THE STATE AND PROGRESS OF TEACHING CHEMICAL ENGINEERING SCIENCES AT THE UNIVERSITIES OF SCIENCES IN HUNGARY*

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The history of sciences testifies that science have been born out of practical activity for meeting life's needs, their progress is controlled by the interests of society, and so are the aim and purport of university education. Just as science abstracted from experience of practical activity is incomplete without practical observations and the knowledge of production, the modern university education is unimaginable without an acquaintance with practical problems.

Education and research in chemistry booming early in the 20th century at the University of Sciences Budapest declined after World War I and its development was often due only to initiatives by individuals. Upon objective motivation namely the slow industrial development (based on coal) in the 1930s years, modernization of food industry, state control of industrial, alimentary and agricultural products professor Aladár Buzágh, world-famous colloid-chemist introduced lecturing on certain chapters of chemical technology in the frame of colloid chemistry about 1932. The lectures restricted to problems of some important branches of industry were completed two years later by laboratory exercises in technical analysis.

The conditions at both other universities of Debrecen and Szeged were even worse than those in Budapest. Also chemical education within the faculty of arts aimed mainly at training teachers of chemistry but many so-called free philosophers have graduated since 1940 in analytics and biochemistry at the Medico-Chemical Institute of Debrecen. Features of that region and personal ambitions of the director at that time are reflected in a few theses on agricultural chemistry, but the scarcity of jobs deterred from organized specialization in this field. The Szeged University of Sciences, legal successor of the Kolozsvár University, was inaugurated in 1921. The situation at the Szeged University was similar, except that here more chemical departments existed than in Debrecen, opening wider fields of specialization to

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applicants to doctor's degrees. The chemical doctors found employment mainly as researchers even in the industry.

Prior to 1945, the restrictions of cultural policy hindered the progress of teaching up-to-date natural sciences. The establishment of the people's democracy in 1949 brought about a crucial change. This is the year when the Faculty of Natural Sciences at the Budapest University has been organized, and the perspectives of industrial development — involving chemical industry — began to take shape.

The concepts of industrial development of the '50s were undoubtedly not flawless, all the same, they involved considerable development of the chemical industry and laid the bases of building chemical industrial plants and of organizing scientific research institutes. To meet the expected high need in specialists of the chemical industry a new, specialized university, the Veszprém University of Chemical Engineering has been established. The hitherto industry settlement policy injurious to the countryside (centered on Budapest) has been abandoned for settling chemical plants and industrial research institutes, even the new chemical university on the countryside (Veszprém).

One may meditate if the chemical education at the faculties of natural sciences of both universities in Debrecen and in Szeged has been organized to supply the new countryside chemical plants with chemists, i.e. if the real demographic problems have been considered or not, in fact, however, chemical staffs of the Chemical Works Sajóbábony, Pharmaceutical Works Tiszavasvári and Debrecen mostly comprise graduates from Debrecen after 1951, not only as laboratory research workers and developers, but also as higher technical managers and production leaders. Prosperity and development of these factories highlights the profound and convertible knowledge imparted the young chemists. At that time students in Debrecen were given lectures in two engineering subjects: machines for the chemical industry and chemical technology. These made up 13% of all the lessons, what is quite significant considering the total of 40 lessons per week. Until 1952, in lack of a department for chemical technology, the training of these subjects was directed by the Department of Organic Chemistry and lectured on by leading chemical engineers of various provincial chemical plants. The high professional standard by experienced teachers, the approach to industrial practice and the liking for practical work done for the welfare of the community were imparted by the rapidly developing industrial relations of the Department of Organic Chemistry. The Department of Applied Chemistry for teaching chemical technology was organized in Debrecen only in 1952/53 but even then, not in the best conditions, poorly equipped, imparting only quality test methods during five or six years, so that students got acquainted with the production process only through the product itself.

At the Szeged University, chemical education faced problems similar to those in Debrecen, except that here it already started in 1946 and because of the agrarian character of the region since 1947 organic and inorganic chemical technology were joined by the subject of agricultural chemical technology of a high number of lessons together with 15 lessons of laboratory exercises during two semesters each. Also technical analysis was included in the curriculum. In 1950/51 — sooner than in Debrecen — a new Department of Chemical Technology was organized, headed by professor Árpád Gerecs, for teaching the disciplines of industrial chemistry.

