1	-	-	6
2. Science and Technology							164
(i) Physics	3	3	2	2	-	-	10
(ii) Chemistry	2	2	-	-	-	-	4
(iii) Mechanics and statics, graphs	3	3	4	2	-	-	12
(iv) Mechanical drawing	6	6	3	-	-	-	15
(v) Technology of the trade	2	2	2	2	-	-	8
(vi) Resistance of materials	-	2	3	-	-	-	5
(vii) Elements of machine construction							
a) Theory	-	2	6	6	-	2	16
b) Exercises	-	-	4	4	-	-	8
(viii) Lifting machines and metal constructions							
a) Theory	-	-	1	2	2	2	7
b) Exercises	-	-	-	4	5	-	9

ix) Hydraulics and hydromechanics							
a) Theory	-	-	2	2	-	2	6
b) Exercises	-	-	-	-	-	6	6
c) Lab. work	-	-	-	-	4	-	4
(x) Heat and combustion engines							
a) Theory	-	-	-	3	9	6	18
b) Exercises	-	-	-	-	6	6	12
c) Lab. work	-	-	-	-	4	4	8
(xi) Heating and Ventilation	-	-	-	-	2	2	4
(xii) Machine tools and workshop techniques	-	-	-	-	2	2	4
(xiii) Electrotechnology and electrical machines							
a) Theory	-	-	2	1	2	2	7
b) Lab. work	-	-	-	-	1	-	1
3. General Subjects							16
(i) Mother tongue (French)	2	2	2	2	-	-	8
(ii) Foreign language	3	2	-	-	-	-	5
(iii) Book-keeping	2	1	-	-	-	-	3
Totals	35	36	38	36	39	36	220

Entrance Requirements:

(i) Certificate of proficiency in apprenticeship.

(ii) Successful entrance examinations in French, arithmetic, geometry, algebra, mechanical drawing.

Length of studies: Six semesters (approx. 4,200 periods of instruction)

(1) 1 unit = 19 periods of instruction (approx).

2. Electrical Engineering-power (Technicum of Bienne)

Subjects	Instruction periods per week: Semesters 1	2	3	4	5	6	Total (Units)(1)
1. Mathematics							46
(i) Algebra	4	3	-	-	-	-	7
(ii) Geometry	2	2	-	-	-	-	4
(iii) Trigonometry	2	2	-	-	-	-	4
(iv) Calculus (diff. and integral)	4	4	4	4	-	-	16
(v) Advanced mathematics	-	-	-	-	2	2	4
(vi) Analytical geometry	-	1	2	2	-	-	5
(vii) Descriptive geometry	-	2	2	-	-	-	4
(viii) Harmonic analysis	-	-	-	2	-	-	2
2. Science and technology							173
(i) Physics	3	3	2	2	-	-	10
(ii) Chemistry							
a) Theory	4	2	-	-	-	-	6
b) Lab. work	-	-	2	2	-	-	4
(iii) Mechanics	3	2	2	2	-	-	9
(iv) Mechanical drawing	4	4	-	-	-	-	8
(v) Technology of the trade	-	2	2	2	-	-	6
(vi) Resistance of materials	-	2	3	-	-	-	5
(vii) Elements of construction	-	2	3	5	-	-	10
(viii) Theory of construction	-	-	2	-	-	-	2
(ix) Construction	-	-	3	3	4	4	14
(x) Electrotechniques	2	2	3	2	-	-	9

(xi) Electrophysics							
a) Theory	2	2	2	2	-	-	8
b) Lab. work	-	-	-	-	4	-	4
(xii) Electrical installations							
a) Theory	-	-	2	2	2	3	9
b): Exercises	-	-	-	4	3	4	11
(xiii) Adjustments (theory, and practice)	-	-	-	-	4	4	8
(xiv) Measurements (lab. work)	-	-	3	3	-	-	6
(xv) Electrical machines							
a) Theory	-	-	-	-	5	4	9
b) Lab. work	-	-	-	-	3	4	7
(xvi) High tension	-	-	-	-	-	2	2
(xvii) Electrical traction	-	-	-	-	-	3	3
(xviii) High frequency, low-power currents	-	-	-	-	2	4	6
(xix) Electronics	-	-	-	-	3	-	3
(xx) Telecommunication techniques	-	-	-	-	3	3	6
(xxi) Amplification techniques	-	-	-	-	3	-	3
(xxii) Mechanical machines-mechanical adjustments	-	-	-	-	3	2	5
3. General subjects							19
(i) Mother tongue	2	2	2	2	-	-	8
(ii) Foreign language	2	2	2	1	-	-	7
(iii) Economics	2	2	-	-	-	-	4
Totals	36	41	41	40	41	39	238

Entrance requirements, length of studies - see time table 1.

(1) 1 unit = 19 periods of instruction (approx).

3. Mechanical engineering (Technicum of Fribourg)

Subjects	Instruction periods per week						
	Semesters						Total (Units)(1)
	1	2	3	4	5	6	
1. Mathematics							48
(i) Arithmetic, algebra	8	6	-	-	-	-	14
(ii) Geometry, trigonometry, analytical geometry	5	6	2	-	-	-	13
(iii) Calculus (diff. & integral)	-	-	3	3	2	2	10
(iv) Descriptive geometry	3	3	3	-	-	-	9
(v) Measurements	-	-	-	-	-	2	2
2. Science and Technology							171
(i) Physics (theory + lab. work)	4	3	5	-	-	-	12
(ii) Chemistry (theory + lab. work)	3	3	2	-	-	-	8
(iii) Mechanics - statics, graphs (Theory + lab. work)	-	6	3	2	4	4	19
(iv) Mechanical drawing	8	6	-	-	-	-	14
(v) Technology of the trade	2	2	-	-	-	-	4
(vi) Resistance of materials	-	-	4	2	-	-	6
(vii) Elements of machines and lifting machines	-	-	4	4	4	-	12
(viii) Hydraulic machines	-	-	-	6	4	4	14
(ix) Construction of lifting and hydraulic machines	-	-	6	8	9	4	27
(x) Heat and engines	-	-	-	-	5	7	12
(xi) Construction of heat and engines	-	-	-	-	4	11	15

(xii) Machine tools	-	-	-	6	-	-	6
(xiii) Electrotechnology, Electrical machines (theory + lab. work)	-	-	6	8	3	3	20
(xiv) Industrial organisation	-	-	-	-	1	1	2
3. General subjects							21
(i) Religion and social economics	1	1	1	1	1	1	6
(ii) Mother tongue (German)	3	2	1	-	-	-	6
(iii) French	3	2	-	-	-	-	5
(iv) Book-keeping	-	-	-	-	2	1	3
(v) Law	-	-	-	-	1	-	1
Totals	40	40	40	40	40	40	240

Entrance requirements:

(i) 9 years of schooling (compulsory period) plus certificate of proficiency in apprenticeship.

(ii) Successful entrance examinations in French, arithmetic, geometry, algebra, technical drawing.

Length of studies: 6 semesters x 19 weeks x 40 periods = 4,500 total periods of instruction

(1) 1 unit = 19 periods of instruction (approx.)

(Appendix IV.B)

4. Electrical engineering (Technicum of Fribourg)

Subjects	Instruction periods per week						
	Semesters						Total (Units)(1)
	1	2	3	4	5	6	
1. Mathematics							46
(i) Arithmetic, Algebra	8	6	-	-	-	-	14
(ii) Geometry, trigonometry,	5	6	2	-	-	-	13
(iii) Calculus (diff. & integral)	-	-	3	3	2	2	10
(iv) Descriptive geometry	3	3	3	-	-	-	9
2. Science & Technology							173
(i) Physics (theory + lab. work)	4	3	5	-	-	-	12
(ii) Chemistry (theory + lab. work)	3	3	2	-	-	-	8
(iii) Mechanics and statics, graphs	-	6	3	2	-	-	11
(iv) Mechanical drawing	8	6	-	-	-	-	14
(v) Technology of the trade	2	2	-	-	-	-	4
(vi) Resistance of materials	-	-	4	2	-	-	6
(vii) Elements of machines and lifting machines	-	-	4	4	-	-	8
(viii) Hydraulic machines	-	-	-	2	-	-	2
(ix) Mechanical construction	-	-	6	6	-	-	12
(x) Heat engines	-	-	-	2	-	-	2
(xi) Machine-tools	-	-	-	2	-	-	2
(xii) Electrotechnology	-	-	6	6	-	-	12
(xiii) Theory of electrical machines	-	-	-	4	5	6	15

(xiv)	Construction of elect. machines	-	-	-	4	8	7	19
(xv)	Electrical installations, el. traction	-	-	-	2	4	6	12
(xvi)	Low-power, telephones	-	-	- -	-	3	3	6
(xvii)	High frequency currents	-	-	-	-	5	5	10
(xviii)	Laboratory work in electrotechn. and high frequency	-	-	-	-	8	8	16
(xix)	Industrial organisation	-	-	-	-	1	1	2
3.	General subjects							21
(i)	Religion and social economics	1	1	1	1	1	1	6
(ii)	Mother tongue (French)	3	2	1	-	-	-	6
(iii)	German	3	2	-	-	-	-	5
(iv)	Book-keeping	-	-	-	-	2	1	3
(v)	Law	-	-	-	-	1	-	1
	Totals	40	40	40	40	40	40	240

Entrance requirements and length of studies:
See time-tables (3) - Mechanical engineering.

