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The Chemist, Facing the Structural Changes in Chemical Industry

International Meeting of the Chemical Society Presidents organized by the New Swiss Chemical Society (NSCS) on the occasion of IUPAC 97, Geneva, August 23, 1997

On the occasion of IUPAC 97 in Geneva, Switzerland, the New Swiss Chemical Society (NSCS) organized on August 23, 1997, an 'International Meeting of the Society Presidents'. The Presidents and the General Secretaries of all national Chemical Societies were invited. The topic of the meeting was 'The Chemist, Facing the Structural Changes in Chemical Industry'.

After a short opening and introduction (Prof. A. von Zelewsky, Dr. R. Darms) the two main presentations of the morning session were given by Dr. H. Kindler (Member of the Executive Committee, Novartis AG, Basel) and Dr. H. Jucker (Former Chairman of the Board of Aluisse-Lonza Group AG, Zürich). A discussion followed both lectures (chairper-

sons: Prof. F. Diederich, Dr. W. Graf). In the afternoon session the discussion was continued (chairperson: Dr. H.L. Senti). The meeting was highly appreciated: 45 participants from ca. 30 different countries attended the meeting, representing all important chemical societies and thus ca. 80% of the chemists worldwide.

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Presentation

by Hans Kindler*

Member of the Executive Committee, Novartis AG, Basel

Introduction

The significance and the image of the chemical industry and the position, the mission and the professional perspectives of the chemist have experienced significant changes over time. There were continual changes from the medieval alchemist, a magician searching for gold and immortality, the scientists of the early 19th century creating the modern sciences and striving to understand and control the elements and the processes of life, to the

chemists of a hundred years ago, who produced the first man-made dyestuffs on a large scale. The beginning of medicinal chemistry in the 1920s, the increasing knowledge and understanding of chemical reactions and the new material sciences resulted again in a change of the position and the possibilities of the chemist and the scope, structure and environment of the chemical industry. The increasing knowledge about biological processes, the growing relevance of biochemistry and the rapid developments in the field of genetics, in data management and information technology have had again a remarkable impact on the role and the situation of the chemist.

In all these different eras, there was a common feature to the image of the chemists: For people who are not familiar with the profession, there existed always some-

what unclear and sometimes unrealistic notions about the activities, possibilities, limitations and the power of the chemists.

The working environment for the chemist, the mission and working conditions have also experienced important changes during the past few decades. The chemist in industry of the first half of this century was either working in a research laboratory at the bench or in chemical production. In either case, he was working in isolation with little communication and almost no flow of information across the organisation. The business was technology-driven, chemical research and manufacturing were the core competencies of the company, and production had a preferred central position.

Since the 1950s, the pharmaceutical/chemical industry became more and more market-driven. New and innovative products had to be developed and manufactured to satisfy customers. A good integration of R&D projects in the business strategy is important to manage the innovation process successfully.

In the same period the knowledge and understanding of biological and biochemical processes were increasing in scope and in depth at a rapid pace, leading to a stronger influence and position (Stellenwert) of biosciences in the discovery and development process. In manufacturing, the efforts to improve the production pro-

*Correspondence: Dr. H. Kindler
Novartis AG
Postfach
CH-4002 Basel

cesses were extended from optimising the cost of production to improving safety and ecology parameters at the same time. All these trends were leading away from the working approach of the isolated chemist to an interdisciplinary working environment, to the team approach and an open communication across boundaries of departments, disciplines and locations.

For the chemist, these developments mean above all that there is no special status for him as a scientist and that he has to be able and willing to work in interdisciplinary teams. He contributes with his basic and specialised knowledge in the interdisciplinary team, in which – ideally – all of the relevant disciplines are represented.

There are two major areas through which the chemist in industry can proceed and where chemists can contribute value to the respective company:

- In the area of life sciences, the chemist integrates his knowledge with the knowledge of biologists and other specialists in medicine or animal and plant sciences.
- The second avenue for chemists leads towards engineering, mechanical, electrical and physical sciences. The vast field of material sciences offers many opportunities and challenges for innovation. There is a need for new materials like composites, ceramics, additives for textiles and plastics, intermediates and catalysts for manufacturing, as well as for new analytical methods, chemical sensors and optoelectronic devices.

