Chemical Engineering: Professionally Ignored?

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Abstract

Chemical engineering was founded about a century ago, when the demands of the society for chemical products together with the modern life style enforced major evolutions in chemical industry. Educational programs at the universities had to change accordingly. Furthermore, the broad application and importance of chemical engineering field has resulted in its division into many new subdisciplinaries such as polymer, dyes, textile industry, etc. In recent years, job market for chemical engineers has become very volatile. As a consequence, chemical engineers have become desperate, and are often absorbed by other fields based on job availability and their general skills. These fields are sometimes not even engineering. Chemical engineers sacrifice their long-term professional career to earn quicker money. The evolution of the modern industry from a conventional hierarchical (top-down) into a skill-oriented (cross linked) design has become evident. Personal skills like being a team worker, communicative, collaborative, initiative for quality, design and efficiency are becoming more attractive to companies over specialized skills in certain fields. Many companies prefer to hire engineers based on general skills, and then train them through a post-employment program according to their own standards. There are also programs to send the chemical engineers back to the university to take various courses required based on their new responsibilities at work. These companies have shown to be more productive and successful in most cases. In the current professional working environment of engineering, a more specific definition for a professional chemical engineer is required. Universities should implement modern equipment and update the applied courses according to the modern industrial technology and requirements. However, students will require a standard basic knowledge of chemical engineering fundamentals. Industrial experiences of an engineer in addition to his educational career have enabled him to grasp a brighter image of the realities in this field of engineering worldwide.

1 Introduction

It is required to know about the history of the chemical engineering profession in order to understand its concept and purpose. Although chemical engineering came to era over a century ago, but many people still don't know what chemical engineering is. Old stories about the dreams of mankind looking for a chemical substance, which can transform copper (cheap material) into gold (valuable material), are well known among the nations. This substance was first called “Kimia” in Persia, which is believed to be the source of the name “Chemistry”. Rhazes[17] (Zakariya Razi) as a chemist produced sulfuric acid, and also explored alcohol by distillation about 8th-9th centuries. The crafts of soap-making and distillation entered north Europe from Mediterranean in the 12th-14th centuries. Dyeing, metal refining, manufacturing of wine, glass, soap, and cement have long been practiced in small-scale units, but the improvement was very slow until 17th century.

Modern chemical engineering emerged as a distinct profession about at the same time as the Industrial Revolution, which involved the rise of modern chemistry and industrial chemical processes after 17th and 18th centuries[4]. Chemical engineering was first conceptualized in England as early as 1881, although it was not popularly accepted, but its primary educational and industrial evolution occurred in US [2, 3]. The idea of chemical engineering was born in the chemical laboratories, when the need for chemical products exceeded the production capacity of the laboratories, and at the same time, cost was a major concern. This demanded a major scale-up, and in turn, required engineering calculations as well. Germans preferred to make a team of chemists and mechanical engineers to do the job, and they designed and constructed many chemical plants in this way.

During 1898-1915, industries were using industrial chemistry and nonquantitative descriptions of processes[1]. Little[1, 7] described the concept of “Unit Operation”, which took hold for a decade (1915-1925), in his report as: “Chemical Engineering as a science, ... is not a composite of chemistry and mechanical engineering and civil engineering, but a science of itself, the basis of which is those unit operations which in their proper sequence and coordination constitute a chemical process as conducted on the industrial scale...”

Wayne M. Pafko[7] has created an interesting website about the history of chemical engineering. He has focused on the studies done in US about the chemical engineering profession.

The application of chemical engineering in our modern life is overwhelming. Plastics, synthetic fibers, synthetic rubber, catalytic converters, oil derivatives, and many other vital products have made our modern life possible. However, the history of chemical engineering can be a good way of understanding where we are standing right now, and also to assist us in defining a set of more specific subdivisions in this field rather than having a common field, which is just a defined structure rather that applied engineering field.

In what follows, a short review on chemical engineering history and timeline in Canada is presented as well.

1.1 Chemical engineering in Canada

The first chemical engineering program in Canada was established in university of Toronto in 1904. On the other hand, based on applied or practical chemistry, McGill’s university program should be ranked first. Since that time, several institutions along the country have included chemical engineering in their engineering degree programs. In terms of a timeline, the development of Canadian chemical engineering professional organizations can be summarized as following:

The first chemical engineering organization in Canada was the Canadian section of Society of Chemical Industry, SCI, formed in 1902 in Toronto[3]. This was the only chemical related organization before World War I. Canadian Institute of Chemistry, CIC, was established in 1921 afterwards. About 6 years later, Canadian Chemical Association, CCA, was established in 1927. The Chemical Institute of Canada was found in 1944. The first Canadian publication for chemical engineering was the Canadian Journal of Chemical Engineering, established in 1957. The "Directory of Chemical Engineering Research in Canadian Universities" was formed in 1962. Canadian Society for Chemical Engineering (CSChE) was established in 1966. IEC was formed for environmental research by restructuring National Research Council, NRC, in 1990.

