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Chemical Education for a Competitive and Dynamic Europe

Components of a “European House of Chemical Education”: Situation – Good Practice – Recommendations

Michael Cooke, Leo Gros, Maren Horz, Walter Zeller (editors)

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Chemical Education for a Competitive and Dynamic Europe

Components of a „European House of Chemical Education“:
Situation - Good Practice - Recommendations

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Foreword

In a draft paper[1] for a sectoral workshop held in Brussels in November 2004, the authors cited „education and skills“ as the number one cross-cutting factor and one of the key barriers to sustainable development:

„The availability and mobility of an appropriately qualified and skilled labour force is essential to the long-term viability and innovative capacity of the European Chemical Industry. The ability to attract high quality human resources and funding for chemistry education throughout an enlarged Europe is an objective to be pursued with partner organisations such as the Alliance for Chemical Sciences and Technologies in Europe“ [2].

What is described here as crucial for the sector of chemistry in the context of the Lisbon declaration needs a broad basis of information and expert orientation. FACE (Forum for Advancing Chemical Education[3]), the first EU-funded LEONARDO DA VINCI network project in the sector of chemistry, was designed in 1999-2000 to contribute to this European sectoral task.

FACE has gethered information on chemical education at all levels and in many countries, thus bringing together the horizontal and the vertical aspects of mobility.

The present White Book is a product of FACE. 30 partner institutions[4] in 13 European countries have contributed to it.

The FACE White Book team[5] thanks all colleagues in the sector who supplied information, asked questions, gave answers, contributed good practice examples and hosted the FACE meetings. Special thanks go to the German National LEONARDO Agency at BIBB with its head Klaus Fahle for constant advice and support. FACE would not have been possible without previous projects (see 1.5.), supported by DAAD with Marina Steinmann as the EU project adviser.

The FACE team hands this book out to the chemical community, to social partners and to political, school and academic decision makers in Europe, hoping that the information and conclusions help to shape a true „European House of Chemical Education“. Our vision is that this house has room for talented chemists of all educational levels in each country, and that it allows mobility across national borders and across levels.

You see things and say: „Why?“
But I dream things and say „Why not?“ [6]

Idstein and Vienna, November 2004

Leo Gros, Maren Horz and Walter Zeller

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1 Draft : A European Technology Platform for SUSTAINABLE CHEMISTRY: The vision for 2020 and beyond. A working discussion document for the 9 November 2004 workshop in Brussels.
2 http://www.allcheme.org
3 http://face.fh-fresenius.de (former address:http://www.face.net.tc)
4 see Appendix 1
5 see Appendix 2 – All chapters without an author's name were written by Leo Gros.
6 G.B. Shaw, John Bull's Other Ireland (on a poster in Dublin airport)

1. Chemical education in the European context

1.1. The context of European educational policy: From Maastricht to Bergen

Building the European Union is a historical process that offer many more chances than it has risks. It will not only help to give the coming generation a peaceful space for development and co-operation, it also may help to make Europe a stronger partner and competitor in a global world. It is a common belief of all responsible men and women that education plays a decisive role in this context, and that co-operation and steps towards a European educational space are top tasks on the European agenda. Transforming Europe to a knowledge based society needs the best education that can be given to young people and life long learning for all citizens.

A brief review is given here to show in which framework the project FACE sees itself embedded.

A first step was taken in Maastricht on February 7th,1992. In the treaty signed, the European Community declares itself responsible for developing education and training of high quality as well as following a policy which supports the measures undertaken by the individual members of the community[7].

One of the most important conferences for this target followed 7 years later. On the 19th June 1999 29 countries signed a declaration in Bologna affirming the will to create common grounds of education at the tertiary level within Europe[8].

Soon afterwards, on March 23rd and 24th, 2000, the European Prime Ministers met in Lisbon to discuss education and employment in Europe. They decided that Europe should „become the most competitive and dynamic knowledge-based economy in the world capable of sustainable economic growth with more and better jobs and greater social cohesion." As one means for achieving this target, education and especially vocational training shall be promoted[9].

One year later the ministers of education decided, in Stockholm, to increase the quality and efficiency of education and to open the paths of knowledge for everybody, not only in Europe but in the world. Additionally, all new member states were included in the Lisbon process[10].

In Bruges, on 29th and 30th October 2001, it was decided that the complete system of vocational education and training should become part of ECTS. This European credit transfer system has been „too" successful on the tertiary level and should now spread to other fields.

The prime ministers demanded in Barcelona on 15th and 16th March 2002, that vocational education and training becomes a world-wide reference for quality[11].

Life-long learning was the central topic of a meeting in Brussels on 30th May 2002[12].

In Copenhagen, 31 European ministers of education met again on 29th and 30th November. They decided that all countries must cooperate more closely as far as vocational education and training are concerned. What must be improved especially in this area is the quality and transparency of this system[13].

The joint interim report[14] „Education and Training 2010 - The success of the Lisbon strategy hinges on urgent reforms" published by the council and the commission is a valuable source of objectives in the reform of education and training systems.

A meeting in Bergen will follow in 2005.

Aspects relevant for FACE are:

- The interdependence of economic competitiveness and education is all the more important for an innovative high-tech field with sustainable products on which well-being, health and safety of all citizens are based
- If this is true then the sectoral needs of chemistry and related fields must become an integral part of European educational policy
- If the first two statements are true, chemical education must be studied and developed in a holistic manner, since only well trained personnel on **all** levels of education can ensure innovation and sustainable and safe production
- Tools for documentation, recognition and trans-national as well as trans-level transfer of knowledge, skills and degrees must become available and viable in the sector
- Due attention must be given to quality standards and their control
- Life long learning is of special importance in a scientific and technical field with a high rate of innovation, both in basic knowledge and technical application

FACE has to combine the general European approach to education with these sectoral aspects. It is one aim of the present White Book to make information on the status quo and on needs of the sector available to the chemical community and to decision makers, especially for the Bergen conference. It therefore also reports on expert opinions concerning possible consequences of knowledge gathered for the political process.