It is in this environment of changes that we are asking ourselves how the environment will impact on the chemists' future role. I will sketch some of the important changes taking place in industry in the areas of the economic, the social and the technological/scientific environment, and in a second part, I shall try to analyse the consequences and challenges such changes impose on the chemist of the future. My thoughts relate more to the Life Sciences Industry, whereas Dr. *Hans Jucker* will discuss more the area of the basic and technical chemistry.

Changes in the Economic Environment

The economic environment of the chemical industry is influenced primarily through the globalisation of the markets and the increasing competitive pressure. Through networks of trade and information, all major products and services are today offered worldwide, and the competi-

itive edge of many products is determined by the ability to differentiate them in performance or price. Companies determined to prevail in this competitive situation have to anticipate the world markets.

There exist no longer any traditional home markets which determine the product range of the industry. Home markets have the same rules as the global markets. This also means that the preferred locations for marketing organisations and technical operations will be determined by strategic factors, the availability of resources, the social and legal environment and the proximity to the customers.

The players in the global markets have to adjust their structures and locations and they must refocus their activities in view of their competitive advantage. This leads to an increasing concentration of the industry by mergers and acquisitions, as we are experiencing ourselves. The companies have to exploit their synergy potential through management effectiveness, rationalisation and through focusing on core competencies. Outsourced segments offer, *e.g.*, many opportunities for small, for highly specialised or for start-up companies.

We observe a dramatic increase of cost for innovation and of the expectations and pressures of the financial community.

Another source of changes, particularly affecting the pharmaceutical industry, can be described as the 'power shift' of customers. Traditionally, the medical doctor has decided and prescribed the therapy and the medication for his patients. The decision power now shifts more and more towards the payer, the health insurance companies and the patient. This shift influences the marketing strategies, the organisational structures, the product range and the supply concept in the pharmaceutical industry.

The internal technical and commercial resources of the chemical industry are increasingly focused on segments with high value-added potential and on product innovation and improvement. The Swiss import/export ratio of chemicals illustrates the importance of added value. In 1996, Switzerland imported chemical products for CHF 13.5 billion, compared to exports of almost twice that amount (26 billion); according to SGCI, the average cost of imports was *ca.* CHF 3.5 per kilogram, whereas the average price of exported chemicals was *ca.* CHF 17, a fivefold increase in value. It has to be noticed that the value-added segments are more and more shifting from the producer to the creator of ideas and innovations. A strong process and product innovation effort is

therefore the crucial factor for long-term success in maintaining a position in the high added value segment of any business. Consequently, the research and development activities of the chemical industry are increasing in absolute terms as well as in percentage of sales.

Changes in Science and Technology

The developments and ongoing changes in science and technology are among the most striking and highly visible changes taking place in our industry. There were never so many people with such a high level of knowledge, and never was communication of results and data so thorough and so easy. Information technology and computer power facilitate most tasks of the chemist and enables the progress in areas like gene technology, testing methodology and data handling. As a result, the disciplines of chemistry, biology and medicine are moving closer together and the traditional gaps between the disciplines are being closed.

Biotechnology, molecular biology and its application in gene technology are broadening the scope of the tools available in life sciences. They are complementing, not replacing, the range of presently available methods and products in the areas of health care, plant breeding and crop protection. The full impact of methods like somatic gene therapy and xenotransplantation is not foreseeable yet, however, we have to be prepared to stay at the forefront of the development of such emerging technologies.

New technologies are also developing in nonbiological sciences. In the field of material sciences, new light-weight materials with improved mechanical and heat-stability properties are being developed. New supramolecular structures are being investigated which exhibit unusual optical, optoelectronic and magnetic properties useful for data storage and other electronic or optical devices. Research in catalysis, especially in stereoselective reactions, has made great progress in the past few years and opens new possibilities for ecologically improved manufacturing processes. New territory is also explored in the research of energy storage and molecular batteries, in sensor technology and analytical/diagnostic tools.

Obvious examples of multidisciplinary techniques are the new approaches in synthesis and testing of large libraries of compounds, the computational and combinatorial chemistry and high-throughput screening. These are methods and ap-

proaches to new products which are possible only as a result of combining biological, medicinal and chemical knowledge with know-how in computer technology.

Changes in the Social Environment

A recent study by the German Institute for Economic Research (DIW) has confirmed a clear pattern of the internationalisation of the industry: the sites for industrial manufacturing follow the customer, the key markets. Sooner or later, research and development follow. Besides the economic parameters, several legal and social factors like social stability and acceptance of scientific progress and new technologies influence the selection of production and research & development sites. The social changes taking place in Europe today are characterised by reluctance to accept the activities of the chemical industry, including technologies like genetic engineering, the necessity to experiment with living organisms and the need for a thorough coverage of intellectual property protection.