The Faculty of Natural Sciences in Budapest organized in 1949, delivered chemical technology in the frame of the colloid chemistry till 1952, when it became an independent discipline lectured on in the newly established Department of Chemical Technology directed by professor Vilmos Schermann. Already since 1950 machines for chemical industry has been included and gradually improved, especially after 1955, due to the developing and organizing activity of professor Árpád Gerecs. Since 1965 a new subject "chemical machines and unit operations" has been discussing also the theoretical bases of unit operations.

Up to 1961 the subject-matter of education at the three universities was similar but not identical, due to different personal and financial conditions. Their chemist graduates mainly found employment at industrial plants, inducing the university to improve the methods of teaching chemical engineering sciences and to better utilize the time at disposal. To meet higher professional and educational requirements, in 1954 the Ministry of Education raised the compulsory study time from eight to nine, and in 1957 to ten semesters. This longer study time permitted to increase longer the number of lessons in technology exercises and lectures, too.

The educational reform in 1961 elaborated by the Ministry of Education prescribed a new compulsory program and curricula, further refining the education in chemical engineering subjects, righteously introducing the subject "technical drawing" and "machine elements", while being wrong in reducing the subject "unit operations" to the benefit of "chemical technology". The curriculum specified as much as 19 lessons of laboratory exercises in chemical technology during three semesters. Problems arose both from the decrease of lessons spent on the subject "unit operations", and from the lack of financial means for the efficient utilization of the increased number of lessons for exercises.

The 1964 reform results partly in facilitation, partly in new difficulties. This new curriculum includes four subjects in a better ratio for improving professional knowledge and engineering approach in students. The change provides for the increase of lessons in technical drawing, in machine elements and in unit operations to the detriment of lectures and exercises in chemical

technology. Unfortunately, the total of lessons decreases, in spite of the insertion of a new subject "fundamentals of chemical industrial production" concerned with the organization and operation of, and correct attitude to chemical plants, to form a good technical-economical approach. The three universities are, however, not prepared for this kind of subjects, the program of lectures are completed later, to be launched in Debrecen as late as in 1967. The lectures centered on the fundamentals of business management and on the safety measures in chemical plants.

As a matter of fact, the 1964 reformed curriculum provided for formal conditions of the up-to-date training in chemical engineering sciences. After the subjects of chemical machine elements, unit operations and chemical technology, introduction of courses in chemical business management meant to involve a spectrum of chemical engineering sciences. The next years were expected to fill the updated frames with a valuable content. By 1972, the pioneering work of some experts lecturing at the universities, primarily of professors Árpád Gerecs and Pál Benedek brought about an up-to-date division and systematization of subjects, and the lecture matters are published also for the students. These eight years from 1964 to 72 have been the most fruitful period of improving the training in the field of chemical engineering sciences, not only because the quoted formal conditions of the curriculum urged the composition of an up-to-date subject matter of instruction, but also because the educational authorities better funded the training in chemistry. It is then that new chemistry buildings were inaugurated in Debrecen, further contributing to the dynamic development of the education in chemical engineering sciences, too. Connections with chemical plants have been established or furthered, university departments formed their profiles, tendencies differentiating the education.

The factories, especially those in the region of attraction were still invariably interested in chemist graduates that peaked in the 1964 to 68 period. 65—70% of chemists in a course graduated from the Debrecen University started working in factories. At their reunions, graduates related of their experiences in, and opinion on the education and made suggestions to improve it. The reports gave account of adequate knowledge imparted our chemists to start of convertible knowledge in natural and technical sciences to be relied on — together with a due ambition — for an advance in career. The suggestions of already demanding young specialists made, however, two problems clear. On the one hand, more exercises were needed involving up-to-date mechanical equipment and instruments, even automated units, but this had financial obstacles in spite of the growing support. On the other hand, our training appeared to lag behind the recent methods of industry in spite of all our efforts. There was a plan to solve this contradiction, namely to make the training more effective via up-to-date visual aids and operating models,

but realization was protracted because of the deficient teaching and auxiliary staff (technicians).