(1) 1 Unit = 19 periods of instruction (approx.)

(Appendix IV.B)

5. Mechanical Engineering (Technicum of Geneva)

Subjects / Years:	Instruction periods per week — Semesters 1	2	3	4	Total (Units)(1)
1. Mathematics					23
(i) Algebra, analy. geometry	7	-	-	-	7
(ii) Geometry, trigonometry	5	-	-	-	5
(iii) Calculus (diff.)	-	7	2	-	9
(iv) Applied mathematics	2	-	-	-	2
2. Science and Technology					93
(i) Physics (theory + lab. work)	2	4+2	2+2	-	8+4
(ii) Chemistry (theory + lab. work)	-	2+2		-	2+2
(iii) Mechanics	-	2	2	-	4
(iv) Technical drawing and design	6	4	2	2	14
(v) Theory of echanics and strength of materials	-	-	7	5	12
(vi) Hydraulic machines (theory/lab.work)	-	-	-	4+2	4+2
(vii) Heat engines (theory + lab. work)	-	-	-	5+1	5+1
(viii) Machine tools and tooling	-	-	-	4	4
(ix) Electrical engineering	-	2	4	-	6
(x) Automatic systems	-	-	-	2	2
(xi) Properties of metals (theory and tests)	-	2	-	-	2
(xii) Metallography (theory + lab. work)	-	0+2	1+1	2+2	3+5

(xiii) Hydrodynamics	-	-	5	-	5
(xiv) Thermodynamics	-	-	3	-	3
(xv) Aeronautical engineering	-	-	-	4	4
(xvi) Aerodynamics (lab.work)	-	-	-	1	1
3. <u>General subjects</u>					<u>22</u>
(i) Mother tongue (French)	4	2	-	1	7
(ii) German	4	2	-	-	6
(iii) History, geography	-	-	2	-	2
(iv) Civics and law	1	-	-	-	1
(v) Accounting	2	-	-	-	2
(vi) Physical training	1	1	1	1	4
4. <u>Workshop practice</u>					<u>14</u>
Machining and manufacturing processes - Engineering, Workshop Organisation	4	4	4	2	14
Total:	38	38	38	38	152

<u>Entrance requirements</u>: 9 years of schooling (compulsory period). Certificate of proficiency in apprenticeship is not compulsory. However, holders of this certificate may enrol without entrance examinations in the first year of the course, or after successful examination in the second year of the course.

<u>Length of Studies</u>: 4 years (approx. 5,700 periods of instruction).

(1) 1 unit = 37.5 periods of instruction. (approx).

6. Mechanical Engineering (Technicum of Neuchâtelois)

Le Locle - La Chaux-de-Fonds

Subjects	Instruction periods per week: Semesters 1	2	3	4	5	6	7	8	9	10	Total (Units)(1)
1. Mathematics											38
(i) Algebra	2	2	2	-	-	-	-	-	-	-	6
(ii) Geometry, trigonometry	3	4	1	-	-	-	-	-	-	-	8
(iii) Analytical geometry	-	-	2	2	-	-	-	-	-	-	4
(iv) Calculus (diff)	-	-	2	2	3	3	4	-	-	-	14
(v) Applied mathematics	-	-	-	-	-	-	-	2	2	2	6
2. Science and technology											207
(i) Physics	-	-	2	2	2	2	3	2	2	-	15
(ii) Chemistry	1	1	1	1	1	1	1	-	-	-	7
(iii) Mechanics											
a) Theory	1	1	2	3	3	2	2	-	-	-	14
b) Lab. work	-	-	-	-	-	-	5	5	5	5	20
(iv) Technical drawing	5	5	5	5	-	-	-	-	-	-	20
(v) Resistance of materials	-	-	-	-	-	2	2	2	2	2	10
(vi) Elements of machines	-	-	-	-	2	2	3	3	3	3	16
(vii) Hydraulics and Hydraulic machines	-	-	-	-	-	-	-	2	2	2	6
(viii) Mechanical construction											
a) Theory	-	-	-	-	2	2	3	3	3	3	16
b) Practice	-	-	-	-	5	5	5	5	5	5	30
(ix) Heat, combustion engines	-	-	-	-	-	-	-	-	3	3	6
(x) Machine tools	-	-	-	-	2	2	-	-	-	-	4

(xi) Electricity (general)	2	2	2	2	2	2	1	1	1	-	15
Lab. work	-	-	-	-	-	-	-	5	-	-	5
(xii) Elect. installations	-	-	-	-	-	-	-	-	1	-	1
(xiii) Metallurgy	1	1	2	2	-	-	2	-	-	-	8
(xiv) Mechanical workshop techniques (theory)	-	-	-	2	4	2	-	-	2	4	14
3. <u>General subjects</u>											<u>48</u>
(i) Language (French and civics)	2	2	2	2	2	2	-	-	-	-	12
(ii) German	1	1	1	1	1	1	-	-	-	-	6
(iii) English	2	2	2	2	2	2	-	-	-	-	12
(iv) Industrial law	-	-	-	-	-	-	-	-	2	2	4
(v) Book-keeping, costings	-	-	-	-	-	-	2	2	-	2	6
(vi) Work organisation	-	-	-	-	-	-	-	2	1	1	4
(vii) Statistical control	-	-	-	-	-	-	-	-	2	2	4
Total theory:	20	21	26	26	31	30	33	34	36	36	293
Workshop practice:	30	29	24	24	19	20	17	16	14	14	207
Total, theory and practice:	50	50	50	50	50	50	50	50	50	50	500

<u>Entrance requirements</u>: (i) 9 years of schooling (compulsory period).

(ii) Successful entrance examination in lgebra, geometry, French, German. Aptitude and intelligence tests .

<u>Length of studies</u> : 5 years (plus 3 months for the diploma study)

Total periods of instruction = approx. 9,500

(1) 1 Unit = 19 periods of instruction (approx.)

7. Mechanical Engineering Courses
Comparison of time-tables (1,3,5,6)

Groups of subjects	Total periods of instruction			
	Bienne	Fribourg	Geneva	Neuchâtelois
1. Mathematical disciplines	760	910	860	720
2. Scientific and technological disciplines	3,140	3,250	3,490	3,940
3. General subjects	300	400	825	900
4. Workshop practice	-	-	525	3,940
Total	4,200	4,560	5,700	9,500

Entrance requirements

(i) Years of schooling	9	9	9	9
(ii) Certificate of apprenticeship	Yes	Yes	No	No

C. CURRICULUM OUTLINE

MECHANICAL ENGINEERING: EXAMPLE TAKEN FROM THE TECHNICUM OF GENEVA (1)

I. TYPE OF INSTRUCTION GIVEN

MECHANICAL ENGINEERING

1. The purpose of the mechanical engineering section (M) is to provide industry with technicians capable of specialising in calculations and the design of machine tools, hydraulic machines and heat engines, in factory administration, and in work done in research and testing laboratories. These technicians also receive a good grounding in metallurgy, aeronautical engineering and automatic systems.

2. When they have gained sufficient experience in industry, they will be capable of taking charge of an office, department or laboratory.

II. THE PROGRAMME

1. MATHEMATICAL SUBJECTS

(i) ALGEBRA, ANALYTICAL GEOMETRY — 1st and 2nd years

General:

Fundamental concepts: sets, relationships, functions, operations, isomorphism; natural, relative, rational, real and complex numbers; powers, logarithms.

Algebra:

Polynomials, development of the binomial power; rational

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(1) See page 101 for the corresponding time-table.

fractions, factorisation. Equations: Simple and quadratic equations involving one unknown and equations which can be reduced to this: biquadratic, exponential, logarithmic, irrational systems of linear equations: finding the equation for problems and solving them.

Analytical geometry:

Straight line and circle.

Linear algebra:

Vectors, linear transformations, matrices and determinants.

(ii) <u>GEOMETRY, TRIGONOMETRY</u> <u>1st Year</u>

Geometry:

Transformations: translations, rotations, displacements, symmetrics, homothetics.
Vector calculations: simple space vectors, scalar products, vector products, applications.
Properties of some plane figures: triangles, polygons, circles.
Mensuration and volume of solids: use of formulae.

Plane trigonometry:

Functions defined on the trigonometric circle, addition theorems and corollaries; trigonometric equations; small angles; resolving of right-angled and other triangles; use of tables and slide rule; finding the equation for problems and solving them.

Descriptive Geometry:

Monge's form, axonometric projection, incidence and problems of mensuration.

