

HISTORY OF HYDRAULIC ENGINEERING EDUCATION

In Commemoration of the Bicentenary of Training Hydraulic Engineers in Hungary

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INSTITUTUM GEOMETRICUM, a unit organized in 1782 within the *University of Sciences* seated in *Buda*, and resettled in 1784 to *Pest*, had been the first all over the world to graduate *civil engineers*, in particular, *surveying and hydraulic engineers*, and to issue certificates thereof.

Recapitulation of some particulars of the development of hydraulic engineering subjects will refer to the following dates:

- 1782—1850 *Institutum Geometricum*
- 1846—1856 *Joseph Technical School*
- 1850 *Institutum* merging with *Technical School*
- 1856—1934 *Joseph Technical University* (JME)
- 1878—1879 *Independent Department of Hydraulic Engineering*
- 1934—1948 *Palatine Joseph Technical and Economical University* (JMGE)
- 1942 *Department of Hydraulic Engineering II*
- 1948—1952 *Technical University, Budapest* (BME)
- 1952—1955 *Technical University of Building* (ÉME)
- 1955—1967 *Technical University of Building and Transport Engineering* (ÉKME)
- 1963 *Department of Water Management*
Department of Hydraulic Engineering
- 1967 *Technical University, Budapest* reunited
- 1971 *Institute for Water Management and Hydraulic Engineering*
- 1971 *Section of Water Supply and Canalization*
Hydraulic Laboratory.

Development of subjects **Hydrology** and **Hydrometry** fits that of the University, best seen by textbooks and notebooks¹⁻¹⁶.

¹ HADALY, K.: *Elementa hydrotechniae quae in usum suorum elucubratus est.* — 2nd edition Pozsony, 116 pp. + 2 tables, 7th edition Buda, 1821.

² RAUSCH, F.: *Compendium hydrotechnicum cum tabulis aeneis VI.* — Pest, 1797.

³ PETZELT, J.: *Lectures at the Engineering Institute of the Hung. Roy. University of Sciences in Hydraulics, Hydrometry, Hydraulic Engineering and Mill Construction.** Lithograph, Pest, 1846/47, 990 pp. + 4 tables, 564 figures.

From the late 18th to mid-19th century, hydrology had been focussed on big watercourses^{1,2,3}. In the late 19th century, the program of lectures on "Agricultural Hydrology" by B. GONDA (Annals of JME, 1880/81) points to the recognition of the importance — beyond of big watercourses — of small watercourses, brooks, hydrology-type sources, different-type still-waters (marshlands, moors, lakes), and finally of ground-water balance determining surface and subsurface hydrological and hydrogeological conditions. Ö. BOGDÁNYFY was the first to systematize the subject "Hydrology"^{4,5}. Later S. ROHRINGER⁶ made hydraulic analyses to determine the process of surface water accumulation. An up-to-date, comprehensive treatment has been devoted to hydrology and hydrometry problems^{7,9,12,14,15} as well as on problems of sediment motion¹⁰.

GY. SZILÁGYI⁸ did pioneering work in applying probability calculus including mathematical statistics, and so did W. LÁSZLÓFFY¹¹, and also the mentioned lecturers on hydrology completed thereby their notebooks. Recently, J. REIMANN¹³ examined the theory of probability from the aspect of hydrology. Of course, latest probability analysis underlies hydrology calculations¹⁶.

Development of hydrometric gauging exercises as a means to acquire the subject matter of hydrology under natural conditions is internationally instructive. River gauging exercises on the *Danube* look back to 160 years, to 1842 as read in the recently published diary of GARZÓ [3] from the past century. Danube exercises had several sites (*Vác, Óbuda, Nagytétény* etc.), and since Professor PETZELT considered more instructive for the students to gauge smaller rivers so he led his pupils to the river *Ipoly*. Systematic gauging exer-

⁴ BOGDÁNYFY, Ö.: Hydraulic Engineering, in Particular under Hungarian Conditions. I. Hydrology*. Publishing House of the Society of Hungarian Engineers and Architects, Budapest, 1901, 165 pp.

⁵ BOGDÁNYFY, Ö.: Hydraulics of Natural Watercourses*. Edited by the Author sponsored by the Hungarian Academy of Sciences, Budapest, 1906, Vol. I, 285 pp., Vol. II, 294 pp.

⁶ ROHRINGER, S.: Hydraulic Computations*. Manual, Budapest, 1926, 184 pp. + 1 table.

⁷ NÉMETH, E.: Hydrology and Hydrometry*. Notebook, Budapest, 1944, 185 pp.

⁸ SZILÁGYI, GY.: Mathematical Statistics in Engineering Practice, in Particular, in Hydrology Research*. Notebook, Budapest, 1953, 155 pp.

⁹ NÉMETH, E.: Hydrology and Hydrometry*. Budapest, 1954, 662 pp. and 85 photos.

¹⁰ BOGÁRDI, J.: Theory of Sediment Motion*. Budapest, 1955, 547 pp.