7 http://europa.eu.int/abc/obj/treaties/en/entoc01.htm
8 http://www.bologna-bergen2005.no/
9 http://www.europarl.eu.int/summits/lis1_en.htm
10 http://www.europa.eu.int/comm/publications/ booklets/move/29/txt_en.pdf
11 http://www.europarl.eu.int/bulletins/pdf/01s2002_en.pdf/
12 http://europa.eu.int/comm/education//life/communication/com_en.pdf
13 http://europa.eu.int/comm/education/copenhagen/copenhagen_declaration_en.pdf
14 http://europa.eu.int/comm/education/policies/2010/doc/jir_council_final.pdf

1.2. The context of European Chemical Industries: Sectoral needs and development of the sectoral labour market

1.2.1. A central science with a high diversity - a bird's eye view of chemical and related industries

„Chemistry - the central science". If the Royal Society of Chemistry, London, proudly uses this motto, there is more to it than just publicity. Chemistry is the science of matter in a broad sense. Chemists seek to unveil and understand the structure of matter, to make new materials such as nanomaterials and drugs, to design new analytical methods and to develop devices for environmental, industrial and clinical analysis. The understanding of structure-property relationships makes chemistry a necessary basis for, among others, biology, biotechnology, medicine, pharmacology, physics and material science. This is why the scope of FACE comprises chemistry and its neighbouring fields and applications such as the pharmaceutical and polymer industries, food production and biotechnology. Thus, the industries and research institutions cover a very broad scope of activities and special fields. Major issues in the recent and coming years were, and will be, aspects of product innovation, sustainability, health and safety[15]. Chemistry is and will be a key factor if the Lisbon aims are to be reached. All educational policy, if it shall serve the sector, must consider the high standards which employees in the sector have to and will have to meet.

What is equally important is the structure of the industry that makes these products. „The chemicals sector comprises some 25,000 enterprises in Europe. 98% of these have less than 500 employees and may be considered as SMEs, accounting for 45% of the sector's added value. The EU25 chemicals industry currently employs 2.7 million people directly, of which 46% work in SMEs, and many times more of Europe's workforce are employed indirectly[15]." On the other hand, there are large multinational companies having general policies, demanding high flexibility of production sites and acting locally in their respective national and regional environments. Moreover, outsourcing of parts of a production and complex networks of furnishers of modules for complex products like cars demand highly flexible yet reliable logistics and trans-national co-operation. This is why educational policies must always bear the needs of SME's and of multinational companies, local and global needs, and the need for team work and mobility in mind.

Finally, it is important to know that the relevant industries are at very different levels of development and economic success. In the western European countries, harsh structural changes in a globalising economy lead to transfer of productions to countries with lower production cost for mass products, but also to countries where the customers are, e.g. in the Far East. However the chances are good to retain old and create new jobs in fields where innovation, an environment favourable for high tech production, and stable social conditions are available.

Companies which manage these changes are successful. Their success is in sharp contrast to conversion problems chemical industry is still undergoing in some new or future EU countries such as the Czech Republic, Bulgaria and Romania. It is obvious that chemical education in these countries is affected by the situation and that a „sick industry" cannot be a viable partner for educational activities.

1.2.2. Structural changes - personnel profiles

In the '90s of the last century, industries, including the chemical and related sectors underwent considerable change and a structural crisis with a severe loss in jobs in Europe and the almost total loss or partial transfer to non-European regions of industries such as the fibre industry. The series of mergers, acquisitions, closing down or downsizing of companies is still going on. In the years 1992-96, the increase in unemployment followed the fall of the Iron Curtain.

Structural changes demand and induce organisational changes in the industries involved. Technically driven companies transformed to more market driven organisations or at least strengthened the organisational influence of market aspects. Deep, sometimes rigid and immobile hierarchies are developed into mobile, more flexible and flat hierarchies/project teams. Table 1 schematically summarises some of the general features of this process, emphasising the transformation of job requirements.

Tayloristic		Modern
work by separate steps	→	integration / co-operation
centralised decision making	→	inter-departmental thinking and local responsibilities
standardised work	→	flexibility
minimum of qualification	→	oligo- / multi-qualified persons
control of result	→	control of process
end-of-the-pipe „repair" of environmental risks	→	process integrated environmental protection
Quality Control	→	Total Quality Management

Table 1: Structural Changes in Industry (Modified version of a slide presented by Prof. Dr. Hans Brunnhöfer, Chairman of DECHEMA task force on Fachhochschule Studies in Chemistry, Frankfurt am Main, D, 1998)

15 Draft: A European Technology Platform for SUSTAINABLE CHEMISTRY: The vision for 2020 and beyond. A working discussion document for the 9th November 2004 workshop in Brussels.

A German specialist for Organisation and Economics gave a talk during a national meeting on Engineering Education and Training in a trans-atlantic comparison[16] and identified four main features[17] of change in a global economy which he qualifies as crucial for engineering/technology related business:

- What is produced? Transformation of product mix:
  - product diversification
  - complementary offer of products plus service
  - decreasing product life cycle time
- For whom is it produced? Transformation of markets:
  - globalisation of markets
  - segmentation of markets into local and/or functional markets
  - de-regulation of market access opens new markets
  - customer becomes a co-producer
- How is it produced? Transformation of processes
  - production on demand
  - more flexible production
  - reduction of production to core competencies
  - team orientation and outsourcing
  - co-operations and alliances
- Where is it produced? Transformation of sites
  - de-centralisation and regionalisation
  - internationalisation and global sourcing
  - footlose industries[18]

The internationalisation and the organisational demands that acompany these changes affect large companies as well as SMEs and increasingly involve not only higher ranks of hierarchy but also technical staff members[19].

Some specific information on the sector of chemistry has been gathered in a UK study. The results of an inquiry concerning job requirements, with special attention given to higher education, may be considered typical, if not representative for other levels of education and for other European countries[20].