(iii) CALCULUS 2nd year

Fundamental notions:

Simple and compound integrals, derivatives, radicals, fundamental theorem, simple and total differentials, differential equations, Euler's formulae. Calculating derivatives. Finding the radical. Calculating integrals.

Applications:

Limited expansions, indeterminate forms, graphical representation of functions, radius of curvature, calculation of errors; area of plane figures, area of surfaces of revolution, volume, length of an arc, of a plane, curve, etc.; finding the equation for problems and solving them. Numerical and graphical methods: anamorphosis; approximate solution of equations; approximate determination of derivatives and integrals.

Theory and applications 3rd year

Differential equations: exact and approximate solution of simple equations - Curvilinear integrals - Fourier series - Laplace transformation: fundamental properties, application to the solution of differential equations. Congruent representation.

(iv) APPLIED MATHEMATICS 1st and 2nd years

Characteristic form of a number - Calculation of orders of magniture - Use of tables - Approximate calculations with numbers near unity - Elementary theory of errors - Slide rule, logarithms.

2. SCIENCE AND TECHNOLOGY

(i) PHYSICS 1st year

Introduction:

Physical magnitudes, experiments, problems, methods of reasoning and calculation.

Energy and matter:

Energy and its conversion, equivalence between different forms - Structure of matter, particles, orders of magnitude - Properties of matter: revision and simple problems dealing with changes of state; elementary laws of deformation, properties of liquids, Boyle's law, Charles' law.

Radiation and light:

Radiation, light in relation to other radiations - Propagation, index, properties of media, absorption, diffusion etc. - Formation of images (bundles of rays). Laws of reflection and refraction, dispersion. Optical systems: plain and spherical mirrors, refracting prisms. Thin, compound and thick lenses. Aberration and principle of simple corrections. Optical instruments: the eye, the camera, reflecting and refracting telescope systems. Collimators, projectors - Elementary photometry, black and selective receivers and emitters; principal technical applications.

Kinematics: 2nd year

Reference position - Speed and acceleration (vectorial presentation) - Application to the four simple motions - Relativity of motion: Coriolis, Lorentz.

Energy and impulses:

Kinetic and potential energy - Conservation of energy, conserving and dissipating systems (efficiency and capacity). - Field of force. Calculation in some special cases: gravity, elasticity, attraction - Impulses (definition)- Impulse theorem - application of impulses, centre of gravity, elastic and soft impact, propulsion.

Dynamics:

The fundamental equation (deduced from the impulse theorem). Consequences: three principles of conventional mechanics. Applications: inclined plane, Maxwell wheel, mass, elasticity, circular motion and centrifugal force - Centrifugal and centripetal forces, law of areas - Universal attraction.

Dynamics of systems:

Displacement of the centre of gravity - Fixed axes - Calculation of moments of inertia. Steiner's theorem. Analogy between the rotary motion of systems and the motion of particles. Applications: pendulum, rolling motion - Generalisation of rotary motion. Moving axes of rotation - Gyroscopes and other applications.

Deformable bodies (Deformation of solids):

Application of concepts of continuity to matter - Stress and strain - Deformations, Hook's and Poisson's laws, relationships between the various coefficients - Simple cases of bending, buckling and torsion - Limits of validity of the elementary laws, relaxation time and hysteresis. Work done in rupturing, and binding forces.

Fluid mechanics:

Internal and surface tension of fluids. Work done in deformation. Static equilibria - Viscosity and boundary layers - Viscous and laminar flow - Loss-free flow - Similarities, Reynolds', Froude's and Mach numbers - Turbulent rotational and irrotational flows - Real flows, low losses, life and passive resistance, energy dissipation.

Heat - Introduction and first principle:

Extensive magnitudes, molar mass units - Precise concept of absolute temperature, quantity of heat, specific heat. Calorimetry, heat and changes of state - Equations and magnitudes - work done vis-à-vis the environment and internal energy - Enthalpy - First-principle expressions.

Thermodynamics of gases:

Units of power (cheval poncelet et cheval vapeur) - horse -

power - Static equation of gases - Joule's law of expansion - Isotherms and adiabats - Real gases, Van der Waals' equation - Some applications of special properties,

Kinetic Theory of Gases:

Principle of equipartition - Osmosis - Boltzmann's constant and Brownian movement - Diffusion and transmission of heat - Reversibility - Concept of empirical entropy and its statistical aspect.

Conversion of heat into work:

Second principle - Application to energy transfer, free energy - Definition of absolute temperature. Laws of radiation from black bodies.

Electromagetism:

Introduction and definition: Basic magnitudes, current strength and the amperage - voltage, quantity of electricity, resistance - Applications to circuits (Kirchhoff's laws) - Charger properties (including microphysical). The E field and forces in the field - Potential - Charge/field relationship, Maxwell's first equation - The displacement field - Matter in the field - The capacitor - Field energy.

Induction: The magnetic field of a current, coils - The Vector potential in simple form - Induction/field relationship - Forces in the field, magnetic moments - Energy and Lenz's law - Matter in the field; dia-para-ferro-magnetism - Maxwell equations in integral form.

Quasi-stationary currents: Self-induction, sinusoidal functions, effective and mean values, impedance - Resistance, self-induction and capacity in the sinusoidal system - Simple circuits.

Conduction: Transference of charges - Ions and electrons - Gaseous conduction - Electrolytic conduction - Metallic conduction, Ohm's Law, superconductivity - Hall and

Tollmann effects - Contact potential, polarisation, batteries, accumulators - Thermo-electric effects - Various radiations accompanying discharges.

Laboratory work:

Basic measurements: Length, angle, time, mass, Gauss curves.
Mechanics: Simple, compound and torsion pendulums - Bending, torsion, sag of a taut wire.
Optics: Measuring focal length, refractive indices - Magnifying power of microscopes, telescopes - Photometry. Spectroscope, interference.
Heat: Calorimetry, thermometry, changes of state, conductivity.

Oscillation theory: <u>3rd year</u>

Damped harmonic oscillation - Continuous oscillation - Non-sinusoidal oscillation, Fourier's representation, and spectrums - Forces oscillation, resonance - Couplings - Anharmonic oscillation and relaxation.

Wave Physics:

Concept of a wave, types of waves, polarisation - Standing waves - Propagation; Huyghens-Fresnel - Wave equation: calculation of rate for an elastic solid and a string, electromagnetic waves and sea waves, dispersion and group velocity. Doppler effect - Wave-transmitted energy; reflection and radiation resistance - Interference - Diffraction.

Acoustics:

Sound, timbre, spectrum, scales and instruments, sound intensity.

Physical optics:

Optical diffraction and interference - Resolving power - Simple and special gratings - Waves and particles (electron diffraction)

Radioactivity:

Models of atoms and nuclei; emission, activity, half-life - Elementary particles: protons, neutrons, etc. Projectives, detection, counters, scintillators, ionising agents - various radiations: Photo-electric and Compton effects, spectra.

Laboratory work:

Measuring instruments: Electrical measurements, various methods, bridges, ballistic galvanometers, power measurement. Measurement of magnetic quantities: co-efficient of induction, inductance, flux, permeability.
Single-phase and multi-phase alternating currents. Active and reactive power, impedance, resonance, meter testing under real and notional load.
Magnetism induced in iron by alternating currents.
Curve shapes. Rectifiers. Triodes, amplifiers.
Radioactivity: simple measurements.
Rotating machines: characteristics, power and torque measurement.

(ii) <u>CHEMISTRY</u>

Theory: <u>2nd and 3rd years</u>

Matter: physical and chemical phenomena. Mixtures, simple analysis, compounds, chemical analysis, simple substances.
Atomic theory: structure of the atom; molecules, valency.
Inorganic nomenclature: acids, hydroxides, salts.
Electrolytic dissociation: neutralisation and hydrolysis.
Quantitative equations: atomic weight, molecular weight, equivalent weight.
Universal volume, Boyle's and Charles' law.
Inorganic chemistry: the principal metalloids and alkali metals.
Oxidation and reduction: equations.
Chemical equilibrium: speed of reaction, catalysis, law of mass action; calculation of pH value.

Introduction to organic chemistry: stereochemistry and nomenclature of hydrocarbons; general concepts of organic function; nomenclature.
Elementary thermochemistry: heat of reaction, heat of formation, heat of combustion; Hess's law: higher and lower calorific values.
Electrochemistry: Faraday's laws; potential of electrodes.
Option sections: Fuels. Lubricants. Dyestuffs. Plastics.

Laboratory work:

Qualitative analysis: exercises concerned with electrolytic dissociation; identification of some cations and ions.
Quantitative analysis: measurement of volume, acidimetry, and measurement of hardness of water.
Titration by reduction: determination of iron, formaldehyde, sodium hypochlorite.
Analysis of industrial gases.
Calcimetry.
Chemical analysis based on physical phenomena: Simple measurement with PH-meter; conductometric titration; refractometry; polarimetry; spectrophotometry
Calorific values: oxygen-bomb and Junker's calorimeters.
Inorganic preparations; hydrochloric acid, sulphuric acid; Javel water (bleach); copper sulphate, etc.
Quantitative analysis and preparation by electrolysis: determination of copper; preparation of lead; preparation of Javel water; preparation of caustic soda.
Standard tests for oils and motor fuels: viscosity; flash point; analysis by ebullition.
Determination of carbon in steel.
Organic chemistry: determination of the molecular weight of organic compounds.
Preparation of nitrobenzene, aniline, aniline black; formaldehyde; dinitrodiphenylamine, etc.