¹¹ LÁSZLÓFFY, W.: Chapters on Hydrology (for 4th-year Students in Hydraulic Engineering)* Budapest, 1953, 187 pp.

¹² V. NAGY, I.: Hydrology*. Notebook, Budapest, Vol. I, 1968, 283 pp., Vol. II, 1974, 374 pp., Vol. III, 1974, 352 pp.

¹³ REIMANN, J.: Probability Theory*. Notebook, Budapest, 1976, 312 pp.

¹⁴ V. NAGY, I.: Hydrology I. (Physical Hydrology)*. Notebook, Budapest, 1977, 279 pp.

¹⁵ V. NAGY, I. & al.: Hydrometry*. Notebook, Budapest, 1979, 263 pp.

¹⁶ KONTUR, I. — KÓRIS, K. — WINTER, J.: Hydrological Computations I—II.* Notebook, Budapest, 1980, 684 pp.

* Self-intended, the language of instruction is Hungarian, and so is that of textbooks and notebooks, translated here to English for convenience, except the first few ones in Latin.

cises were made at *Szob* on the *Danube* since 1883, while the first university hydrometrical gauging station (to my knowledge) all over the world has been that at *Nagyvaros* on the *Danube* where ground and premises were purchased by the Technical University in 1894.

Gauging exercises have been extended on small watercourses (brooks of *Óbuda* and *Visegrád*) assisted by notebooks¹⁷.

An important part of hydrology is hydrometeorology, another subject matter of important development. The already quoted program of B. CONDA (JME, 1880/81) dating from more than a century ago, includes several of such details, to be considered therefore the beginning of hydrometeorological education in this country. Since then, every lecturer on hydrology has been laying much stress on this discipline. Let it be mentioned that the Author delivered four courses in hydrometeorology — in academic years 1953/54, 1979, 1980 and 1981 — to students of the *Eötvös Loránd University of Sciences*. Again, the Author lectured on hydrology and meteorology problems of agricultural water management (in strict relation to agrometeorology) as an “optional mandatory subject” for students in geography at the *Eötvös Loránd University of Sciences* for about ten years in the last two decades. At present hydrology is a mandatory subject for certain students in geography.

Let us consider the development of some further accessory priming subjects related to hydrology.

Education in hydrobiology dates back to the '20s when G. ENTZ, Jr. delivered this subject in two terms, according to the following sketchy program (JME, 1918/19): “Position of hydrobiology among disciplines, its history, devices, tools. Fundamentals of water ecology. Classification of waters from the aspect of biology. Plankton, benton etc. Systematic presentation of organisms of importance in hydrobiology, from protozoans to fishes.” Later (JME 1930/31) the subject was extended: “Hydrobiology and fish breeding”. But for a long time it was not lectured on as an independent subject but only as an important part of “Canalization and Water Supply” though ever growing in significance so that actually special exercises are spent on it¹⁸.

Education in hydrogeology¹⁹⁻²¹ is strictly related to that in hydraulic engineering within the subject “Geology”. The first lectures were delivered by F. SCHAFARZIK, in academic years from 1891/92 to 1894/95, under the title: “Selected chapters of engineering geology (springs, wells, artesian wells)” (JME, 1891/92): “Springs, groundwater, ordinary and artesian wells, well-sinking. Artesian well boring. Normal boring with a hand borer, boring with gravity borer, rope boring, sludger boring, diamond borers.” Since then, lectures by F. SCHAFARZIK,

¹⁷ KÓRIS, K. — WINTER, J.: Hydrological Measurement Exercises*. Notebook, Budapest, 1979, 185 pp.

¹⁸ ÖLLÖS, G. (editor), KOLLÁR, GY. & al.: Chemistry and Biology of Water Supply and Canalization, Exercises.* Notebook, Budapest, 1978, 280 pp.

A. VENDL¹⁹ (1951/52), F. PAPP, J. MEISEL laid much stress on hydrology. F. SCHAFARZIK completed the subject matter with the examination of subsurface waters (groundwater, deep water) of Budapest; A. VENDL with the bitter waters of Buda, F. PAPP with problems and results of spring finding, Danube fugitive sources, research problems and results of karstic waters, and classification of sources. F. PAPP did pioneering, and at the same time rather efficient, work in realizing the *Vas Imre Karstic Water Research Station* in *Jósvafő*, inaugurated by himself and the rector of this university on 7.11.1957, granting hydrology a score of new scientific research results by making observations with the participation of students in the pertaining *Vas Imre karstic cavern* 1 km long, and in the "Lófő" siphon source. (Actually this research belongs to VITUKI but it has ever been managed by L. MAUCHA.) Education in geology and in hydrology has been integrated by geological study tours²⁰. Here it should be mentioned the introduction of education in engineering geology urged by F. PAPP²¹. Education in hydrogeology was much influenced by engineering geology delivered by S. VITÁLIS at the *Eötvös Loránd University of Sciences*. Actually the centre of education in hydrogeology is at the *Technical University of Heavy Industry, Miskolc*²².