A further problem was that the increased interest in industrial jobs would have, reasonably, requested a deeper penetration into chemical engineering subjects and the introduction of specialized education, but the new education reform reduced the number of lessons spent on chemical engineering sciences by 30%.

Although the aim of education at the universities of sciences is different from that at technical universities, the disciplines belonging to chemical engineering sciences are to be taught also at universities of sciences on university level, since chemists employed in factories are given the title and the responsibilities of an "engineer" to be faced in the way of chemical engineers. These engineering tasks require mainly from beginners more of a certain practical skill: handling instruments, fundamental managing knowledge in work safety and security, so-called technical skill, rather than the theoretical interpretation of the problems in a chemical factory or of production. Time shortage prevented simultaneous development of practical skill and theoretical discussion of problems, especially in the lack of all conditions of a rapid increase of education efficiency.

Although lectures delivering chemical technology at faculties of natural sciences have relatively more complicated tasks than have their colleagues at technical universities, since a considerably smaller staff is expected to do the same educational work on high level as done by several departments at technical universities, at an inadequate appreciation. The financial limits and research facilities of departments are moderate in spite of the other then unsussessful training at universities of sciences, even from the point of view of industry. This is proved by the professional careers of our chemists, and it has to be especially emphasized that the success is the results of the common work of all the departments. Relying on the bases laid by departments for natural sciences, departments for chemical technology strove to develop a technical — economical approach in students and to find more efficient educational methods. The 1972 reform assisted us by permitting to systematize the development since 1964, by disposing of unified chemical education, leaving the universities of sciences to freely shape their curricula, educational aims and methods according to their staff, local possibilities and requirements of industries in their range of attraction. Only the theme of and lessons in minors (ideology, physical training, foreign language and national defence) were prescribed by the ministry, but — regrettably enough — the higher time demand of experimenting subjects was left out of consideration, the number of weekly lessons was uniformly fixed for any section.

The basic idea of the reform was to increase the students' time for self-education by reducing the number of weekly compulsory lessons. This undoub-

tedly right concept ignored, however, the higher time demand in experimenting sciences to achieve technical skill and to acquire proper laboratory behaviour.

Interesting enough, although the three universities of sciences were allowed to develop their educational goals, their curricula relied on the same fundamental. The first three years of priming subjects were followed in the fourth and fifth years by high-niveau lectures in subjects necessary to solve some definite tasks on scientific level, to specialization, i.e. to find industrial jobs. The new curriculum deliberately accepted the possibility of chemists to work in a wide spectrum of jobs with different professional requirements, relying on the principle of creating solid professional bases, imparting convertible knowledge and an ability to observe and solve the problems, — a goal difficult but urgent, achievable only by enhancing the efficiency.

In order to increase the efficiency of training several measures were taken by the faculties of natural sciences, first of all, the connections between departments were strengthened. (Especially in Debrecen and Szeged the organisation in department groups got reinforced and its range increased.) Single subjects were thoroughly examined and overlappings sieved out, maintaining the reasonable principle "repetitio est mater studiorum" (repetition is mother of knowledge). The students' approach to industry was formed through industrial relations. In the new research system ever more problems of the national preferential program have been shouldered by the faculties of natural sciences. Purchase of some precious special instruments (maybe in common with factories) strengthened the grouping and farthered interdisciplinary research. Partly the small-group system of training, partly the relatively increased number of educational staff improved human touch between teachers and students. As a result, the students got acquainted with methodology and organizatory problems of modern research work.

At the Eötvös Loránd University, chemical technology as priming subject is joined by optional subjects of mathematical discussion of chemical production processes and some generalizable questions of manufacturing processes. Subsequently, the group of lecturers on the above subjects was organized by Pál Benedek into an independent Laboratory of Chemical Cybernetics. Another line of specialization has followed the appreciated subject of fundamentals of plastics production, kinetics and mechanism of polymerization. Also the subject-matter of the "priming" technology has undergone considerable modification, it is concentrated on the chemical processing of coal, petroleum and natural gas, on the production therefrom, and possible further processing of reactive primary materials.