(iii) MECHANICS — 2nd year

Revision of vector calculus and associated subjects.
Statics: forces acting at a point, conditions of equ'librium, work.
Statics of perfect solids: analysis of a diagram of forces, conditions of equilibrium, centre of gravity.
Statics diagrams: polygon of forces, catenary polygon, diagrams of breaking stresses and bending moments.
Triangulated systems: nucleus method, sectional method.
Fundamental principles of the statics of deformable solids.
Point kinetics: movement in a plane and in space.

3rd year

Point dynamics:

Fundamental equation, field, potential, conservation of energy, areas, quantity of motion - Forces of cohesion, friction and resistance of the medium.
Vibratory motion, electrical analogy - Finding the equation for and solving various problems.
Kinetics of a perfect solid - Instantaneous centre of rotation, theory of relative motion.

Dynamics of a perfect solid:

Movement of centre of gravity, rotation of solids, conservation of energy - Finding the equation for and solving various problems - Introduction to the dynamics of systems.

(iv) TECHNICAL DRAWING AND DESIGN — 1st year

Technical writing (V.S.M. standards).
Orthogonal projections, use of lines, sections, isometric perspective.
Conventional representation of machine components - Screw-thread, hexagonal nuts, toothed wheels, Springs - Format and scale.

Exercises based on components shown in isometric projection. Dimensions: determination, location, arrangement - Dimensioned sketches - Surface finish - Machining symbols - Working drawings of simple components.

<u>2nd year</u>

Exercises in free-hand dimensioned sketches of machine components - Applications of tolerances and I.S.O. systems - Working drawing of complicated components on tracing paper and tracing cloth (pencil and ink).
Working drawing of components from assemblies (reading of drawings) - General arrangement drawing based on component parts of machines and tooling.

<u>3rd year</u>

Mounting of plain and ball bearings, gearboxes; welded structures - Gauges and setting up.

<u>4th year</u>

Theoretical and practical design studies conducted in groups of about seven or eight students, so that each student's work may be followed more closely - Modernisation of the various components of a machine. Modification of the characteristics of an existing mechanism.

(v) <u>THEORY OF MACHINES AND STRENGTH OF MATERIALS</u>

<u>3rd and 4th years</u>

Permanent joints: riveting, welding, banding, etc.
Joints intended to be taken apart: pins, keys, splined and otherwise profiled shafts - Screw threads, bolts and nuts, locking systems.
Screws for transmitting motion, presses, conditions for higher efficiency.
Elastic connections: leaf and spiral springs. Torsion springs, torsion bars, coil springs. Characteristics and mounting of springs; vibrations, damping.

Lubrication: theory of lubrication, various methods of lubrication, lubrication systems - seals for stationary, sliding and rotating parts.
Bearings: plain and thrust bearings. Clearances and contact pressure, friction losses and heating. Ball, roller and needle-roller bearings, special bearings.
Straight shafts, single and multiple throw crankshafts. Design, strength and elastic deformation. Critical speeds (bending and torsion).
Connecting-rod and crankshaft system. Calculation of forces involved, and of acceleration and its influence. Design devices.
Flywheels. Principles and application of flywheel calculations. Static and dynamic balancing.
Rigid flexible and elastic couplings. Universal joints, homokinetic systems.
Cone, single-plate and multi-plate clutches. Centrifugal, electromagnetic and hydraulic clutches. Fly-wheels.
Drives: friction, and steplessly-variable systems.
Belt grip and application to flat belts and V-belts, influence of centrifugal force. Rope drives; design of pulleys.
Band, shoe and disc brakes. Hydraulic and electromagnetic brakes.
Straight-tooth, helical, bevel, spiral bevel, skew etc. gears.
Interference, correction of profiles. Design calculations for teeth [deflection and wear (contact pressure)].
Various profiles of wormwheel. Chains. Reduction gears, planetary and differential gearing. Special devices, cams, controls, copying devices, follower systems. Industrial applications.
Fundamental hypotheses. External and internal forces, breaking stresses, limit of elasticity, permissible stress. Metal fatigue, safety co-efficients.
Simple tension and compression. Stresses, elastic deformation.

Hooke's law, modulus of longitudinal elasticity.
Design calculations for components having regard to their own mass.
Tensile stresses and elastic deformations, arising from indirect causes, centrifugal force and pressure. Calculation of thin-walled tubes and rings.
Shearing. Transverse stresses and elastic deformation.
Joints subjected to shearing stresses.
1st, 2nd and 3rd order support reactions. Laws of equilibrium and applications to various joints subjected to external forces - stress analysis.
Simple bending and torsion. Centre of gravity, static and centrifugal moments, equatorial and polar moments of inertia, radii of gyration, ellipse of inertia.
Bending and torsional stresses, shearing forces - deformation by torsion and bending.
Elastic-line equation and use in calculating deflection - graphical method of determining deflection (sag).
Relationship between load, shearing forces and bending in sagging components.
Investigation of most common cases by analytical and graphical methods.
Euler's and Tetmajer's buckling formulae.
Compound stresses of the same nature, bending with tension or compression, excentric loads (central nucleus), deflection out of true; prestressed components.
Tensile stresses in an oblique section taken in two perpendicular directions; Mohr's circle. Principal strains, design of components subjected simultaneously to longitudinal and transverse tensile stresses.
Introduction to elasticity in compound stresses. Work done in elastic deformation. Castigliano's theorem and its applications. Hypotheses of rupture at principal tension at maximum deformation, at maximum shearing stress; Mohr's hypothesis, hypothesis on maximum elastic deformation strain.
Comparisons and applications (Bach's and Mohr's formulae).
Hyperstatic joints. Components subjected to tension or compression, tightening down cylinder heads, banding,

prestressing and thermal stresses. Hyperstatics in bending (beams and gantries). Further information on bending, area method. Shearing stresses in sagging beams and finding the patterns formed by the principal lines of stress.
Introduction to photo-elasticity. Isochromaticity and isoclinic lines. Thick-walled tubes. Calculation of pressure having regard to various hypotheses of banding ruptures. Design calculations for beam spans. Introduction to design of curved components.

(vi) HYDRAULIC MACHINES 4th year

Theory:

Flow measurements, history of the turbine, introduction to mathematical hydraulics, general properties, similarity laws, testing of hydraulic machines with applications in the college laboratory.
Presentation of results in form of a mimic diagram.
Pelton wheel and Francis turbine, propellor-type and Kaplan turbines - turbo pumps. Irregular flows in channels and pipes, water-hammer.

Laboratory work:

Laminar and turbulent flows - finding the Reynolds' number - flows round submerged bodies - finding drags with different Reynolds' numbers.
Hydraulic machines: determining characteristics of a centrifugal pump and efficiency curves for turbines,
Pelton wheels and Kaplan turbines.
Functioning and efficiency of a hydraulic ram.

(vii) HEAT ENGINES

Theory: 4th year

Compressor-type and absorption refrigerators.
Heat pumps.
Internal combustion, spark-ignition and diesel engines.
Steam and gas turbines.

Piston compressor and turbo-compressor.

Laboratory work:

Refrigerators. Determination of refrigerating capacity and heat balance.
Internal combustion engines. Summary of characteristics: power, torque and speed, indicator diagrams etc., analysis of gases, heat balances.
Turbines. Summary of characteristics. Tests of blade assemblies. Combustion chamber: temperature measurement and analysis of gases.

(viii) MACHINE-TOOLS AND TOOLING — 4th year

History and general remarks - rules of design.
Power absorbed in machining, turning, drilling, milling, grinding, broaching; efficiency of machine tools.
Rotary motion, stepless and other variable-speed transmissions, gearboxes, speed preselector.
Design calculations for gearbox components.
Translation motions - slideways etc., plattens and saddles - spindle design - Controls for translation motions - intermittent motions.
Safety devices - shape and strength of beds etc.
Hydraulic feeds and feed calculations - design of hydraulic components and valves.
Copying machines. Circuit design and applications.

(ix) ELECTRICAL ENGINEERING — 2nd year

Magnetic circuits, electromagnetic induction.
Ampere's theorem.
Single-phase sinusoidal alternating currents; methods of calculating complex numbers and exponentials by the use of vectors.
Ohm's, Joule's and Kirchhoff's laws.

3rd year

Resonance.
Linear networks, superposition principles.
Thévenin's theorem, transfiguration formulae, applications to balanced star-delta systems.
Balanced three-phase systems.
Dipoles and quadripoles.
Theory of electrical machines, synchronous and asynchronous alternators, direct-current machines.
Transformer theory.
Concept of transient phenomena.
Unbalanced three-phase systems.
Impedance and admittance points.
Introduction to electronics.