The main factors identified as driving change in the labour market are[21]:

- Increasing competition on price, and market pressures, to speed up product development and delivery times
- The need to meet more demanding customer specifications and legal requirements
- The impact of changes in work organisation such as flatter management structures, growth in team-working and the greater exposure of technical staff to direct contacts with the customers

For the case of laboratory work, Peter Storz of Dresden University and others have detailed the consequences of change for Saxony in a booklet[22]. In a survey on educational demands for a sustainable development[23], Storz stresses the importance of process and problem solving oriented thinking and acting, especially when doing chemical analyses for different purposes and customers. This means that the learner must be trained to work in interdisciplinary and multi-task teams.

Finally, all experts agree that the prospect of holding „jobs for life“ in one company is an illusion for most chemists. Change and insecurity demand life-long learning[24].

1.2.3. Factors influencing employability

As a consequence of all these structural and organisational changes, it is obvious that the sector needs personnel who have a thorough basic training but also „key qualifications“ e.g. presentation skills, team skills, self- and project management, and who are aware of the importance of problem solving and of life long learning. Chemists on all levels of education and work must respect safety and environmental protection rules.

Sectoral studies have come to many conclusions for action needed. A selection of relevant findings is described here. Special attention is given to results involving practical work experience.

- We need an easily understood framework of chemistry qualifications which embraces the range from technician level awards through to vocational Masters degree and short courses of adult training, including the definition of multiple entry, exit and re-entry points - with appropriate certification[25]
- We need technical staff with vocational training including not only knowledge but also social, international and problem solving competences, ideally having been trained to tackle complex tasks in a result-oriented manner[26]
- We need university graduates with soft skills and with job relevant experience and skills alongside with their chemistry knowledge and hence better co-operation between industry and university with active participation of both partners[27]. (FACE partners have evaluated that the level on which this co-operation works in each country is very different and influenced by its surrounding tradition or

16 Neue Ansätze für die Ausbildung und Qualifikation von Ingenieuren -Herausforderungen und Lösungen aus transatlantischer Perspektive. BMBV Bonn, April 1999. Tagungsband.
17 Hans-Jörg Bullinger: Globalisierung und technischer Wandel als Herausforderung für die Ingenieurausbildung. In ref. 16 p. 111
18 Footlose industries are those that do not have to locate close to raw materials (unlike the early iron and steel industry that had to locate close to iron ore and coal etc). Footloose industries locate in pleasant environments near transport routes and near the markets.
Footloose industries have to locate close to research centres like universities. See http://www.geography.learnontheinternet.co.uk/topics/secondary.html#what
19 Andreas Diettrich, Internationalisierungsstrategien der chemischen Industrie und Konsequenzen für die Aus- und Weiterbildung am Beispiel des Qualifizierungsförderwerks Chemie GmbH in Halle. In: Dieter Münk (Ed.): Perspektiven der beruflichen Bildung und der Berufsbildungspolitik im europäischen und internationalen Kontext. 13. Hochschultage Berufliche Bildung 2004. ISBN 3-7639-3248-8. Bielefeld 2004, S. 89 ff.
20 Change and Diversity: The challenges facing chemistry higher education. A report by Geoff Mason, National Institute of Economic and Social Research to The Royal Society of Chemistry and The Council for Industry and Higher Education. March 1998, ISBN 0-85404-915-0.
See http://www.chemsoc.org/networks/learnnet/change_diversity.htm Relevant information can also be found under www.chemsoc.org/networks - link to FECS/ European Network for Chemistry- A study on mergers and acquisitions and their influence on the sector is found at http://www.rsc.org/pdf/general/m&aukreport.pdf
21 see p. 50 of lit. 20
22 Klaus Drechsel, Peter Storz, Gisela Wiesner (Eds): Wandel der Arbeit im naturwissenschaftlich-technischen Labor. Perspektiven der Laborarbeit in Sachsen. Dresden 1997. ISBN 3-932777-01-8
23 Peter Storz, Zum Bildungsanspruch für die Gestaltung einer nachhaltigen Entwicklung. Wissensch. Zeitrschr. der TU Dresden. 49 (2000), Heft 6, S. 82
24 see Lit. 20, p. 54
25 see Lit. 20, p. 55
26 see the different aspects covered in Burkhard Hecht (Ed.): Chemieberufe: Ausbildungsstrukturen und Kompetenzen. 13. Hochschultage Berufliche Bildung 2004. ISBN 3-7639-3238-0. Bielefeld 2004
27 Erich Staudt et al., Chemiker: Hochqualifiziert aber inkompetent? In: Innovation: Forschung und Management Band 8. Institut für Angewandte Innovationsforschung. Bochum 1997. ISBN 3-928854-08-9. p. 105 f

culture, by legal frameworks and by the economic situation of the relevant industries, see chapter 2 and 4.).

- We need practical (industrial) work periods as a good chance for the future university graduate to realise which knowledge and skills play a role beyond the classical technical/chemical subjects traditionally taught in the academic world[28].
- We need careers guidance about the relevance of course choices for future employment prospects[29].

A very detailed, thorough and useful study on a student employability profile for the sector of chemistry recently published[30]. The profile lists subject benchmark indicators, discriminating between cognitive skills, generic competencies, personal capabilities, technical ability, business and/or organisation awareness and practical and professional elements. Reflective questions help students and educators to apply the indicators to self-evaluation.

Among six „employers' criteria" we find the following two being related to practical work experience:

- Business and/or Organisation Awareness: An appreciation of how businesses operate through having had (preferably relevant) work experience.
- Practical Elements - Vocational Courses: Critical evaluation of the outcomes of professional practice; reflect and review own practice; participate in and review quality control processes and risk management.

These criteria highlight again that the intention of the FACE project as stated in 2001 has remained on the agenda and is relevant for the sector.

In a recent survey[31] „How Does Chemical Engineering Education Meet The Requirements of Employment?" among young chemical engineers who entered employment no longer than five years ago, from 63 countries, the World Chemical Engineering Council comes to the conclusion that fewer chemical engineers are needed for research and that a broad spectrum of professional tasks waits for the graduates. In contrast, study programmes are still too oriented towards technical knowledge, while soft skills and marketing/business orientation skills are lacking. The study meticulously lists differences between the relative importance that the worlds of education and of work attribute to skills and competences and shows that, to a large extent, the academic world lags behind needs of the work place.