Education in geology is paralleled by that in pedology²²⁻²⁶ introduced by the group of pedology at the Department of Agricultural Chemical Technology, Faculty of Chemical Engineering, and its internationally renown head, E. 'SIGMOND. Pedology was delivered to civil engineering students in section C, hydraulic engineering in 1929/30 (E. 'SIGMOND, R. BALLENEGGER). Becoming independent in 1942, the Department of Pedology headed by L. MADOS contributed to the science of pedology mainly by groundwater balance investigations. After the liberation the department was transferred to agricultural high schools and this subject was delivered either by non-university lecturers or by other departments of this University (Department of Mineralogy and Geology^{23,24}). Later this subject merged with subjects "agriculture", then "agricultural water management" to become recently an independent subject partly in specialist engineering education, and partly, curious enough, in geodesy and surveying education²⁵. Pedologic effect of soil cultivating machinery is given a comprehensive analysis²⁶ at the Department of Agricultural Machinery delivering post-graduate courses.

¹⁹ VENDL, A.: Geology I—II.* Budapest, 1951—52, 1326 pp.

²⁰ SCHAFARZIK, F.—VENDL, A.—PAPP, F.: Geological Excursions*. Budapest, 1964, 295 pp.

²¹ MOSONYI, E.—PAPP, F.: Engineering Geology*. Budapest, 1959, 617 pp.

²² JUHÁSZ, J.: Hydrogeology*. Budapest, 1976, 767 pp.

²³ FEKETE, Z.: Pedology*. Budapest, 1952, 410 pp.

²⁴ FEKETE, Z.—HARGITAI, L.—ZSOLDOS, L.: Pedology and Agrochemistry*. Budapest, 1967, 426 pp.

²⁵ VÁS, K.: Pedology (for Geodesists)* Notebook, Budapest, 1974, 135 pp.

²⁶ KÉGL, L.: Recapitulation of Pedology Fundamentals from the Aspect of Cultivators.* Institute of Post-Graduate Engineering Education, No. 2847, Notebook, Budapest, 1954, 109 pp.

Some chapters of **hydrochemistry** have been incorporated into the curriculum of Water Supply, Canalization. As early as in 1880/81, the program of lectures by B. GONDA refers to "... quality and temperature of irrigation water ...". The 1906/07 program of lectures by I. FORBÁTH specially mentions "the water quality". After the liberation, the subject "Water chemistry" was delivered and developed by Sz. PAPP. At present it is an important chapter in "Water Supply, Canalization" unfolded in a special exercise notebook¹⁸. A special laboratory of hydrobiology and hydrochemistry was equipped for exercises and research in 1967.

Another subject belonging to fundamental sciences is **hydraulics, hydro-mechanics**²⁷⁻⁴⁸ comprising statics and dynamics. The education in hydraulics arose even before that in hydrology. Hydraulics was delivered already at e.g. the *Nagyszombat University* by J. IVANCSICS in 1752, and at the *Mining Academy of Selmec* by M. BODA. Later, at the Institutum Geometricum, "Hydraulics" was an important chapter³.

It is worth mentioning that Á. JEDLIK, applying for teachership about 1830, composed a notebook on Hydraulics²⁷ preserved as manuscript. First comprehensive treatment of hydraulics was due to I. HORVÁTH, academician, who at his untimely death passed down all his wealth to the University to open yearly alternating competitions in mechanics and in hydraulics for university students to be rewarded from the interests. After him, hydrodynamics was for a short time delivered by K. SZILY, Sr. (1883/84), followed by D. BÁNKI under the denomination "Practical Hydraulics" as part of "Hydraulic Machines"²⁸, and further developed as "Hydraulic Engineering" by Ö. BOGDÁNFY^{29, 5}. Subsequently it gets to departments delivering marginal sciences such as Department of Hydraulic Machines (D. BÁNKI after 1899)^{30, 31} where hydraulics and aerodynamics had been lectured on by K. FÉNYES and M. TREER, respectively; Department of Fluid Mechanics³² as well as to the actual *University of Wood Industry and Forestry* and its legal predecessor^{33, 34, 35, 36, 37, 38}. Direct

²⁷ JEDLIK, Á.: Hidraulica. Remains in manuscript, Pozsony, early 1830s.

²⁸ BÁNKI, D.: Practical Hydraulics*. Lithographed notebook, Budapest, late 19th century, 160 pp.

²⁹ BOGDÁNFY, Ö.: Hydraulics*. Edited by the Author, sponsored by the Hungarian Academy of Sciences, Budapest, 1904, 417 pp.

³⁰ SASVÁRI, G.: Hydromechanics*. Budapest, 1925, 354 pp.

³¹ PATTANTYÚS-ÁBRAHÁM, G.: Practical Hydrodynamics*. Budapest, 1951, 280 pp.

³² GRUBER, J.—BLAHÓ, M.: Fluid Mechanics*. Budapest, 1952. (about 300 pp.)