(x) AUTOMATIC SYSTEMS — 4th year

Servomechanisms:

Definition of servomechanisms.
Revision of mathematics: transfer functions, differential equations, frequency equations; step, impulse, and frequency response.
Block diagrams.
Frequency response curves: point of transfer (Nyquist), phonic and amplitude curves (Borde), Black's link.
Study of a second-order system.
Stability of linear systems - fundamental condition for stability.

Linear servosystems:

Feedback system: transfer functions and block diagrams.
Nichols' abacuses.
Stability of linear servosystems: residues.
Nyquist, Hurwitz, Learhard, and Bode criteria, stability/precision dilemma.
Compensation in servosystems: network equalizers

(phase lead and lag).
Non-linear servosystems.

(xi) PROPERTIES OF METALS — 2nd year

Material testing: mechanical and technological.
Metals and alloys.
Structure, properties and use of alloys:
Pure metals. Theory and general properties of alloys.
Temperature measurement. Ordinary and special steels: classification, structure, properties, heat treatment.
Iron. Copper alloys. Aluminium alloys. Sintered metals.
Working of metals (introduction) - casting, welding. hot and cold plastic deformation.

(xii) METALLOGRAPHY

Laboratory Work: — 2nd year

Tests: tensile strength, hardness, resilience, flexure, density, modulus of elasticity.
Structure: thermal analysis, binary equilibrium diagram, constitutents of steels and irons, time-temperature transformation curve.
Alloys: construction steels, tool steels, stainless steels, irons, brasses, bronzes, copper-aluminium alloys.

Theory: — 3rd year

Different structures of alloys; theory and practice:
Atomic structure: the atom, energy levels, inter-atomic bonds.
Crystalline structure: methods of investigation (X-rays) lattices, pure metals, solid solutions, inter-metallic combinations.
Micrographic structure: methods of investigation, binary and tertiary equilibrium diagrams, diffusion.
Macrographic structure: solidification, segregation, ingots.

Laboratory work:

Thermometry, work hardening and annealing, fatigue, extrusion, spectrography, radiocrystallography, dilatometry, micrography and macrography.
Tensometry; photoelasticity, strain gauges.

Theory: 4th year

Heat treatment: general theory of hardening and tempering, gaseous atmospheres, cementation, nitriding.
Choice of materials:
General properties: wear, mechanical properties, fatigue, flow, corrosion, weldability, machinability.
Metals used: Steels: for construction purposes, tool steels, heat resisting and stainless steels.
Cast iron: grey, malleable, nodular.
Brasses: lightweight bronze alloys, special alloys, castings and sintered parts.
Moulding and foundry work: materials, processes, marking out inspection.
Welding: classification, processes, weldability of metals and alloys.
Presswork: principles, tools, presses, sheet metal.

Laboratory work:

General hardenability: Jominy's test, transverse hardness and critical diameter, cooling curves, "h" factor and ideal diameter.
Hardening and tempering diagrams for construction steels.
Cementation, hardening and tempering of a high-speed steel, structural hardening.
Radiography: inspection of welds and castings.
Welding and brazing.
Foundry work: Collaud diagram.
Blanking test under a press, measurement of forces.

(xiii) HYDRODYNAMICS 3rd year

Principles of fluid mechanics and basic equations - Some

applications in hydrostatics and aerostatics.
Principles of fluid statics and basic equations - some applications in hydrostatics (pressure gauges; Archimedes' principle, equilibrium of floating solids, hydrostatic thrusts). Some applications to aerostatics (the atmosphere and lighter-than-air craft).
Principles of dynamics of perfect fluids, and basic equations - springs and wells - transformations.
Euler's, Saint Venant's and Bernoulli's equations - impulses.
Flow of real fluids - viscosity, Reynolds' number, pressure drop, distribution systems. Application to liquids and gases.
Introduction to hydraulic machines, general principles.
Gravity machines, volumetric machines, turbines.
Introduction to ventilation.
Introduction to regulation.
Experiments and demonstrations in the aerodynamics laboratory and hydraulic machines laboratory.

(xiv) <u>THERMODYNAMICS</u> — <u>3rd year</u>

Thermometers - calorimetry - transmission of heat - combustion.
Thermodynamics of gases and vapours, gas-vapour mixtures - entropy diagrams - heat engine cycles.
Fluid dynamics - flow measurement.

(xv) <u>AERONAUTICAL ENGINEERING (and applied subjects)</u> — <u>4th year</u>

Revision of basic principles of fluid mechanics - general principles of aerodynamics - wings and wing profiles.
Aerodynamics of the aeroplane - overall aerodynamic effects.
Calculation, analysis and use of polers - concept of compressibility.
Introduction to equilibrium and stability of aircraft - control surfaces.

Introduction to propulsion systems - Applications of the impulse theorem.
Various propelling devices: airscrews, pulse jets, ram jets, turbo-jets, rockets.
Calculation of flight performance: take-off and landing; climbing, straight and level flying, gliding and turning - Some flight mechanics problems - Minimum consumption - Wind-tunnel practice - Measuring instruments and devices.
Discussion on laboratory organisation - laboratory work and demonstrations.
Introduction to ventilation - Movements of air in a room - Forced-air intakes and outlets.
Practical aspects concerning the aerodynamics of various bodies: motor cars, railway trains, buildings.
Introduction to the statics of the aeroplane, simple calculations of wing vibration, international standards and aircraft design, calculation of some special cases of flight; general dimensioning of aircraft.
Introduction to aircraft construction and lightweight construction in general: the chief light alloys used in aircraft construction.

(xvi) AERODYNAMICS 4th year

Laboratory work:

Wind tunnels, measuring instruments and apparatus. Design and calibration of strain-gauge balances. Measurement of peak speeds, pressures, aerodynamic forces and slipstreams. Visualisation experiments; construction of mock-ups and various wind tunnel experiments. Special experiments to demonstrate certain principles (air cushions, windbreaks, air curtains etc.).

3. GENERAL SUBJECTS

(i) FRENCH

1st year

Grammar: syntax of different types of clause; use of moods and tenses.
Spelling: rules and exceptions. Dictation.
Widening the vocabulary: introduction to etymology (for scientific vocabulary).
Study of style; drafting; correspondence.
History of French literature, from its beginnings to the 17th Century.

2nd year

History of French literature from the 17th Century to the 20th.
Study of literary passages.
Précis writing.

4th year

Tutorial groups (8-10 students) - Preparation for oral and written dissertations on literary, general and technical subjects - Students meetings and discussions.

(ii) GERMAN

1st year

Conjugation of auxiliary verbs of tense and weak verbs.
Declension of articles, nouns, pronouns and adjectives.
Prepositions and conjunctions.
Construction of main and subordinate clauses.
Passive voice.
Principal parts. Auxiliary verbs of moods. Relative pronouns. Separable verbs, pronominal and impersonal verbs.
Some strong verbs. Numerous exercises, including composition, translation and dictation.

2nd year

Study of strong verbs, continued
Some every-day German phrases and idioms. Reading and translation of numerous passages relating to science and industry.
Reading and translation of passages concerning industry, technology and science.

(iii) HISTORY AND GEOGRAPHY

History: 3rd year

The great discoveries and their consequences.
The Industrial Revolution. Birth and development of liberalism.
Some economic aspects of the French Revolution and Napoleon's Empire. The 1848 Revolutions. The First World War. The World from 1920 to 1939. The Second World War. Current problems and the search for stability.

Geography:

Problems facing Switzerland.

(iv) CIVICS AND LAW

Civics: 1st year

Civics: Form of the State, organisation of States. Political and administrative organisation of the Swiss Confederation, the Canton of Geneva and the Geneva Communes. Local problems.

Law:

Introduction to civil law and law of contract and tort, vocational training. Contracts of employment, collective agreements, work agreements, contracts of sale, leases. Unemployment and accident insurance. Labour tribunals. Guarantee and suretyship. Trading companies and firms. Trade register. Public liability.

(v) ACCOUNTING — 1st year

Calculation of production costs and selling prices. Accounting records; postal cheques, bills of exchange and bank cheques. Book-keeping: Inventory, Balance Sheet, Day-Book and Ledger. Organisation and financial structure of firms. Cost Accounting.

4. WORKSHOP PRACTICE

MACHINING AND MANUFACTURING PROCESSES - WORKSHOP ORGANISATION

Workshop technology: — 1st year

Introduction to materials - Tools etc. used for measuring and marking out, and simple inspection devices - Filing, various files and cuts - Marking, drilling, tapping reaming (simple operations) - Principle of cutting, cutting angles and their influence - Turning and planing tools - Heat treatment of tools - Introduction to machine tools: chief components, drives and adjustment.

Practical work:

Filing practice on wood and steel - Turning wood and steel with hand tools - Turning with slide rest - Use of drills, taps and dies - Simple tooling exercise - Work with machine tools.