All these structural changes and the needs and employability criteria found in the sector and only briefly reviewed here cannot leave the world of education unaffected. Instead of waiting for change to shape us, we - the chemists in the sector and the educators on all educational levels in all European countries - have to contribute to shape it.

A brief review of the social partners' and professional organisations' views will shed light on some key educational issues which the important stakeholders in the sector discuss.

1.3. The context of stakeholders: The social partners and professional organisations speak

It has been said that „Our social structures are... based on shared values of equality and are distinguished by their universal nature and by the extent of their social support systems...European social standards are higher and stronger than those of all other comparable economies... Social transfers in EU Member States help us to prevent poverty... The importance of achieving a balance between economic and social policy and between flexibility and security lies at the heart of the process of European integration...Social policies are vital for greater and more widely shared prosperity...Social policy is a productive factor that brings benefits for the economy, for employment, and for competitiveness...The more work becomes flexible, the more people will demand security through social protection, as a means of ensuring their health and safety, lifelong employability, social inclusion, equal opportunities and fair treatment... We think it is important that all the candidate countries pay particular attention to how social partner organisations develop and to encourage active, autonomous dialogue between them... the legal acquis also covers provisions relating to freedom of movement of workers, and regulations ensuring social security coordination for migrant workers...The legal acquis includes the case-law of the Court of Justice... The Amsterdam treaty extends the scope for Community (social policy) acquis, particularly as regards employment, public health, the fight against discrimination, and the fight against exclusion[32]."

The European producers in the sector are represented by CEFIC[33]. In a study concerning the future of the European chemical industry (2015)[34] we read: „In recent years there has been a sharp decline in the number of students graduating in chemical-related disciplines and this trend is expected to continue in the foreseeable future. The decline reflects the greater attraction of areas such as services and ICT. If the sector is to remain innovative and continue to grow, then this trend must be reversed." CEFIC took action: A website for young people[35] and a forum for politicians and other stakeholders, the Alliance for Chemical Sciences and Technologies in Europe[36] intend to link the sector with its possible future employees and (offering seminars for them) with members of the European parliament.

ECEG, the European Chemical Employers' Group represents CEFIC on a European level. They discussed education matters with the European, Mine, Chemical and Energy Workers' Federation (EMCEF) during a meeting in Finland in

28 Looking to the future. The times are a-changing, and the RSC needs to be in the forefront, Steve Ley tells Richard Stevenson. Chemistry in Britain, August 2001, p. 24f.
29 Lit. 20, p. 48
30 http://www.cihe-uk.com/PDFs/Chemistry.pdf
31 http://www.chemengworld.org
32 QUINTIN, O., Presentation in a meeting with PHARE co-ordinators from the 10 candidate countries, The Development of European Employment and Social Policy, 2 March 1999, DGV, European Commission. (inclusion of social policy in brackets for clarification). See http://www.ose.be/files/EUsocCDLP.pdf
33 http://www.cefic.be
34 http://www.cefic.org/files/Publications/Scenarios2.pdf
35 http://www.chemistryandyou.org
36 http://www.allcheme.org

September 2004. As a result, a joint position paper was issued[37]. This key document states that „...a lack of skills is already faced by the chemical industry, at least in some European countries and in some areas of the industry, as a reality, despite the high levels of unemployment in many European countries. EMCEF and ECEG believe such shortages hinder economic growth as well as positive developments of European labour markets. They might indeed become a danger to the so-called Lisbon-Goals agreed upon at the Lisbon Council in 2000 to make the European Union the most competitive and dynamic knowledge-based economy in the world, capable of economic growth with more and better jobs and greater social cohesion. This being even more the case as future demands for qualifications of employees of the chemical industry will rise continuously. The proportion of higher qualified staff has already risen during the last decades, and this development will continue and might even accelerate further. Changes in technology used at workplaces are increasingly frequent, organisation of the working process changes more often, and therefore also the way to work is subject to frequent alterations. This highlights the need for an even more flexible structure within the companies, which itself is again the reason for an increase in the demand for highly qualified staff. A positive attitude towards processes of life-long-learning will be necessary for the industry as well as for employees in order to secure future success of the sector as a whole within the European economy as well as the employability of its employees. The social partners declare their common interest in highlighting the importance of high education levels, good standards of vocational training and a commitment of industry and employees to further vocational training and life-long learning throughout the entire working life, in order to secure the innovative strength of the industry as well as the employability of the possible future employees of the industry.

ECEG and EMCEF agree that joint action on these subjects has to be promoted. Thereby they identify tasks both for the industry and the employees and their respective representatives - at a company, regional, national and European level. Furthermore there are tasks to be dealt with by public or semi-public institutions, together with the Social Partners, which has to be decided on the basis of the different national systems and traditions in this area within the European Union."

In a paragraph on Vocational Education and Training and on lifelong learning we read:

„ECEG and EMCEF are both convinced that vocational training, regular and appropriate further training and life-long learning over the entire working life is essential, not only for companies in order to remain successful, productive and efficient, but also for each employee in order to maintain his or her employability. Employers within the European chemical industry therefore have a strong interest in offering opportunities for their employees for an initial as well as further vocational training in accordance with the requirements of the specific jobs dealt with by the employees and to motivate employees to participate in this training. Employees within the European chemical industry have the same strong interest in looking after their individual vocational skills and in investing in these qualifications in order to keep their employability at the highest possible level.

ECEG and EMCEF and their respective national affiliates will support both employers and employees in these processes, which are marked by a shared responsibility. They both ask for better, more transparent and flexible frameworks regarding European and national regulations governing vocational training and education as well as for the public funding supporting the activities in these areas."

Finally, the partners agreed to form a Joint Working Group:

„ECEG and EMCEF have decided that a Working Party should analyse the following subjects in more detail, possibly including the writing of a report on these subjects:

- a more in-depth analysis of the status quo regarding skills, qualifications, vocational (further) training and lifelong learning within the industry;
- an exchange of information and good practice of the different national systems of education, vocational (further) training and lifelong learning in order to support the further development in these areas."