The situation and goals are similar at both countryside universities. The classical, descriptive chemical technology is replaced by the up-to-date comparative discussion of the range of products from a basic material in order

to develop a technical-economical approach and to show the validity of the Korach fundamental laws. Specialization courses are offered in Szeged in petrochemistry and catalytic reactors, while in Debrecen in the production of drug and insecticide intermediates and on chemical reactors. Both in Budapest and in provincial universities special laboratory exercises are held to support this special training.

In Debrecen, chemical plant management is lectured on from the aspect of industrial business management, while in Budapest this subject is optional and rather implies process operation. The subject of work safety is similarly delivered at all the three universities. As a matter of fact, the departments of chemical technology at the three universities assume essentially identical point of view on the education of chemical engineering sciences.

The education aims at presenting the production system, to describe — possibly by mathematical representation — procedures, processes, organizatory and economic activities leading to obtain chemical industrial products by transforming natural raw materials. In our view the training is expected to give the future chemists a general survey on the methodology, structure, possibilities, tasks and significance of the chemical industry (with special respect to the inland one); to provide also special, more than general, knowledge in a narrower field: acquaintance with particularities and laws of chemical unit operations, procedures and of the integrating production processes: and finally, the capacity to integrate all these with the modern natural scientific world concept and to face practical problems.

The Hungarian research network known to be complete is expected no extensive development, consequently the graduated chemists will increasingly find jobs in the production sphere: industry and agriculture. Nevertheless, our ideas for the future are not lead by these facts, but by a social phenomenon, the scientific-technical revolution, imposing qualitatively new requirements on education.

Without claim to completeness, these are as follows:

Above all, the efficiency of instruction in unit operations and equipments has to be improved by up-to-date aids and operating models.

The equipments of technology exercises has to be updated, mechanized and instrumented.

The complexity of problems has to be increased to resemble real technological problems. Lectures involving systems approach to chemical technology are advisable. Setting out basic principles permits to renounce of completeness as imposed by time shortage. The simultaneous presentation of processes seems to be illustrative of the correlation between technical solution and economy.

Besides, we have to strengthen in our students the cooperativeness, indispensable to successful work in a modern-minded research institute. Our

students have to be convinced that the most important means of social development is to transform the science into producing force. One of the main functions of science is to supply the producing and non-producing spheres of society with new scientific results. It is to be pointed out that the modern science takes the demands of production increasingly into consideration. manifested by the trade of mental products (patents, know-hows), by the exponential increase of productivity and the structural transformation of economy. These mental products arise in research institutes, in university research facilities, at strict inner and outer labour division rather than from the intuition of individual researchers. In these institutions researchers are working at each stage from the new scientific discovery to the product coping with social requirements, researchers with different tasks, but the same aim, they are specialists but not polymaths; specialists not required to be creative in every detail, but expected mutual understanding. This is eventually the most expressive interpretation of the new educational program characteristic of the future work at universities. Specialists of high professional intelligence and susceptible to the problems of society have to be trained whose intelligence includes also knowledge on technical realization. Namely the concept of research cannot be restricted to the methodology of exclusively abstract achievements. Research is meant as investigation of each stage of the way leading from the discovery to the new product. Accordingly, the question arises whether engineering sciences would be better cultivated at universities of sciences, or not? For this equation no unambiguous answer is expected yet, it will be given by life after 10—15 years. By all means, it is a social interest to prepare the young people for the real tasks of life.

To complete our analysis, in some words we have to mention the problems of chemical technology education of students to be chemistry teachers.

Relying on majors of chemistry teacher courses, the subject of chemical technology presents production processes transforming natural raw materials into chemical products. The purpose of this subject is to make the chemistry teachers well informed in industrial applications of chemistry (physics, biology), to lend them a survey on the possibilities, tasks and significance of chemical industry in the solution of practical problems of vital importance (e.g. energy production, structural materials, food industry, health protection, environmental control); to make them able to reconcile their knowledge with the modern natural scientific world concept and to make use of it in teaching chemistry (physics, biology).

Summary

A chronological survey is given on teaching chemical engineering science in general and its special subjects: chemical technology, unit operations and equipments, business management, etc. at the Universities of Sciences of Szeged, Debrecen and Budapest. Special care is taken of developing in students the engineering approach requested by the social progress.

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