Workshop technology: — 2nd year

Cutting tools: further study of cutting (angles, cutting speeds, depths of cut, feeds, chip cross-sections and relationship between these factors). Surface finish: surface texture comparisons, effect of the cutting-tool position, measurement of surface roughness. Grinding of tools and cutters: by hand and by machine, chip-breaker. Machine tools and automatic machines: further study of machine tool components. Introduction to blanking, stamping and other press work. Control of machine tools: control devices used with machine tools.

Practical work:

Cylindrical and taper turning and boring - Facing - Parting - Cutting right and left hand metric and Whitworth threads - Acme threads - Turning parts to size, using gauges - Application of I.S.O. standards - Tolerance systems - Use of machine tools: milling machines, grinding machines, planing machines - Patternmaking and forge work - Planning of simple operations - Introduction to arc and acetylene welding (practical instruction).

<u>3rd year</u>

Modern and semi-automatic machine tools (demonstration in a factory).
Planning and time fixing for the production of machined parts in a factory.
Acceptance inspection of machine tools.
Study and design of jibs and tools for short, medium and long production runs.

<u>4th year</u>

Workshop technology and practice:

Mechanical efficiency of machine tools.
Study of "Ks".
Further study of cutting, angles, speeds, depths of cut, feeds, and chip cross-section (using strain gauges), Prony brakes, and chip flow.
Surface finish and roughness; surface measurement.

Workshop organisation:

Forward planning. The longer term. Progress and planning. Workshop organisation from planning standpoint. Analysis of workshop capacity, and stock control.

(Appendix IV.C)

D. SPECIMENS OF FINAL EXAMINATION PROJECTS

1. MECHANICAL ENGINEERING

(Technicum of Geneva - Academic year 1963)

EXAMPLE I: HYDRAULIC MACHINES

Subject for diploma

Design study for propeller assembly for a light motorboat, based on the new Pentha Volvo technique (inboard engine, outboard propeller unit).

The power and torque curves etc. of the engine will be those of the 1,800 cm^3 Volvo or Peugeot 404 unit.

The engine is not included in the work for the diploma.

Hull characteristics will be supplied to the candidate.

Description of work required

Calculation and design of the outboard transmission components. Design study for the universal joint allowing the propeller unit to be raised. Design of steering gear. Calculation and design of the propeller screw. Design study for the propeller assembly hull mounting. A drawing to show the general lines, from the standpoint of styling (important from the commercial angle).

Papers to be submitted:

1. Drawing of the propeller screw.
2. Longitudinal section and plan view of the transmission.
3. Isometric view of the unit fitted to the hull.
4. Sketch showing method of mounting.
5. Dissertation comprising a hydrodynamic study of the propeller screw and calculations proving that the transmission components will be reliable and function satisfactorily.

EXAMPLE 2: HYDRAULIC MACHINES

Subject for diploma:

Drawings and calculations for the construction of a small hydraulic ram intended for the Hydraulic Machines Laboratory at the Ecole Supérieure Technique.

Plans of the premises where the ram is to be installed will be supplied to the candidate.

It is expected that the characteristics of the installation will be as follows (but this is subject to modification):

Output	Q = 3.1/sec.
Working head	h = 0.7 m
Delivery head	H = 3.5 m

Description of work required:

Theoretical study and design of the equipment. Use of the Bergeron method to calculate the ram effect in the unit. Calculation of estimated output Q from the ram.

In view of its intended use, the unit should be designed for rapid assembly and dismantling, and in such a way that it can be constructed as far as possible in the Ecole des Arts et Métiers workshops.

Papers to be submitted:

1. A general arrangement drawing, to show method of functioning, assembly and dismantling.
2. Drawings of the more important components.
3. Calculations justifying the design from the hydraulics and strength of materials standpoints.

EXAMPLE 3: MACHINE TOOLS

Partial design studies for a lathe of new design

(a)	Centre height	175 mm
(b)	Spindle speed (sustained)	30 to 3,000 rpm
(c)	Spindle nose to take chuck	
(d)	Diam. of hole through spindle	41 mm
(e)	Spindle taper	Morse No. 5
(f)	Motor rating	4 ch

Gearbox:

Number of metric threads	28 (standardized)
Metric pitch	0.5 - 12 mm
Whitworth + module	28
Number of feeds per spindle rev.	28
Sliding feeds	0.03 - 0.5 mm
Surfacing feeds in relation to above.	

Candidate A to design:

(a) Headstock, spindle and drive as far as output spindle for screwcutting.

(b) Transmission from variable speed unit which will be regulated by auxiliary "stop" motor.

Candidate B to design:

(a) Gearbox of enclosed type, full use being made of corrected gear-tooth forms.

(b) Saddle and drive by hardened partial lead screw with recirculatory-ball type of nut.

Drawings to be submitted

1. General arrangement drawing showing design details of headstock and lower structure, including motor and variable speed unit, and of gearbox, saddle and drive, together with necessary views and sections.

2. Working drawing of any one component.

EXAMPLE 4: MACHINE TOOLS

Design study for motorised spindle unit for a vertical copy-miller.

Characteristics:

(a) Flanged motor, 3ch, 1,500 rpm.

(b) No.4 Morse taper spindle or rapid clamping device.

(c) Adjustment of spindle travel 80 mm.

(d) Provision for clamping the arbor.

(e) Nine or 12 spindle speeds in geometrical progression, from 90 to 2,000 rpm.

(f) Centralised lubrication.

(g) Adjustable stylus position.

Drawings to be submitted:

1. General arrangement drawing showing design details of spindle head and master cylinder, together with necessary views and sections of gearbox, spindle and clamping device.

2. Working drawing of any one major component.

Dissertation:

Studies and calculations for hydraulic copying device, with general diagram.

2. ELECTRICAL ENGINEERING

(Technicum of Geneva - Academic year 1963)

EXAMPLE 5: ELECTRONICS

Subject: Pulse circuits

1. Mr. FORSTER

Theoretical study of a sinusoidal pulsed voltage generator. To comply with C.C.I.R. standards. Application to video control.

2. Mr. PRINA

Theoretical study of a stepped-voltage generator.

To comply with C.C.I.R. standards. Application to video control.

To be submitted

Three dissertations, and one generator of each type in working order, matched to the Port Gitana transmitter.

EXAMPLE 6: ELECTRONICS

Transistorised volume expander and compressor

Allocation of work:

(a) Volume expander, Mr. Moreillon.

(b) Amplifier to be designed jointly.

(c) Volume compressor, Mr. Girardin.

Work to be done:

(a) Design and construct a transistorised volume expander-compressor. The input must be suitable for a microphone or a crystal pick-up with corresponding signal level. The output must be designed for either loudspeaker or tape recorder.

(b) Carry out various measurements: frequency response curve and input level response curve, scale of distortion etc.

Presentation of work:

Three diplomas, one per student and one for the College. One general diagram and one detailed diagram.

EXAMPLE 7: ELECTRONICS

Curve tracer for transistors

The point-by-point plotting of transistor and vacuum tube characteristics is a somewhat lengthy process. It is proposed to construct an instrument that will allow these characteristics to be observed on an oscilloscope. As far as possible, the instrument should be suitable for both transistors and tubes.

The work comprises:

1. Theoretical study of the problem and possible solutions.

2. Project for a simple instrument for plotting the characteristics of low-power transistors.

3. Construction of an experimental rig.

4. Diagram of the instrument (one drawing).

EXAMPLE 8: ELECTRONICS

Frequency measurement

Conversion of the frequency of a signal into a proportional (d.c.) voltage.

Work to be done:

The study is in two separate parts:

1. Frequency measurement to an accuracy of the order of one per cent over the widest possible frequency band.

2. Frequency measurement to an accuracy of the order of 0.1 per cent around a well-defined frequency. It includes the construction of the instrument.

Drawings:

Detailed circuit diagrams.

EXAMPLE 9: ELECTRONICS

Transistorised LF amplifier

The work comprises:

1. Design and construction of a transistorised push-pull power amplifier. The amplifier must be designed for the audio-frequency range. Scale of distortion will be as low as possible (less than 2 per cent for a power of 8 watts).

2. Design and construction of a pre-amplifier to go in front of above amplifier. The input should be suitable for connection to a high or low impedance pick-up, or a microphone.