CEFIC is among the founders of the Alliance for Chemical Sciences and Technologies, AllChemE, in Europe.

During an AllChemE workshop in Brussels 1998, the participants recommended that „Internships" (FACE comment: industrial placements for chemistry students) „should be developed on a European basis with increased involvement for SMEs"[38].

The AllChemE meeting on „University-Industry Interaction: Meeting the Needs of the Future through Chemistry and Chemical Engineering", held in 1997, came up with suggestions for a reform of PhD training in Europe[39] and said that „research periods abroad and in industry during PhD studies should be encouraged. This is one way to learn problem solving skills which are considered important."

The European Association for Chemical and Molecular Sciences (EuCheMS) „takes over the role and responsibilities of the Federation of European Chemical Societies and Professional Institutions. It is a non-profit-making organisation. Its object is to promote co-operation in Europe between those non-profit-making scientific and technical societies in the field of chemistry whose membership consists largely of individual qualified chemical and molecular scientists and whose interests include the science and/or practice of chemistry[40]." The EUChemS (FECS, Federation of the European Chemical Societies) member organisations deal with educational issues in their respective countries.

ECTN[41], the European Chemistry Thematic Network, member of AllChemE, has a working group on Industrial Placements. During their 2004 Toulouse meeting and at the initative of FACE, ECTN (a FACE member) decided to expand their activities into Vocational Training and to take in institutions offering such courses. Thus this inclusion of Vocational

37 http://www.emcef.org/Committees/SD/Che/2004/ECEG-EMCEF-Decl-EN.pdf
38 http://www.chemsoc.org/pdf/enc/allchemereport2.pdf
39 http://www.chemsoc.org/networks/enc/allcheme_pub3d.htm
40 http://www.chemsoc.org/networks/enc/fecs.htm
41 http://www.cpe.fr/ectn/

Education in the shaping of a European educational space is a consequence of EU policy.

ECTN had so far been devoted to academic studies and participated in the development of the Eurobachelor core curriculum (see 3.4.3).

During a European seminar held in Dresden[42] in June 2004, chemistry teaching experts from universities discussed issues of Chemistry Studies in the European Higher Education Area. In a „recommendations" paper, the seminar participants sum up the results of their discussions. Referring to practical elements in First Cycle courses, and based on opinions brought in by FACE members and other Fachhochschule and industry colleagues, they come to the following conclusions[43]:

- „In some cases a practical thesis (e.g. in a partner SME) as the final element in BSc studies at higher education institutions other than traditional universities may enhance the employability of the student.
- Training placements in industry shorter than 6 months have only a limited value."

Last but not least, IGIP, the International Society for Engineering Pedagogy[44], issued a position paper on engineering education[45], as a result of a workshop initiated by FACE, during their meeting in Fribourg (CH) in September 2004. It says:

„IGIP general assembly discussed engineering education in the framework of the Bologna process. IGIP members express their strong conviction that all members of the engineering community, responsible politicians and other decision makers should help shape engineering education in the framework of this process taking into account two important features:

- Local identity, i.e. proven good practice in all countries and on all levels of education, shall be preserved and strengthened by re-defining them in terms of modules, ECTS credits and two tier degrees.
- Employability of Bachelor graduates as one of the leading principles of the two tier system of education shall be duly taken into account.

Therefore IGIP encourages academic institutions to offer practical experience as an essential part of the engineering curriculum. This is particularly true for application oriented study programmes.

Consequently, the official study time for such programmes must not be limited to 6 theoretical semesters (180 credits). IGIP strongly recommends that academic institutions be allowed to offer 7 (210 credits) or 8 (240 credit) courses, in accordance with the Bologna corridor for Bachelor courses."

IGIP has, since its foundation in 1971, always been an important bridge to the countries of the east of Europe, and colleagues from these countries, whether new EU members, future EU members or not, represent an important part of IGIP members.

This brief review shows that the process of shaping a European Educational space has been well adapted by stakeholders in the sector, and that European alliances are formed, either emerging from existing national and trans-national networks or being newly created.

It is obvious that there is a broad agreement about the structural changes happening and to be initiated. One issue which has been discussed as a part of this process is the training and the employability of chemists at all educational levels. All stakeholders have expressed, in some form or other, the importance of training that is relevant for the labour market, practical experience at the work place being one feature needed in the sector.

The role of FACE is to offer a forum for the discussion of these issues and for collecting and documenting the relevant information which is its indispensable basis.

1.4. The context of tools: European education made transparent

In the past decade, some excellent tools for European education have been developed and are already widely used. While the two-tier system of a bachelor and a master degree were declared compulsory and are being introduced in the EU, no such system for vocational training exists. The tools briefly reviewed here are catalysts of the development of a European educational space including the sector of chemistry.

ECTS[46]**:** The European Credit Transfer and Accumulation System is a student-centred system based on the student workload required to achieve the objectives of a programme, objectives preferably specified in terms of the learning outcomes and competences to be acquired. ECTS is based on the principle that 60 credits measure the workload of a full-time student during one academic year. The student workload of a full-time study programme in Europe amounts in most cases to around 1500-1800 hours per year and in those cases one credit stands for around 25 to 30 working hours. ECTS is currently being studied as a tool for vocational training as well[47].

Grading[48]**:** The performance of the student is always documented by a local/national grade. It is good practice to add an ECTS grade, in particular in case of credit transfer. The ECTS grading scale ranks the students on a statistical basis. Therefore, statistical data on student performance is a prerequisite for applying the ECTS grading system. Grades are assigned among students with a pass grade as follows: A best 10%, B next 25%, C next 30%, D next 25%, E next 10%. A distinction is made between the grades FX and F that are used for unsuccessful students. FX means: „fail - some more work required to pass" and F means: „fail - considerable

42 Report see: http://www.gdch.de/taetigkeiten/ausbildung/ddreport.pdf
43 see http://www.gdch.de/taetigkeiten/ausbildung/recommendations.pdf; p. 1
44 http://www.lme.die.supsi.ch/~igip/en/index.html
45 Report on the meeting, so far only available in German http://www.eif.ch/symposium04/common/docs/Abschlussbericht%20Ruprecht.pdf
46 http://europa.eu.int/comm/education/programmes/socrates/ects_en.html.
47 http://www.bibb.de/en/13394.htm
48 http://europa.eu.int/comm/education/programmes/socrates/ects_en.html.

further work required". The inclusion of failure rates in the Transcript of Records is optional.