The image of the chemical industry and of the profession of the chemist in the public have an impact on the availability of employees, the attractiveness of natural sciences for students and the education system. A sound education system which stimulates the interest of students in the humanistic area as well as in the science field is of great importance for the education of future employees for our industry. Teaching science subjects at secondary school level is a must for a country, which wants to host chemical/pharmaceutical industries. Excellence in teaching from high school to universities and in basic research at university level have stimulating effects and foster the formation of well-trained chemists, which the industry will also need in the future.

Among the social changes, we have also to mention some ongoing changes in legislation. Government activities and industry efforts should be complementary. Legislation should stimulate progress and investments and not restrict them. Initiatives like those being launched in Switzerland to forbid the use of some technologies are restricting the development in the country. An attractive country for an innovative industry has to provide an innovation-friendly environment with a positive attitude towards new technologies. This includes practicable legislation in the areas of ecology, animal rights, gene technology and permits for construction and operation of pilot plants.

The social responsibility of the enterprises in all decisions, on the other hand, is also a precious good. The chemical industry is executing important personnel matters in close cooperation with their social partners. Permanent training and additional education are provided by the firms and are considered as an important social contribution. Broad training and flexibility of the employees help to reduce or to avoid terminations and layoffs in the course of industrial restructuring processes.

Consequences for the Position of the Chemist

I want to discuss now a few implications, these changing economic, structural and social parameters have on the situation of the chemist in the industrial environment.

Economic Environment

Among the economic changes taking place in our business, it is the globalisation of the markets which will have the most significant impact on the situation of the chemists. Traditionally, the chemical industry has built on products protected by their quality standards and intellectual property protection law. It has measured the world markets with local standards and has manufactured its products close to the home base. The globalisation is leading to an increased competitive pressure not only for the best and most cost-effective products, but also for participating in the most attractive markets. This means that some production and R&D sites will be transferred to new sites and locations. These transfers require from the chemists **flexibility, mobility and an open mind for opportunities and trends**. The industry needs **chemists with leadership qualities**, who are flexible and prepared to move to new assignments, activities and geographical areas. People with a **sound basic knowledge of their professional field** and the ability to see the entire picture of the business.

The ongoing structural changes in the pharmaceutical/chemical industry have not only the objective to increase shareholder value, they are essential to realise synergies, to achieve more presence and weight in the market places and to reach a critical mass for the innovation potential. The pharmaceutical R&D budget of *Novartis*, e.g., is ca. CHF 2.3 billion. Together with partnerships and strategic alliances with research-based third parties, the Pharma Sector reaches the critical mass which allows to innovate the product range in

such a way that the long-term presence of the company at the forefront of the industry is assured. Chemists and other scientists in this R&D environment have to understand the driving forces of the markets and the dynamics of the business. They must be capable to **translate market needs into R&D programs and projects**, and they must have the ability to explain what they are doing in generally understandable terms.

While some big companies, like e.g., the automotive industry in the USA, reduce their size and structures, many existing positions are substituted. Several activities and services, production of parts and manufacturing of intermediates are outsourced, which creates new opportunities for start-up companies, as can be demonstrated by the figures of the US industry. During the period 1993–1995, the large US concerns have eliminated 3.6 million jobs. At the same time, 5.0 million new positions were created by small and start-up companies. The chemical industry is subject to the same changes, and for this process, needs scientists with **entrepreneurial qualities and economic thinking**.

Social Factors

Unclear notions about the profession of the chemist lead to a lack of social acceptance and confidence into the chemical industry and the profession of the chemist. The uncertainty about the potential of new technologies like gene technology, unclear and misleading information create a certain uneasiness and even fear in the public and add to a low level of acceptance of natural sciences.

Companies have the responsibility to create a sense of purpose and a vision which provides a direction for the scientists.

As a result of these critical views and the present tight job situation in the European chemical industry, the number of chemistry students in Europe has significantly declined during the past few years. As a consequence of these developments, the public funds for research and teaching in chemistry are also decreasing (universities, Nationalfonds), and we have to make real efforts to maintain the high scientific standards that makes Switzerland an attractive country for the chemical/pharmaceutical industry. Many respectable colleagues predict a significantly increased requirement for chemists in 5–10 years.