³³ KÖVESI, A.: Mechanics I—II. (Fluid Dynamics)* Notebook, Sopron, 1922.

³⁴ KÖVESI, A.: Hydraulics*. Budapest, 1946, about 260 pp.

³⁵ KÖVESI, A.: Mechanics III. (Hydrostatics and Hydrodynamics)*. Notebook, Sopron 1950.

³⁶ KÖVESI, A.: Engineering Hydraulics, with Practical Fluid Dynamics (for Students in Forestry Engineering)*. Notebook, Budapest, 1953, 340 pp.

³⁷ SZILÁGYI, GY.—KOVÁCS, GY.—KÁRÁDI G.: Hydraulics*. Budapest, 1950, 100 pp. + 6 tables.

³⁸ NÉMETH, E.—SALAMIN, P.: Hydromechanics*. Budapest, 1951. 167 pp.

education in hydraulics of civil engineers, and later, of specialized hydraulic engineers relied on textbooks and notebooks^{39, 40, 41, 42, 43, 44, 46, 48}. Practical work in hydraulics was offered by non-mandatory, optional "Exercises in Hydromechanics" offered by the Author in the '60s^{6, 37-47}. Education in hydraulics has been considered to be much facilitated by a *laboratory for hydraulics*. The review "Társalkodó" was the first to suggest establishment of a laboratory of hydraulics in 1843 (probably due to Prof. J. PETZELT). Though, the first hydraulic laboratory was established by the Department of Hydraulic Machines (D. BÁNKI, 1909), rather than by that of Hydraulic Engineering; the first laboratory of the Department of Hydraulic Engineering was established by S. ROHRINGER in 1926, featuring a glass canal, mainly for the examination of hydraulic engineering structures. In 1941, the Department of Fluid Mechanics set the first wind tunnel of the aerodynamic laboratory, affine to the hydraulic laboratory, going, and it was J. SZILY who in 1941 developed the hydraulic laboratory of the Department of Hydraulic Engineering II, primarily for river regulation, at last, in 1953, E. NÉMETH established an open-air hydraulic laboratory in Nagymaros for irrigation and water purification research. This laboratory ranks internationally high among those of technical high schools and universities, with its discharge of about 500 litres/sec. Last but not least, in 1971, date of organization of the Institute of Water Management and Hydraulic Engineering, laboratories of the two "water" departments united to an independent Hydraulic Laboratory. (By the way, the staff of the two hydraulic departments made the first sketches, under the guidance of the AUTHOR and Gy. KOVÁCS, of the Hydraulic Laboratory of VITUKI, founded in 1955 and operating since then.)

Knowledge matters of agriculture and forestry⁴⁸⁻⁵⁷ have to be mentioned as auxiliary sciences of water management. At its foundation, the Institutum comprised the department organized in 1777 of L. MITTERPACHER, who authored a very high-niveau textbook⁴⁸ published in seven editions. Already at the JME, L. ZÓLYOMI-WÁGNER developed this subject to a high perfection. J. KVASSAY was concerned in his book⁴⁹ with the forwarding of civil engineering

³⁹ MOSONYI, E. — KARÁDI, G.: Hydraulics I*. Budapest, 1955, 184 pp.

⁴⁰ KOZÁK, M.: Hydraulics*. Budapest, 1961, 339 pp.

⁴¹ NÉMETH, E.: Hydromechanics*. Budapest, 1963, 883 pp.

⁴² HASZPRA, O.: Hydromechanics (for the Speciality of Hydraulic Engineering)* Notebook, Budapest, 1965, 116 pp.

⁴³ BOGÁRDI, J.: Hydromechanics*. Notebook, Budapest, 1976, 547 pp.

⁴⁴ BOGÁRDI, J. — KOZÁK, M.: Hydraulics I — II*. Notebook, Budapest, 1976 — 77, 687 pp.

⁴⁵ HASZPRA, O.: Hydromechanics and Hydraulics*. Notebook, Budapest, 1982.

⁴⁶ KOZÁK, M.: Thesaurus of Examples in Hydraulics*. Notebook, Budapest, 1977, 205 pp.

⁴⁷ SZILY, J.: The Hydraulic Engineering Laboratory and the Model Tests*. Budapest, 1939, 98 pp.

⁴⁸ MITTERPACHER, L.: Elementa Rusticae in usum Academicarum Regni Hungariae. — Pest (previously Buda) 1779 — 1794, last edition 1816.

⁴⁹ KVASSAY, J.: Agricultural Hydraulics*. Ráth Publisher, Budapest, I. Technical Part, 1882, 315 pp. II. Agricultural Part, 1880, 406 pp.

education. In the '20s, an agricultural encyclopedy was delivered by R. KÁROLY. Thereafter for some time, chapters of these sciences were comprised in the subject Hydraulic Engineering II. For some years after the liberation, "Agriculture" was an independent subject^{50, 51, 52}, to be partly embraced by agricultural water management. It remained an independent subject of specialized engineering education, and curiously, an independent subject is "Forestry and Agriculture" for students in geodesy^{53, 54}.