ECTN[49]**:** The European Chemistry Thematic Network Association is one of the outcomes of the six years of network activity. There are currently 79 members of the Association from 23 different European countries. The members are higher education institutions and national chemical societies. The Association was created to provide a sustainable future for the European Chemistry Thematic Network. During its 2004 annual meeting in Toulouse, ECTN decided to broaden its scope to Vocational Education and Training (VET) as well. For further information please visit

EUROPASS[50]**:** Europass is a method of recording the training carried out and skills acquired during a period of work experience, undertaken as part of an on-going training programme, in another European country.

Although it is does not represent formal accreditation, the standard format of this passport style document is intended to ensure a consistent framework for the recognition of skills by training providers and employers throughout Europe.

All the information contained within the Europass is endorsed by the sending and receiving organisations. This information includes details such as the name and level of the course being followed in the UK and the training and practical work undertaken abroad.

Diploma Supplement: The Diploma Supplement is a document attached to a higher education diploma providing a standardised description of the nature, level, context, content and status of the studies that were pursued and successfully completed by the graduate. The Diploma Supplement provides transparency and facilitates academic and professional recognition of qualifications (diplomas, degrees, certificates). A Diploma Supplement label will be awarded to institutions which deliver a Diploma Supplement, to all graduates in all first and second cycle degree programmes, in accordance with the structure and recommendations to be found in the web[51].

Certificate Supplement[52]**:** The certificate supplement contains a detailed description of the qualification acquired by the holder of a vocational certificate. It is issued by the awarding authorities and provides information mainly on the skills and competences acquired, the range of occupations accessible, the awarding and accreditation bodies, the level of the certificate, the different ways of acquiring the certificate, the entry requirements and access opportunities to next level education.

European CV[53]**:** The European curriculum vitae gives a comprehensive standardised overview of education attainments and work experience of an individual. It is complementary to the certificate supplement. The European CV provides information on language competences, work experience, education and training background, additional skills and competences acquired outside formal training schemes. The CV format is available in 13 languages.

The **Eurobachelor** (see also chapter 3.4.3) is an excellent initiative to set a European framework for contents of studies[54].

1.5. The context of sectoral EU-projects: Experience with mobility and pilot projects

The partnership that has worked in FACE is based on 5 previous years of EU-project work, including sectoral mobility and pilot projects.

1.5.1. Mobility projects: UNIC, PASSAGE, PIVOT and ERASMUS

The University Network for Industry in Chemistry (UNIC) was financed by the Leonardo Programme and commenced with UNIC I early in the 1990s. This EU project was so successful that it was followed by UNIC II and UNIC III. Essentially, UNIC offered students in countries such as Germany (the initiating country via the Europa Fachhochschule Fresenius), Spain and the UK a chance to carry out their industrial placement semester(s) with a company or similar entity in a country other than their home country. It relied on the development of personal relationships between university teachers in the various countries who would then identify placement opportunities and seek students from other countries to fill them. Ideally each placement was a matched pair with two students exchanging places. However demand soon became unbalanced and UNIC II and UNIC III addressed this issue by providing subsistence funding for students working in another country with matched funding coming from the placement company. Altogether some hundreds of students benefited from these exchange placements over a period of several years. As the process developed, other countries notably Belgium and Austria joined the programme.

Several lessons were learned from these projects. Companies benefited from the presence of another 'culture' in the work place and, in the UK, several participating companies adopted the practice of routinely searching for placement students and new employees from Europe rather than the UK (a consequence of the non-vocational nature of UK university chemistry courses). Some students were subsequently recruited by the companies with which they fulfilled their placement. Students benefited by improved use of the language of the placement country, a broader outlook on life, experience of new/different work practices and a significant enhancement to their employability potential. The university teachers developed a European network of contacts which has proved useful in subsequent projects such as INCEPI (see 1.5.2.), and now, FACE.

49 http://www.cpe.fr/ectn//ectn_association.htm.
50 http://www.europass-uk.co.uk
51 http://europa.eu.int/comm/education/policies/rec_qual/recognition/diploma_en.html.
52 http://www.cedefop.eu.int/transparency/certsupp.asp
53 http://www.cedefop.eu.int/transparency/cv.asp.
54 http://www.cpe.fr/ect/ceb/doc/041022/EBc041022_Eurobachelor2004.pdf

One specific feature of UNIC was that LEONARDO I allowed the partners to give the German UNIC grants to incoming students from partner institutions and even to such students who went from partner institutions to third countries in which a partner of UNIC was located. Thus, some 25 Spanish students of Institut Químic de Sarrià received UNIC grants to come to Germany and to go to the UK, the Netherlands, Ireland and Austria for 3-5 month work placements (see 4.2) In many cases they were tutored by colleagues of partner universities in the host country, in co-operation with their sending institution.

LEONARDO II blocked this chance, leaving a limited number of grants for incomings. Europa Fachhochschule Fresenius and partners continued their mobility project work with PASSAGE (Placements Abroad for Sectoral Students And Graduates in Europe) I, II and III and with PIVOT (Professional Internship in Vocational Training) I, II. With PIVOT, level 3 pupils in Vocational Training obtained access to short term placements (3-6 weeks) abroad. In the beginning it was difficult to find such placements, because companies say that by the time the student has been trained on the job, he or she will already have to leave. What finally helped to find short term placements for vocational training pupils was that partners who had good experiences with PASSAGE and UNIC students could be convinced of giving it a try. Together with the sending institution and its teachers, they identified work the pupils were able to do.