3. Measurement of the performance of this amplifier.

4. Measurement of the performance of a commercially-reproduced amplifier using tubes.

5. Diagrams of circuits used.

Appendix V

ECOLE DE CONTREMAITRES

(Employers' Association of the Machine Constructors and Metallurgical Industries)

Time-tables

A. Basic course

	Subjects	Hours of instruction
1.	Introduction to training	2 hours
2.	The training of a person	45 "
3.	Instruction, adaptation and re-adaptation.	8 "
4.	Discussion of practical cases	6 "
5.	Technical drawing	23 "
6.	Arithmetic and geometry	24 "
7.	Mechanics	26 "
8.	Technology and resistance of materials.	32 "
9.	Electrotechnology	14 "
10.	Work techniques - machines and use of them.	48 "

11.	Measuring techniques	18 hours
12.	Preparation and supervision of work.	18 "
13.	Remuneration systems and time determination.	38 "
14.	Wastage in the enterprise	4 "
15.	Standardisation	10 "
16.	Delays	6 "
17.	Workshop book-keeping; costing	4 "
18.	Accidents	6 "
19.	Law for factories and w^rkshop hygiene.	8 "
	Total:	340

B. Course for Teachers of Vocational Schools

	Subjects	Hours of instruction
1.	Psychology	
	a) Development stage at the age of apprenticeship.	8 hours
	b) The role of the teacher in his relation with the apprentices.	4 "
	c) Observation and graduation of the apprentice.	16 "
	d) Guidance and influence	16 "
2.	Teaching methods and techniques	
	a) Relations with the apprentice, contract, rules of apprenticeship.	2 "
	b) Practical training	13 "
	c) Related theory	4 "
	d) Visits in industry	6 "
	Total:	69 "

Appendix VI

SELECTED LIST OF INDIVIDUALS AND ORGANISATIONS CONSULTED

1. Federal Department of Public Economy

   a) Office Fédéral de l'Industrie des Arts et Métiers et du Travail

      i) Section de la Formation Professionnelle (Mr.E. Gerber)

      ii) Section de la Protection des Travailleurs et du Droit de Travail (Dr. W. Brunner).

      iii) Subdivision des Statistiques Sociales (Dr. Heiniger)

   b) Division de l'Agriculture (Mr. A. Gysel)

2. Bureau fédéral des statistiques (Dr. Rotach)

3. Centre d'information en matière d'enseignement et d'éducation (Dr. E. Egger, Director).

4. Schools and colleges

   a) Kantonales Technikum, Burgdorf (Mr. Schulthess,Director)

   b) Zentralschweizerisches Technikum, Lucerne (Mr. Ottrubay, Director)

   c) Abend Technikum, Berne (Mr. Müller, Director)

   d) Lehrwerkstätten der Stadt Bern (Mr. Schürch, Director)

   e) Ecole complémentaire commerciale, Berne (Dr. W. Rüfli, Director).

f) Hotelfachschule, Union Helvetia, Lucerne (Mr. Zellweger, Secretary.

g) Fachschule für Betriebsfachleute, Zurich (Mr. Hildebrandt, Director).

5. Société suisse des Ingénieurs et des Architectes (Mr.Wüstemann, Secretary General).

6. Union technique suisse (Mr. Gouthier, Secretary)

7. Union centrale des associations patronales suisses (Mr. K. Sovilla, Secretary).

8. Association patronale suisse des constructeurs de machines et industriels en métallurgie (Dr. Schüpbach, Secretary).

9. Fédération suisse des ouvriers sur métaux et horlogers (M. Bratschi, Secretary).

Appendix VII

SELECTED BIBLIOGRAPHY

1. Draft report on the education and training of engineers of non-university level and technicians in Switzerland (OECD, 1963).

2. Report on the inquiry into the functions of technicians in industry in Switzerland (OECD, DAS/STP/63.82).

3. Economic surveys by the OECD, Switzerland, 1965.

4. Pupil guidance - Education in Europe (Council of Europe, 1965).

5. School systems - A Guide - Education in Europe (Council of Europe, 1965).

6. Loi fédérale sur la formation professionnelle (20 septembre 1963)

7. Loi fédérale sur le travail dans l'industrie, l'artisanat et le commerce (13 mars 1964).

8. Technical Education Reform Act 2/1964.

9. Arrêté du Conseil fédéral modifiant l'ordonnance sur la formation professionnelle et la recherche agricole (26 janvier 1962).

10. Ordonnance sur la formation professionnelle et la recherche agricole (Conseil fédéral suisse, 29 mars 1965).

11. "Die Organisation des Schulwesens in der Schweiz. Statistik über das Schulwesen. Aus: Archiv für das Schweizerische

Unterrichtswesen, Frauenfeld 1964 . (Dr. Eugen Egger)

12. Notes et Etudes documentaires. L'enseignement en Suisse. No. 3046, décembre 1963. (Secrétariat général du gouvernement, Direction de la documentation, Paris).

13. Rapport final de la commission pour l'étude de la relève des cadres scientifiques et techniques, (Berne, avril 1959).

14. L'enseignement universitaire en Suisse (Office national suisse du Tourisme, Zurich, 1963).

15. Les écoles supérieures techniques de Suisse (collège des directeurs des ETS de Suisse, Genève).

16. International Course on Vocational Education of the Agricultural Teaching Staff - Literature (1962, 1964).

17. Règlement d'organisation des examens de maîtrise dans la branche artisanale de la mécanique (Société suisse des maîtres mécaniciens, Berne, 1956.)

18. School-prospectuses and study plans:
a) Technicums = (Zürich, Bienne, Burgdorf, Fribourg, Lucerne, Neuchâtelois, Geneva, Lausanne).

b) Other schools = (Evening technicum Berne, Evening technicum Geneva, Lehrwerkestätten der Stadt Bern, (ASET), Ecole des Arts et Métiers Geneva, Ecole de contremaîtres Winterthur , etc.

19. Information on Education around the World. Switzerland (US Dept. of Health, Education and Welfare, Office of Education, Washington D.C., 1960).

20. Das erweiterte Kurs-system der Fachschule für Betriebsfachleute (Separatdruck aus "Der Betriebsfachmann" No. 3/1965).

21. Internationale Erziehungskonferenz : Schweiz (Geneva 1965).

22. Enseignement : extrait de l'annuaire statistique de la Suisse

(Bureau fédéral de statistique, 1962).

23. Fondation du registre suisse des ingénieurs, des architectes, des ingénieurs-techniciens, des architectes-techniciens et des techniciens - Statuts, règlement.

24. Statuts de l'Union technique suisse (Association de techniciens, d'ingénieurs et d'architectes).

25. Union technique suisse - U.T.S. (Directives pour les salaires des techniciens, des ingénieurs et des architectes. Novembre 1964).

26. Finn Facts - Newsletter (April 1965).

27. Résultats de la statistique des fabriques au 19 septembre 1963, 1964 (Bureau fédéral de statistique).

28. Enquête sur les salaires et traitements versés en octobre 1964 (OFIAMT).

29. Annuaire Statistique de la Suisse, 1964.

30. Rapport annuel du Comité et du Conseil, 1964 (Association patronale suisse des constructeurs de machines et industriels en métallurgie).

31. Rapport d'activitié (Fédération suisse des ouvriers sur métaux et horlogers, 1963).

Appendix VIII

CONCLUSIONS OF THE CONFRONTATION MEETINGS

A: CONFRONTATION MEETING BETWEEN THE NETHERLANDS - SPAIN - SWITZERLAND AND YUGOSLAVIA

The discussions followed the procedure adopted in the previous confrontation meeting between Canada and Denmark, the main conclusions of which were adopted by the meeting. These conclusions are incorporated here as Part B of this Appendix for the sake of easy reference.

The participation of a large number of countries with different systems and methods and the availability of completed reports on these countries made the discussion extremely profitable and lively and brought to light issues which had not appeared before. A brief account of these new issues as they have been discussed under the various agenda items is given below.

a) Standardised qualifications

It appears that an attempt to set international standards as regards technician training courses will not lead to any valid results, because of the existing great differences in structure and content of these courses in the various countries. However, it would be useful to define the minimum qualifications required for each grade so as to devise a yardstick against which one could measure and evaluate the situation in each Member country.

b) The technician force

In most cases technician courses aim at the production of middle-level technical manpower to fill in existing gaps in the rapidly developing economy. It should be emphasised, however, that in countries in the process of industrialisation, the availability of such a technical force might play a decisive role in the establishment of new industrial concerns and be a prerequisite to set developing industry on a sound and competitive basis.

When planning for technical education it is important to know, among other things, the appropriate ratio: university engineer/higher technicians. Although this ratio may vary from country to country, depending mainly on the nature of industry, it is observed that in the majority of cases, a higher technician force three times larger than the respective engineering force will be required effectively to support and supplement the latter.

It was observed that in all four countries under examination there was a scarcity of higher technicians. Among the reasons given for this scarcity, the following, although not always universally applicable, are worthy of note:

(i) Inadequate supply of information to parents and prospective students, as regards technician studies and careers, due to lack of properly organised and functioning educational and vocational orientation and guidance service.

(ii) The role of higher technicians in industry is not, in all cases, well defined and appreciated. The social and professional status of the technician is still vague and in many cases technicians are still considered as "second class" engineers.

(iii) Promotion possibilities through further studies are, in certain cases, extremely limited. Although the vast majority of technicians are expected to enter the "economy" directly, provision should be made for those who have the ability and interest to be enabled to continue their studies for higher qualifications.