Let us have a look now at the development of the principal hydraulic engineering subjects, beginning with "Agricultural Water Management" (water regulation and utilization in agriculture), a subject also delivered at universities and high schools of agriculture and the *University of Horticulture*^{55, 56, 57}.

Traces of delivering agricultural water regulation (concerned with marsh drainage) appear as early as by the end of the 18th century^{1, 2}, the trend being the same by the mid-19th century³. A real development starts in the second half of the 19th century. The program of lectures by B. GONDA (JME, 1880/81) — that still would count as up-to-date, except for the lack of mathematical tools, computers, — in addition to the drainage of marshlands and lakes, features regulation of mountain streams and drainage. By the way, although streams are linear hence belong to the subject on watercourses, but if present at a high density, they cannot be detached from the concerned area, placing them with the agricultural water management of rather areal character⁴⁹. Within the subjects "Hydraulic Engineering" I and II, small watercourses have been dealt with⁵⁸⁻⁶⁴, with reference to other problems of watercourse regulation.

⁵⁰ HAJAS, J.: Agriculture*. Budapest, 1951, 132 pp.

⁵¹ ALCSEI, J.: Agriculture*. Institute of Post-Graduate Engineering Education, Budapest, 1961, 121 pp.

⁵² PETRASOVITS, I.: Knowledge in Agriculture*. Notebook, Budapest, 1966, 165 pp.

⁵³ VAS, K.: Knowledge in Forestry (for Geodesists)*. Notebook, Budapest, 1969, 122 pp.

⁵⁴ VAS, K.: Knowledge in Agriculture (for Geodesists)*. Notebook, Budapest, 1976, 136 pp.

⁵⁵ PETRASOVITS, I.: Ecology and Agricultural Water Management*. Manuscript, specialist engineering notebook, Gödöllő, 1981, 303 pp.

⁵⁶ SZALAI, GY.: Agricultural Technique I—II. Agricultural Water Management*. Notebook, Gödöllő, 1958/59.

⁵⁷ OROSZLÁNY, I.: Water Management in Agriculture*. Budapest, 1965, 318 pp.

⁵⁸ SZLÁVIK, I. (After Lectures by KOVÁCH-SEBESTYÉN, A.): Hydraulic Engineering*. Lithograph, Budapest, 1902/03.

⁵⁹ NÉMETH, E.: Hydraulic Problems in Up-to-Date Agriculture*. Notebook, Institute of Post-Graduate Engineering Education I/5, Budapest, 1942, 136 pp.

⁶⁰ NÉMETH, E. & al.: Agricultural Water Management*. Notebook, Budapest, 1951, 618 pp.

⁶¹ NÉMETH, E.—DOBOS, A.: Agricultural Water Utilization II*. Budapest, 1955.

⁶² SALAMIN, P.: Agricultural Water Management I—II*. Notebook, Budapest, 1966, 532 pp.

⁶³ SALAMIN, P.: Agricultural Water Management III/A*. Notebook, Budapest, 1969, 166 pp.

⁶⁴ LIPTÁK, F.: Agricultural Hydraulic Engineering 1. Water Regulations*. Budapest, 1980, 314 pp.

This scope has much been forwarded at the *University of Wood Industry and Forestry*, and its legal predecessor, in particular, regulation of mountain streams and binding of gullies. The term „inland drainage” is first encountered in the lecture program of S. ROHRINGER, and much of its development is due to notebooks⁵⁹⁻⁶⁴ and where the idea of terrain regulation against soil erosion appears, but SALAMIN⁶²⁻⁶³ is the first to be concerned with protection against erosion in itself. (Let us mention that — according to the inaugural speech of rector G. SZABÓ — in the '40s E. KUND at this Department had great merits in forwarding terracing.) Recently, an independent chapter⁶⁴ has been spent on the relationship between water regulation and environmental engineering.

Agricultural water utilization⁵⁸⁻⁶⁵ (irrigation, fishpond management, etc.) is first encountered early in the 19th century¹. Subchapter “Construction of water utilization objects”³ discusses “Irrigation objects”. For a comprehensive discussion of irrigation let us refer again to the lecture program of B. GONDA (1880/81) embracing even “technical and sanitary problems of irrigation with sewage water”. Civil engineering education has been rather effective also in this field⁴⁹. Thereafter, irrigation is discussed within the subject “Hydraulic Engineering II”⁵⁹⁻⁶¹. Subsequent education lays much stress on irrigation⁶²⁻⁶³ but up-to-date theoretical foundations are due to A. DOBOS⁶⁵. A. KOVÁCH-SEBESTYÉN⁶⁹ was the first to be concerned with fishpond management within the subject “Hydraulic Engineering II” according to his program in JME 1908/09 that belonged to it thereafter, and was further developed by E. NÉMETH⁶⁰ who was a practicing engineer partly in fishpond management, and partly, at the Office of Irrigation.