Since 2001, Europa Fachhochschule Fresenius (EFF) has used PASSAGE and PIVOT chemistry student mobility as a model and extended the scope of mobility to students and pupils of Health Studies and Business studies.

Up to 2004, EFF had not taken part in ERASMUS/SOKRATES projects, except as a partner of other institutions. The International Office had restricted itself to the programme LEONARDO DA VINCI because, as a relatively small institution with innovative courses in the Health Sciences, EFF wanted to seek excellence in one field before playing in another. Now, after several years of taking part in LEONARDO DA VINCI the EFF aims for the three years to come are

- to extend existing university contacts into an ERASMUS/SOCRATES environment and to build up new partnerships using this „tool“
- to find at least one new partner for each study course and start exchanging students and staff, ideas and teaching methods/course contents

The EFF application for an ERASMUS charter has been accepted and the International Office signed ERASMUS contracts with universities in the United Kingdom and Spain. One priority for the health sector is Malta, since our Maltese colleagues have already expressed strong interest in such a co-operation and since EFF has served as a national partner for Maltese occupational therapists to find staff exchange partners in clinics. Another priority is Finland, since EFF already has had ERASMUS and is having LEONARDO contacts with Jyväskylä Polytechnic in Physiotherapy and Chemistry.

1.5.2. Pilot projects: Developing sectoral education

The following table lists sectoral pilot projects of the partnership of FACE. **Table 2**

Project	Contents	Contractor	Period
International Curriculum for European Product Innovation **(INCEPI)**	The project INCEPI produced a variable curriculum consisting of 5 modules that gives a “holistic” view of the process of product development. It was made on the basis of a first draft prepared by a group of experts and was then subjected to critical evaluation by about 70 industrial experts. The method of evaluation was a questionnaire.	EFF	02.12.1996 - 01.06.2000
Needs of Industry in Chemical Education **(NICE)**	The project NICE used a questionnaire approach with the aim to empirically survey (level of primarily industrial beneficiaries of training) and then critically discuss (level of experts in the sector) needs of industry in chemical education. The results were summarized in a White Book.	EFF	08.12.1997 - 07.12.2000
Implementation of Degrees for European Alternating Studies **(IDEAS)**	The project IDEAS collected and critically compared the existing material and knowledge of the partnership about “alternating” education (industrial placements) in the sector of chemistry. IDEAS transferred the EFF „Fachhochschule“ course of study chemical engineering to Vienna (Austria) where such a course type was not offered before. The course is being offered in co-operation with the Höhere Bundes-Lehr- und Versuchsanstalt für Chemische Industrie.	EFF	01.12.1998 - 05.06.2001

Project	Contents	Contractor	Period
Multiple Use of Sectoral Training **(MUST)**	The project was based on the evaluation of the INCEPI curriculum which was modified, spread and adapted to three new target groups in a second step.	EFF	01.12.1999 - 31.05.2001
English for Specific Purposes: Chemistry **(ESP:C)**	ESP:C is a language project with the objective to develop a language course for chemists. Participants shall reach a level of English B2 (as defined by ALTE). Their knowledge will be recognized by a certificate, which will internationally/ transnationally certify this standard. Chemical societies from three countries will first check if this objective has been reached and then discuss whether the contents and the procedures can be accepted for a general recognition.	astyle, linguistic competence	01.10.2003 - 30.09.2006
ECTS - Certification for Chemistry Workers Leonardo project D/03/B/F/ PP 146 006[55]	With the project, bases of a European reference model for education and training of operators in automated plants of the petrochemical, chemical and the pharmaceutical industry will be compiled, applied and tested including the certification of educational results. Thus first results for the internationalisation of vocational education will be gathered on the basis of ECTS for academic training in Europe for the development of human resources in the petrochemical, chemical and the pharmaceutical industry (in compliance with the "Brügge"-process and the coalition agreement of the Federal Government). The FACE contractor Leo Gros is a consultant to this project.	Fachinformationszentrum Chemie GmbH	36 months since 2003

1.6. What is FACE?

FACE, the name of a LEONARDO-DA-VINCI project, is the abbreviation of the „Forum for Alternating Chemical Education“. During the project time it was re-named to become „Forum for Advancing Chemical Education“. This forum, the meetings of experts it organised and its website serve as a means of

- collecting, documenting and evaluating information on chemical education
- information and communication for stakeholders who are involved in the education of chemistry: students, educators, employers
- fostering practical work experience at all levels of chemical education

The partners of FACE have organised expert meetings at a European and at a regional level.

Products of FACE are the present White Book and two national publications in Polish and in Spanish[56]. A major product of FACE is a website in which information on schools and universities is laid down. All those courses are considered in which theoretical knowledge is taught and practical experience in a working environment is gained. A Polish version of the FACE homepage[57] has been developed as an example for the adaptation of FACE to a national environment of a new EU country that is currently adapting its educational system to EU developments such as the Bologna process.

The FACE homepage is not only interesting for pupils, students and their teachers, but for the complete branch of chemical industry. Additionally, FACE is an information source and a discussion forum in which the importance of a practical work experience is justified and propagated. Consequently, decision makers within the European educational system are addressed by this forum.

http://www.face.net.tc is the web address where you can find chemical courses in Europe, information about the different European educational systems, the different educational levels as well as positive responses and experiences of work placements. Useful links and practical information can also be found on this homepage.

55 http://www.ects-chemie.de/english/leonardo.htm
56 Marek Frankowicz, Iwona Maciejowska: Kstalcenie Zawadowe Na Studiach Chemicznych. Kraków 2004. ISBN 83-921505-0-3
Leo Gros, Mercedes Manresa (editores) Estudios con Practicas en la Empresa: Porque los Necesitamos. Informaciones-Argumentos-Buena Pratica. Barcelona 2005.
57 http://www.wsz.tarnow.pl/face/index.htm

2. The national context: Country reports

Reports on the status quo of chemical education in selected countries may serve as examples for how the sector trains its people in different ways. Basic information on the education systems of each country with a FACE member are found on the FACE website, general information is best obtained at the EURYDICE database[58].