(iv) The educational system is finding it extremely difficult to keep pace with the constantly increasing demands of a rapidly developing industry.

(v) Lack of reliable statistical data on present and future needs in technical manpower do not permit of effective planning in the educational field.

c) Technician training courses

When using the term "apprenticeship" one should have in mind that it does not necessarily refer to craft training only. There are countries, such as the United Kingdom, where apprenticeship training covers the whole range of technical force from the skilled worker up to and including the university engineer.

Although school-training is indispensable it should be realised that it has its limitations. Therefore, training within industry should constitute an integral part of the technician training process.

It was agreed that there are at least two possible ways of training in order to ensure the required adaptability of the "end-product" to the continuously changing needs of modern technology:

(i) To give narrow and deep specialisation providing for re-training possibilities on a similar basis, as might be proposed by a special retraining committee ;

(ii) To train on broad scientific and technical background allowing for further specialisation within industry. Special short courses on new developments and techniques may be organised by the technical colleges in collaboration with industry. It appears that the latter method of training gives better results as regards both the quality and adaptability of technical personnel and is therefore highly recommended.

As technology is developing at a rapid pace it does not appear feasible for the educational system to keep abreast of it. Therefore, industry is expected to react first by providing necessary training courses, which may then be adopted and further developed by the technical colleges.

d) Co-ordination of efforts in the training process - industry participation

The establishment of a co-ordinating mechanism charged with policy making and all other matters related to technical education and training is considered of vital importance, no matter what the social and political structure of the country is. Such a mechanism should be composed of representatives of the educational authorities, the teaching force, other governmental and private institutions, participating in the training scheme, employers' and employees' associations and industry.

Under Item 5 of the agenda the several forms of participation of industry in the training process were thoroughly discussed. It was agreed that active participation of industry, including jointly financed (industry/educational authorities) training programmes, is of vital importance and positively contributes to the development of technical education and training. Reference was also made to the pattern of co-operation between industry and education developed recently by the United Kingdom. (Technical training under the Industrial Training Act, 1964.)

Participation of industry representatives in a central co-ordinating mechanism, in technical school boards and examination boards and the establishment of jointly financed (government and industry) training programmes are considered as realistic measures to secure the desirable active participation on its part.

e) Recruitment and training of technical teachers

In the discussion of the problem of recruitment and training of technical teachers, it was revealed that all four countries experience much difficulty in securing in adequate numbers properly qualified personnel to cope with modern industrial and educational requirements.

In order to be efficient in his job, a technical teacher should possess adequate knowledge in a variety of subjects. Technical knowledge and experience should be supplemented by pedagogical training covering child and adult education, psychology of the trade, labour market problems, industrial organisation and financing, productivity, etc. Such knowledge can be acquired only through special training which should, therefore, be regarded as part and parcel of the technical teacher training process.

Entrants from industry to teaching, lacking pedagogical training, frequently experience great difficulty in performing teaching tasks. Often they have to learn by trial and error and the students suffer from their initial ignorance of efficient teaching methods. On the other hand, experience of certain countries shows that, as a general rule, adult personnel originating from industry are rather reluctant to readjust themselves to school conditions and be exposed to formal training.

B: CONFRONTATION MEETING BETWEEN CANADA AND DENMARK
(Revised version)

a) Delineation of the category of skilled labour force under consideration

It was agreed that a "scholastic" definition of the technician should be avoided. The force under consideration was defined as that which lies between the skilled worker at the one end and the professional engineer at the other.

It was decided that although discussions should be focussed on engineering technicians, as information available was mainly in this field, technicians in other fields should also be covered as adequately as possible.

b) Level of Technicians - Certification - Training

It was agreed that the technician force should be classified in two main levels, provisionally termed the junior or lower technician level and the senior or upper technician level. The classification should be based not on functional assignments but on educational qualifications which need not necessarily be acquired in a formal way.

Difficulty was experienced in comparing the training programmes of the two countries because of differences in basic principles. The Danish system is mainly based on apprenticeship training while the Canadian is entirely institutional. After discussion it was agreed that though apprenticeship should not be a prerequisite for technician training a period of practical training in industry is essential. The Danish authorities have already realised this fact and are planning to reduce the apprenticeship period preceding technician training.

By comparing the "Teknikum Engineer" of Denmark with the "Technologist" of Canada it became evident that Senior Technician training should be a standardised post-secondary training of a less theoretical but positively more practical character than the university level training in parallel fields.

By studying the fields of activity of Junior Technicians it was agreed that Junior Technician training programmes should be flexible in character and duration, and should be particularly adapted to the needs of the individual trade in each country. A basic general education of at least 10 years was considered an essential prerequisite for the production of an adaptable "end product". This educational background together with the additional education and training acquired through the course proper, should bring the junior technician to an educational level comparable to that of a full secondary education.

Specific training programmes were further discussed on the bases of an illustrated exposé (projection of slides) by the Danish Delegation.

Standardised certification, already well ahead in Denmark, was considered essential not only at national level but also internationally. OECD was invited to assist Member countries in this respect.

c) Vocational Guidance Service - Wastage from technical courses

Study of relevant information revealed that vocational guidance services in both countries are not adequately organised. It was decided that further steps should be taken to establish effective services in both the vocational guidance and the vocational selection fields.

Wastage from Senior Technician and University courses appeared to be a major problem, particularly in Canada. Many factors seem to influence this wastage; undoubtedly among them is the inadequate method of vocational guidance and selection.

It was decided that further investigation should be undertaken to define (i) the reasons for high wastage, (ii) what happens to the "drop-outs".

d) Recruitment and training of technical teachers

In both countries recruitment of technical teachers presents difficulties because of the scarcity of properly qualified personnel and the competition from industry.

It was agreed that a technical teacher should:

(i) possess qualifications ensuring thorough theoretical and practical knowledge of the subject he is expected to teach;

(ii) have industrial experience in appropriate fields;

(iii) be familiar with basic educational principles and possess adequate knowledge of teaching methods and techniques;

(iv) be kept continuously aware of new developments in educational and industrial fields.

It was agreed that to ensure this represented an important area where further governmental action was necessary. OECD was invited to assist the countries in this respect.

The possibility of securing part-time services of personnel from industry was discussed. It was agreed that this procedure, though difficult to put into practice, at least so far as day courses are concerned, should be further explored; in effect it encouraged the person concerned to keep continuously up to date on both the theoretical and practical sides.

Further discussion led to the conclusion that a reciprocal flow from industry to education and vice-versa is highly desirable. To ensure this, establishment of rules for recognition of a "continuity of service" (years of service, pension, etc.) would be necessary. In Denmark, this problem is being tackled by the technicians' professional association.

revealed that authorities in charge should be advised to work out salary scales, pension allowance, etc., competing with those in industry.

e) Authorities in charge of technical and vocational education - Co-ordination of efforts

Provincial autonomy in Canada creates a special situation and makes comparison with Denmark or some other European countries difficult. Discussion led to the conclusion that although a decentralisation is for several reasons advisable, the existence of a central co-ordinating authority is indispensable to ensure the requirements of sound educational policy at national level and the desirable standardisation of qualifications as a prerequisite for internal mobility.

f) Status of technicians and their careers

An examination of the information available led to the conclusion that at present two types of technicians exist in each country, i.e.:

(i) those classified as technicians by virtue of their educational qualifications;

(ii) those who, because of long experience and aptitude, perform the duties of technicians, regardless of their formal qualifications.

The latter category however was created in each case to meet the urgent requirements of the rapid industrial expansion with which the provision of educational facilities could not keep pace; this category is gradually fading out in both countries.

Discussion on the organisation and functions of technicians' professional associations led to the conclusion that the establishment of such associations should be encouraged, as they greatly contribute to the social recognition of the professional status of this category of skilled personnel. The successful example of Denmark should encourage other countries to proceed in the same direction.

Discussion on the earnings of technicians in industry revealed that these largely depend on the personal ability of the individual and in some cases are higher than those of the professional engineers.

The limited possibilities existing in the two countries for promotion from skilled worker to Junior Technician to Senior Technician was shown to be a feature of the present situation. However, in Denmark, it appears that Teknikum Engineers have many more opportunities as compared to their Canadian counterparts (technologists) to undertake managerial or technical jobs, normally requiring an engineering degree in industry.

It is recommended that promotion from one skilled category to another through further studies be encouraged and facilitated through inter-relating the structure and content of the training programmes. However, it should always be kept in mind that training for each skilled category is an entity in itself and cannot be regarded as part of another; consequently, unnecessary distortion of training programmes, for the sake of continuity and transferability should definitely be avoided.

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g) Availability of statistical data

In both countries the availability of statistical data enabling the planning and implementation of technician training programmes is inadequate or does not exist at all. It was decided that efforts should be made to secure such data mainly based on the real needs of industry and not on the available capacity of the educational establishments. However, one of the main difficulties in estimating the needs of industry in skilled manpower was the hesitation of industry itself to make any firm statement as regards future needs; research and development services were usually found to be more reliable sources for such information.

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