Education in linear water management⁶⁶⁻⁷⁰ (subject „Watercourses”) in particular, river regulation, flood control, anti-inundation, looks back to the foundation of the Institutum^{1,2,3,67}. Later it occurs also in the lectures by J. SCHNEDÁR on road and hydraulic engineering, and in the lecture program of B. GONDA (“River regulation. Crosscuts. Afforestation of flood plains. Embankments. Bank reinforcement. Dykes. Spurs. Weirs. Sluices, bridges. Syphons and aqueducts. Flood plain survey”) to be partly incorporated in “Hydraulic Engineering II” and partly into “Hydraulic Engineering I”⁶ still improved after the liberation⁶⁸⁻⁷⁰.

The subject “Watercourses” is strictly related to that of navigation. Its first traces appear in the early period of the Institutum^{1,3}, but also SCHNE-

⁶⁵ FEKETE, I.—DOBOS, A.: Agricultural and Engineering Design of Irrigation*. Budapest, 1972, 422 pp.

⁶⁶ PETZVAL, O.: Hydraulic Engineering (Hydrotechnique)*. Lithographed notebook, Pest, 1850, 266 pp.

⁶⁷ HUSZÁR, I.: Hydraulic Engineering, I*. Multiplied notebook, Budapest, 1920, 264 pp.

⁶⁸ BÖZSÖNY, D.: Watercourse Regulation*. Notebook, Budapest, 1959, 317 pp.

⁶⁹ KERTAY, E.: Watercourses III*. Budapest, 1968, 456 pp. + XV Annexes.

⁷⁰ KOZÁK, M.—SABATHIEL, J.: Regulation and Utilization of Watercourses, I—II*. Notebook, Budapest, Vol. I. 1974, 273 pp., Vol. II. 1975, 310 pp.

DÁR was concerned with it (e.g. JME 1860/61). Subsequently, it became part of subjects "Hydraulic Engineering I and II"^{6,58,67}. The recent development of this subject is rather promising⁶⁹.

Education in Watercourses has that in **Hydraulic Engineering Structures** as natural concomitant since the early beginnings^{1,3,66}, then in lecture programs of B. GONDA, M. KLIMM, A. KOVÁCH-SEBESTYÉN, J. WEISSMAHR, S. ROHRINGER.

This period is featured by the activity of Prof. SZ. ZIELINSZKY who introduced reinforced concrete structured hydraulic objects, first of all, water towers such as that on the *Margaret island (Budapest)*, but he also designed sluices etc. It occurs as an independent subject in notebooks^{71,72}, interestingly complemented⁷³. Let us mention that the subject "Foundations" was long delivered in the frames of hydraulic engineering^{3,66}, later within the subject "Hydraulic Engineering I". After World War I, a notebook was written on "Foundations" for returning soldiers becoming students⁷⁴.

After the redivisions in 1929/30, in the mid-'40s, students in hydraulic engineering attended lessons of J. JÁKY in soil mechanics, and with the establishment of the predecessor of the actual Department of Geotechnique (1942), the subject "Foundations" got detached from hydraulic engineering. Education in "Foundations" and its auxiliary subjects "Soil Mechanics" and "Earthworks" may be acquainted with from notebooks and textbooks⁷⁵⁻⁷⁹.

Education in water power utilization looks back to the mid-19th century³, in particular, its initial stage, the water mills, as an item in "construction for utilizing water power". Besides of a book on water power published early in this century⁸⁰, S. ROHRINGER was the first to indicate this subject in his program of lectures: "III. Utilization of water: . . . Low and high-pressure hydraulic power plants". The same subject was lectured on by E. NÉMETH, and developed beyond its significance in this country by E. MOSONYI⁸¹. Recently, the subject matter of "Water Power Utilization" has been discussed⁶⁹ in conformity with Hungarian practice.

In connection with hydraulic engineering structures and water power utilization, the subject „**Hydraulic Machines**” generally lectured on by the

⁷¹ MOSONYI, E.: Hydraulic Engineering Objects*. Notebook, Budapest, 1956, 396 pp.

⁷² KOZÁK, M. & al.: Hydraulic Engineering Structures*. Notebook, Budapest, 1978, 493 pp.

⁷³ KOZÁK, M.: Mistakes in Hydraulic Engineering*. Notebook, Budapest, 1972, 203 pp.

⁷⁴ PÓKA, D.: Foundations (based on lectures by KOVÁCH-SEBESTYÉN, A. and WEISSMAHR J.)* Notebook, Budapest, 1920, 100 pp.

⁷⁵ KÉZDI, Á.: Soil Mechanics I*. 1st Edition 1954, 2nd Edition 1969, 499 pp.

⁷⁶ KÉZDI, Á.: Soil Mechanics II*. 1st Edition 1956, 2nd Edition 1970, 515 pp. Budapest.

⁷⁷ KÉZDI, Á.: Soil Mechanics I*. Budapest, 1966, 275 pp.

⁷⁸ KÉZDI, Á.: Earthworks*. Notebook, Budapest, 1966, 368 pp.