Science and Technologies

New technologies, above all **information technology** and molecular biology,

and their application in **genetic engineering** have changed the working environment of the industrial chemist. The new technologies are complementary to the traditional field of chemistry, and they provide new challenges and opportunities for chemists in the chemical-biological direction as well as in the area of chemical engineering, production and material sciences. More and more, we understand the basic chemistry of biological processes, and we are able to describe biological mechanisms in chemical terms. Our knowledge of materials, of molecular and supramolecular structures is rapidly increasing, and we generate a flood of data which has to be handled by electronic means.

Information technology has changed the working environment of many professions, including chemists. Handling literature and patent searches, managing data, accessing data banks, searching and designing of new active principles, process control, are a few important applications, requiring **knowledge and command of electronic tools**.

The increasing complexity of the subjects requires a working approach with **interdisciplinary teams**. The individual members of the teams contribute with their **basic and specialised knowledge** and their **understanding of the areas of application** of their disciplines. The chemical industry will therefore need chemists who are **able to manage and to contribute to interdisciplinary teams** and processes in the areas of chemistry-engineering and in biosciences. Chemists have generally good access to other disciplines and to an interdisciplinary working environment. They have to be trained even more to approach the tasks and problems as **team players**.

In the recent survey by your Association (NSCS), several managers have confirmed these statements and they have emphasised that also medium size and start-up companies, which are focused on biotechnology research, will employ increasing numbers of chemists, because the majority of future drugs will be synthetic products. The exact figures of open positions for chemists in the chemical industry for the next few years are not known presently, the SGCI has initiated a survey to study the future need for chemists in the Swiss industry. It is important to note that the new technologies may cause restructuring and refocusing of industrial functions and sectors, but they cause a substitution rather than a reduction in positions and jobs for scientists.

The education and the training of the new generation of chemists have to be

adapted to the requirements of a **sound knowledge of the basic chemistry, the understanding of the areas of application, the management and working habit of interdisciplinary teams and the understanding of the basic economic principles**.

Education and Universities

In the course of the 'Third International Mathematics and Science Study' about **half a million students of age 14 from 28 countries** were tested in mathematics and natural sciences, and their results were ranked. The Swiss students ended at rank 8 in mathematics, but only on **rank 18 in natural sciences. This is an alarming result**, whatever the reasons may be, large classes, few hours of teaching natural sciences, lack of interest of the teachers or lack of learning pressure. The Swiss authorities, the Department of Education, the Cantons and their bodies should take actions for improving this situation.

The public education system, particularly at university level, is of fundamental importance for preparing chemists for their industry position. At universities and institutes of technology, teaching and research belong close together. Unfortunately, some professors focus their entire interest on their research and consider teaching a nuisance and a burden. Let me state very clearly that the chemical industry considers teaching as the primary mission of universities. High-quality research is a good and sound base for excellence in teaching. We expect that chemists receive a first class, diversified education which prepares them for different positions in industry and gives them a high degree of flexibility in their choice of positions. Universities have to get away from the idea to prepare chemists exclusively for their professional position as researchers. Teaching schedules should also include basics in law, economics, communication and social topics. These topics should be integrated into the regular schedule for students without extending the present time for studying chemistry.

Conclusions

In conclusion, I am convinced that the position and the professional profile of the chemist in today's chemical industry is subject to an evolution, as markets, industry structures and technologies are changing. The requirement for **well-educated, versatile and flexible chemists** in different business areas is high. The future scientists will need the ability to **work in**

interdisciplinary teams and have well-trained social and communication skills. Familiarity with the applications of **information technology** and the potential of **processes in biotechnology and engineering sciences** is essential.

Interest and enthusiasm for science subjects are generated at primary and high-school level. The situation in many countries and certainly in Switzerland is mediocre and needs to be improved. It is an important task for the professional organisations and the chemical industry to provide open information about the attractiveness and beneficial contributions of the profession and the future need for chemists.

The chemical industry will continue to engage in dialogues with the public, with authorities and schools in order to improve the image and knowledge about the merits of the industry and the profession of the chemist. The industry will also continue to support the education of chemists at the educational institutions by common projects and cooperations, by sponsoring scholarships and by engaging members of academic institutes as consultants. We are optimistic that the universities will succeed in adapting their teaching agendas to the needs of today and the future in such a way that chemists will be sufficiently prepared to meet their challenges and to adequately fill the positions needed by the chemical industry in the future.