2 Chemical Engineering Education

The courses for the chemical engineering have fundamentally changed in many universities since early 1900's. This indicates that the chemical engineering education has been evolving during this period. Arthur Little stressed the concept of "unit operation" in 1915. This concept took hold and became the central educational theme for a decade[1]. During 1935-1945 applied thermodynamics and process control courses were added. Applied chemical kinetics and process design came to era between 1945-1955. After 1955, instead of unit operations, more emphasis was given to engineering sciences such as momentum, mass and energy transfer. Professor Olaf Hougen shifted the chemical engineering away from its dominant theme of unit operation to the broad sophisticated exploratory engineering it is today[1]. With this new definition, more interdisciplinary activities became possible; a professor with mechanical processing background might be doing research on design of a batch or continuous reactor for producing hydrogen as a fuel as an alternative source of energy[12]. Such kind of projects will require knowledge about chemistry, energy, mechanical engineering, manufacturing, environment, and many other fields. However, it is indeed a teamwork effort on a chemical engineering project.

After 1980 many industries started to externalize their R&D activities to reduce the spending. Mowery & Rosenberg[6] mentioned that this has been accomplished through domestic and international collaborative relationships with other firms, government laboratories, and universities. Curriculum contents must be developed based on the workplace demands, therefore, an interdisciplinary team is required to correctly identify these demands and develop the required curriculum[14].

2.1 Computers and Education

In the current world of modern technology and telecommunications, it is essential to implement computers and hi tech equipment and facilities for business and also educational purposes. Crynes, Lai & Chung[10] implemented laptop computers, wireless network connections and many other hi-tech facilities in order to improve the performance of teaching and learning and found these facilities very effective.

Many chemical engineering courses cannot be taught without personal computers and knowledge of information technology. For example, modeling and simulation is a very important subject that is essential in modern education and industries. It is vital to familiarize the students with software training packages, which are meant to guide them in design, modeling and simulation of chemical engineering problems without requiring unnecessary focus on the details[16]. In other words, they can save time and be more efficient by learning how to input the data to a computer operator, instead of doing the whole work by them. A hypothetical example can be the replacement of 10 engineers with two engineers and two operators, which will be more efficient.

2.2 Other Skills

Because of the type of industries that chemical engineering is involved with, the role of a chemical engineer cannot be well defined as an individual. He should always be a team player. Therefore, familiarizing the students with other skills such as communication and leadership is very important. Studies have shown that the engineers who have been trained in a collaborative program have performed much better both at the university and in industry[9, 11]. Most of the successful companies are more interested in these personal skills, since they provide their own technical theoretical and practical trainings regardless of the discipline that the new recruit had studied at the university. This implies that the general applicable part of the university education can be summarized in the first two years, when mostly common courses for all engineering fields are taught. For the next two years of a Bachelors program, a closer collaboration between industry and university can be established in order to specifically describe required courses, even ideally on a one-to-one basis. Although it is not possible to reprogram the university curriculum for professional courses more specifically to suit all various industrial demands, establishment of a closer interdisciplinary activity among different fields seems to be necessary. This can be explained as if companies plan to hire students after the second year, but leave them at the university for another two years. Then the post-employment educational program can be performed at the university.

Several studies have been done regarding the importance of the relationship between universities and industries. Upgrading the training laboratories in the universities with modern state of the art advanced equipment, with the assistance of local industries, will not only attract competitive students to engineering fields, but also trains them for modern industries[8]. As the number of university graduates increases, the demand for graduate education opportunities increases as well. This requires greater flexibility to meet the customers' educational needs. The universities need to consider the evolution of graduate studies as well as undergraduate since it will affect the quality of education of future engineers[15].

3 Chemical Engineering Profession

Many engineers believe that since there is a slowdown in economy, and there is not much to discover through research any more, therefore, the age of "professional" engineering has come to an end, and engineers have to look for any available job which can provide them with some money. This fact combined with the volatile job market has made the situation even worse. The spending on university research in fields that are facing slowdown in industrial income has been reduced. This will definitely affect the long-term development of those fields of engineering.

One of the concerns of most industries was the problem-solving ability and IQ of an engineer. It has been proven that these abilities cannot be achieved without enough knowledge about design and modeling of systems as well as creativity[13]. This fact proves that the companies, which ignore the professional side of the education, will pay back in long-term, as they would not be able to solve their problems as effective as those companies that considered the professionalism. This implies the importance of the second two years of the education at the universities for industries.

Successful companies always implement the leading edge technology products to motivate their employees and at the same time, keep the fast pace of progress in the competitive world of industry. I was recruited as a logging engineer in 1995. The interview comprised of a short demo and an IQ test. The method of evaluation of engineers was based on their productivity, skills, and progress in job environment, which was monitored closely, regardless of their GPA or even their university degree. Their long-term career was discussed with them through a feedback program to assure maximum motivation and productivity. However, this was of both sides interest.