⁷⁹ SZÉCHY, K.: Foundations*. Notebook, Budapest, 1966, 459 pp.

⁸⁰ BOGDÁNYI, Ö.: Water Power, Engineering Manual*. Edited by the Society of Hungarian Engineers and Architects, Budapest, 1914, Vol. I. 578 pp., Vol. II. 345 pp.

⁸¹ MOSONYI, E.: Water Power Utilization I—II*. Budapest, 1952—53, 764 pp.

staff of the Department of Hydraulic Machines has to be mentioned. As early as between 1774 and 1792, Professor I. HORVÁTH lectured on machines driven by water and air at the *University of Sciences*. Also the program of B. GONDA includes "Water-raising engines and their comparison". Development of the subject and the department is due to D. BÁNKI, A. DOBOS at the Department of Hydraulic Engineering I elaborated pump peculiarities in connection with plants incorporating them⁶¹. Actual education of students in hydraulic engineering relies on two textbooks in this scope^{62, 63}.

As to the development of **Water Supply — Canalization**⁶⁴⁻⁶⁸, the third main subject, one of the first notebooks³ contained relevant items such as "Constructions for water utilization. (Rainwater tanks, . . . drainage of sewage from streets and homes, canals for floating manure . . .)". Let us refer to the sewage disposal by irrigation in the program of B. GONDA. The 1900/01 program of I. PFEIFER in the subject "Water Technology" (Composition of natural waters. Water use in industry. Examination of boiler feed waters. Chemical and mechanical water purification. Preheaters. Desilters. Surface condensers. Water purification equipment. Checking of water purification plants. Valuation of drinking water. Sewage purification) suggests this subject to be the predecessor of the actual subject "Industrial Water Supply and Sewage Purification". The *de facto* beginning of lecturing on Water Supply—Canalization as an independent subject may be put to early in this century. For years, I. FORBÁTH lectured on "Urban Water Supply" and "Urban Canalization", subjects in the scope of "Hydraulic Engineering II" since the organization of an independent Department of Hydraulic Engineering (M. KLIMM, A. KOVÁCH-SEBESTYÉN, J. WEISSMAHR and S. ROHRINGER). Recent conditions are reflected in textbooks^{64, 65, 66}. The subject boomed with the organization of the independent Section of Water Supply and Canalization (1971)^{67, 68}.

I. DÉGEN^{69, 90} was the first to deliver unified bases of **water management including water resources management**.

Impartment of the subject matter of **water rights** starts with the multifaceted "Agricultural Hydrology" (1880/81. III. Legal aspects). Later it is

⁶² FÜZY, O.: Hydraulic Machines*. Budapest, 1953, 464 pp.

⁶³ VERBA, A.: Hydraulic Machines*. Notebook, Budapest, 1970, 227 pp.

⁶⁴ NÉMETH, E. & al.: Canalization and Sewage Purification. Notebook, Budapest, 1955, 165 pp.

⁶⁵ NÉMETH, E.: Drinking Water Supply*. Notebook, Budapest, 1974, 294 pp.

⁶⁶ BORSOS, J.—SALAMIN, P.: Water Supply—Canalization*. Notebook, Budapest, 1967, 440 pp.

⁶⁷ ÖLLÖS, G.: Water Supply—Canalization II*. Notebook, Budapest, 3rd reprint without alteration) 1974, 294 pp.

⁶⁸ ÖLLÖS, G.—BORSOS, J.: Water Supply—Canalization I*. Notebook, Budapest, 1979, 9th reprint, 606 pp.

⁶⁹ DÉGEN, I.: Water Management, I. Economical Fundamentals of Water Management*. Budapest, 1972, 580 pp.

⁹⁰ DÉGEN, I.: Water Management II. Management of Water Resources*. Budapest, 1972, 251 pp.

delivered as an independent subject by Prof. K. CSIKY (1890/91): "The Law on Water Rights, By-Law on Boat Mills" and by A. KOVÁCH-SEBESTYÉN under the heading "Water Rights and Water Service" (e.g. in 1918/19). This problematic has recently been discussed^{89,90}.

Latest curricula stress computer methods^{91, 92, 93}.

Last but not least, let us consider some accessory education problems.

After the specialization introduced in 1929/30, the civil engineering students in hydraulic engineering, so-called section C, elaborated a subject independently, as an attempt of scientific elaboration, in the framework of „Hydraulic Engineering Seminary" a subject to be considered the beginnings of the work in the *Scientific Students' Circle*, with a view on the mentioned *I. Horváth award* (integrated by the Test Report of *students' independent hydraulic tests* directed by J. SZILY).

A special problem has been *to impart hydraulic engineering knowledge to other than hydraulic engineering students*. To this aim, independent subject matters have been developed and notebooks written for each of the other three specializations: for *geodesists*^{94, 95, 96}; for *structural engineers*^{97, 98, 99, 100}; and for *road and railway engineers*^{101, 102, 103}.

The *design work*, of outstanding importance at this University, is helped by *Aids, Guides, Directives* such as: in *agricultural water management*^{104, 105}; in

⁹¹ KOZÁK, M. & al.: Computer Technique*. Notebook, Budapest, 1972, 203 pp.

⁹² IJJAS, I.: Computer Technique*. Notebook, Budapest, 1981, 217 pp.

⁹³ IJJAS, I. & al.: Agricultural Hydraulic Engineering. Aid for Computerized... Notebook, Budapest, 1981, 376 pp.

⁹⁴ BOZÓKY-SZESZICH, K.: Hydraulic Engineering Knowledge I—II. (For Geodesists)*. Budapest, 1966—67, 302 + 284 pp.

⁹⁵ WINTER, J.—DÁVID, M.: Hydraulic Engineering I. (For Geodesists)*. Notebook, Budapest, 1980, 248 pp.

⁹⁶ DÁVID, M.—WINTER, J.: Hydraulic Engineering II. (For Geodesists)*. Budapest, 1979, 281 pp.

⁹⁷ HASZPRA, O.—SABATHIEL, J.—KOVÁCS, M.: Hydraulic Engineering, Vol. I. (For the Civil Engineering Section of Structural Engineering)*. Notebook, Budapest 1966.

⁹⁸ PAPP, G.—KALINA, E.: Hydraulic Engineering Fundamentals (For Structural Engineers)*. Notebook, Budapest, 1977, 375 pp.

⁹⁹ HAMVAS, F.: Hydraulic Engineering I. (For Structural Engineers)*. Budapest, 1977, 236 pp.

¹⁰⁰ CSONGRÁDY, K.: Hydraulic Engineering II. (For Structural Engineers)*. Budapest, 1979, 159 pp.

¹⁰¹ SALAMIN, P.: Hydraulic Engineering I—II. (For Road and Railway Engineers)*. Notebook, Budapest, 1959, 557 pp.

¹⁰² SZOLNOKY, Cs.—FEKETE, A.: Fundamentals of Hydraulic Engineering (For Road and Railway Engineers)*. Notebook, Budapest, 1978, 447 pp.

¹⁰³ FEKETE, A.—SZOLNOKY, Cs.: Hydraulic Engineering. (For Road and Railway Engineers)*. Notebook, Budapest, 1978, 380 pp.

¹⁰⁴ LIPTÁK, F. (Editor) & al: Agricultural Water Management. Design Aid and Instructions*. Notebook, Budapest, 1966, 244 pp.

¹⁰⁵ MÉSZÁROS, Cs.: Agricultural Hydraulic Engineering, Water Utilization*. (Design Aid). Notebook, Budapest, 1977, 504 pp.

water supply and canalization¹⁰⁶; in *watercourses*,^{107,108}; for *structural engineers*¹⁰⁹; for *road and railway engineers*^{110,111}.

At last, the important development in subjects "Construction", "Building Mechanization" and "Site Management" with the establishment of the Department of Building Management and Organization (1951) must not be left unmentioned^{112,113,114}.

Summary

Hydraulic engineering education looks back to 200 years in Hungary, delivered first at the University of Sciences transferred by that time from Nagyszombat to Buda. Its home, the "Institutum" soon became independent and promoted to a higher educational institution, to be degraded to an industrial secondary school with adverse political events. Increasing importance of river regulation and similar works in this country forwarded its upswing and promotion to the rank of a university. Its subjects delivered by professors of renown multiplied — some of them belonging now to other universities — just as its departments. The relevant textbooks and notebooks are continuously updated.

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¹⁰⁶ ÖLLÖS, G. & al.: Water Supply and Canalization. (Design Aid)*. Notebook, Budapest, 1967, 460 pp.

¹⁰⁷ PAPP, G. — ANDORKÓ, S.: River Hydraulic Engineering. (Design Aid 1.) Regulation of Watercourses*. Notebook, Budapest, 1977, 149 pp.

¹⁰⁸ PAPP, G. & al.: River Hydraulic Engineering. (Design Aid 2.) River Dams*. Notebook, Budapest, 1980, 368 pp.

¹⁰⁹ HAMVAS, F.: Hydraulic Engineering Structures. (Design Aid)*. Budapest, in press.

¹¹⁰ SALAMIN, P. — DOBOS, A.: Hydraulic Engineering (Design Aid)*. Budapest, 1955, 192 pp.

¹¹¹ FEKETE, A. & al.: Hydraulic Engineering. (Design Aid). (For Road and Railway Engineers)*. Notebook, Budapest, 1975, 343 pp.

¹¹² MAURER, GY.: Building Organization. Peculiarities of Organizing Hydraulic Construction Sites*. Budapest, 1953, 101 pp.

¹¹³ MAURER GY.: Building Mechanization of Hydraulic Engineering Structures*. Budapest, 1953, 26 pp.

¹¹⁴ MAURER, GY.: Peculiarities of Organizing Hydraulic Constructions*. Budapest, 1954, 152 pp.

* In Hungarian