In an educational institute, the budget for teaching is based on the students' tuitions. The interest of the students in their current field of study is not always based on their real abilities. On the other hand, most of the instructors rank their students based on their grades. This encourages the students to focus only on obtaining higher marks rather than their long-term career. If the students become familiarized with the history of different professions, their required responsibilities, their lifestyles in working environment, that will give them a brighter view of what they really want to become, and also what will suit them the best. The best performance for such a program would only be achieved through a close collaboration between universities and industries. This will not only enables the student to get the best of his education, but also assists companies in reducing their spending on training and evaluation.

4 Conclusion

We need to know the history of chemical engineering to understand it better. Because of the fast growth of industries, it seems that dividing the definition of chemical engineering into independent subdivisions is required. However, the basic role of chemical engineering would remain as one of the four big fields of engineering.

The second two years of education at the universities can be planned with direct involvement of industry. The companies can apply their post-employment educational programs during this time. It can be interpreted as hiring the students after the second year of their education. Although there are some barriers, e.g. some companies prefer to keep their training programs confidential.

Graduate studies in chemical engineering are as important as undergraduate studies, since they support long-term development by constructive research, and they also provide future teaching resources for future engineers. There should be a balance between university and industry contribution to training, however the boundary is not clear.

Today a successful professional engineer is the one who looks for the most demanding and active engineering field in the international job market. In terms of education, that means, the field that covers theoretical and practical training that is required by most of the job descriptions. Since engineers have their professional pride as well, another key parameter for choosing an engineering field for a career is the fame, prestige and a bright future for long-term progress. In order to keep chemical engineering as a successful profession, a fundamental review is required on the current educational program.

Bibliographic information

[1] History of Chemical Engineering: based on a symposium cosponsored by the ACS Divisions of History of Chemistry and Industrial and Engineering Chemistry at the ACS/CSJ Chemical Congress, Honolulu, Hawaii, April 2-6, 1979, William F. Furter, Washington, American Chemical Society, 1980.

[2] The Early History of Chemical Engineering: a reassessment, Clive Cohen. British Journal for the History of Science. 1996, v. 29, n. 101, pp. 171-194.

[3] Chemical Engineering in Canada: a historical perspective, L.W. Shemilt, Ottawa, Canadian Society for Chemical Engineering, 1991.

[4] One Hundred Years of Chemical Engineering: from Lewis M. Norton (M.I.T. 1888) to present, Nikolaos A. Peppas, Kluwer Academic, 1989. Corporate author: American Chemical Society Symposium (1988: Toronto, Ont.)

[5] The origins and early development of the heavy chemical industry in France, John Graham Smith, Oxford University Press, 1979.

[6] Paths of innovation: technological change in 20th century America, D. C. Mowery, Nathan Rosenberg, Cambridge, UK, Cambridge University Press, 1998.

[7] http://www.pafko.com/history/h_chem20.pdf, by Wayne Pafko, 1995.

[8] A Collaborative University-Industry Agreement to Establish an Advanced Communication Laboratory, A. Eydgahi, M. Fotouhi, R. Baddock & C. S. Bolek, ASEE Annual Conference and Exposition 2000.

[9] Collaborative Learning in Engineering Classrooms E. Koehn, 2000, Lamar University, ASEE Annual Conference and Exposition, June 18-21, 2000, St. Louis, Missouri.

[10] Chemical Engineering Fundamentals: Better Learning Through Computer-Based Delivery, B.L. Crynes, Y-K Lai & W.S. Chung, University of Oklahoma, ASEE Annual Conference and Exposition 1999.

[11] Revitalizing Statistics in the Chemical Engineering Curriculum, D. E. Clough, University of Colorado, ASEE Annual Conference and Exposition 1997.

[12] Reactor Design With Matlab In a Manufacturing Environment, Charles U. Okonkwo, Arizona State University, ASEE Annual Conference and Exposition 1997.

[13] Problem Solving is Necessary, but not Sufficient, W. Ernst Eder, Royal Military College of Canada, ASEE Annual Conference and Exposition 1997.

[14] The Impact of Interdisciplinary Faculty Teams on Engineering Technology Curricula, J. C. Wood &L. Mack, ASEE Annual Conference and Exposition 1997.

[15] The Future of Graduate Education in The School of Technology, D. R. Depew & R. J. Herrick, Purdue University, ASEE Annual Conference and Exposition 1997.

[16] Experiments in Learning Chemical Engineering Modeling Skills, N. Rappin, M. Guzdial, M. Realff & P. Ludovice, School of Chemical Engineering, Georgia Institute of Technology, Atlanta, ASEE Annual Conference and Exposition 1997.

[17] A Medical History of Persia and the Eastern Caliphate, Cyril Elgood, Cambridge University Press, London, 1952.

Biographical information

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