2.1. Country report Austria
(Karl Maly, Walter Zeller)

2.1.1. „Dual" Technician Training at the workplace and at schools (ISCED3)

Companies, mostly large enterprises[59], offer apprenticeships in chemistry, where young people take part in school based course elements along with the in-company training.

The certificate form gives information on how the course is organised[60]:

- Entry requirements: successful completion of 9 years of compulsory schooling
- Duration of education: 3.5 years
- Company-based training: comprises 4/5 of the entire duration of the training and focuses on the provision of job-specific skills and competences according to Article 3 of the Training Regulation, BGBl. (Federal Law Gazette) II No. 185/00, enabling the apprentice to exercise qualified activities as defined by the profile of skills and competences specified above.
- Education at vocational school: School- based education comprises one fifth of the entire duration of the training. The vocational school for apprentices has the tasks of imparting to apprentices the basic theoretical knowledge, of supplementing their company based training and of widening their general education in the framework of subject- oriented part-time instruction.
- Training in the framework of the given Training Regulation for Chemical Process Engineering and of the curriculum of the vocational school for apprentices.
- Admission to the final apprenticeship examination upon completion of the apprenticeship period specified for the apprenticeship trade concerned. The final apprenticeship examination aims to establish whether the apprentice has acquired the skills and competences required for the respective apprenticeship trade and is able to carry out the activities particular to the learned trade herself/himself in an appropriate manner; alternatively
- Admission to the final apprenticeship examination in accordance with Article 23 (5) of the Berufsausbildungsgesetz (Vocational Training Act). An applicant for an examination is entitled to sit the final apprenticeship examination without completing a formal apprenticeship training if she/he has reached 18 years of age and is able to prove acquisition of the required skills and competences by means of a relevant practical or an on-the-job training activity of appropriate length, by attending relevant courses etc.

2.1.2. Fachschulen (Technician Schools)[61] (ISCED 3)

Fachschulen offer a four year course for pupils having completed year 8 successfully. The course contains general and chemistry related subjects and includes options in a special field of chemistry. A minimum industrial placement time of 4 weeks (Ferialpraxis) is required. The technician school is a school alternative to the industry-based technician training. In contrast to the HTL (see 2.1.3.), the Fachschul- certificate does not give access to University or Fachhochschule studies, nor does it include the obtention of the title „Ingenieur" after two years of professional experience.

2.1.3. The Austrian „HTL"-system[62] (ISCED 3)

Höhere Technische Lehranstalten (HTL) is a rather unique system of vocational training. An Austrian „HTL" offers a mixture of general education and initial vocational training for young people between the ages of 14 and 19. Additionally, the Austrian state obliged companies by law to accept these „HTL"-students for work placements during the summer holidays. It is certainly not difficult to imagine this duty, for which the company is responsible, is on the non-profit side, but firms still try to comply. Why?

This historically grown educational system which can still be found - with slight variations - all over the states of the former Austro-Hungarian Empire is not typical for other EU-countries. It can be critically viewed, e.g. that the field of specialisation has to be chosen much too early in life, as a youngster might have too little experience of, and knowledge about, all the areas of possible jobs. Also 39 or even more hours of actual teaching per week deprives the adolescent of time for finding personal solutions concerning the big questions of life which often are much more pressing. Such a school also provides a highly specialized knowledge at a young age and does not allow time enough for broader ideas and more varied background experience. In other words, the humanities are hardly taught in depth.

However, the Austrian economy is flourishing and it normally booms, even when a depression bothers neighbouring countries. The causes for economic achievements will be manifold when analysed by experts, but certainly one of the

58 http://www.eurydice.org/Eurybase/frameset_eurybase.html
59 e.g.http://www.chemie.at/sandoz_lehrlinge.htm
60 http://www.zeugnisinfo.at/xml/5525/5525.pdf ; see also http://www.certificate.at and http://www.bmwa.gv.at
61 http://htl17.at
62 http://www.eurydice.org/Eurybase/Application/frameset.asp?country=AT&language=EN

reasons - one, which is usually not mentioned - is the high standard of the well trained workforce of major companies in this country. Elsewhere the social system might be cheaper, ecological rules and trade union regulations might be more lenient, but the value of good education ranks higher among employers than mere financial considerations.

Companies also draw other advantages from this educational system and its peculiarities. They need not employ unknown people because they have had a chance to watch a new candidates' performance in his or her work environment before employment. The employer and the employee also know very soon whether they can find a good basis for cooperation, which certainly increases motivation. Most important of all, however, is that people, 15 or 16 years old, have their first work experience and can assess themselves as to whether their early choice of a certain vocational training was correct. Additionally, they can direct their studies in such a way that their future work will cover their greatest field of interests.

This system, including two one-month periods of practical work in a 5-year education, has developed gradually over more than 150 years. It still shows many advantages and therefore cannot be too wrong. Adaptations to the dictate of time must, of course, also be introduced to this type of education continuously.

Chemistry courses at HTL-level are offered in Wels[63] and at HBLVA Vienna.[64] HTL graduates have access to tertiary level studies (ISCED 5) and can apply for the title of an Ingenieur after three years of professional experience.

Vienna HTL graduates have access to a higher semester of Fachhochschule courses of Europa Fachhochschule Fresenius under defined conditions (performance, entrance examination) .

How does an „insider" (teacher at HTL) see this school? „A „Höhere Technische Lehranstalt", in a verbatim translation „Higher Technical Educational Institution", is typical for level 3 in Austria, the Czech and Slovak Republic, Hungary, etc. Such an institution trains and educates young people from around 15 to 19 years of age. After this 4 or 5 years of study a student has acquired a sound basis of the subject area s/he has chosen.

What does this mean? An adolescent enters a school which gives him/her ideas of a technical area. In our case only chemistry is of interest but other technical fields such as all kinds of engineering, communication technology, building, etc., are offered.

The student begins the day at around 8 o'clock in the morning and sometimes only goes home after 6 o'clock, when school ends. Nowadays around 40 hours per week are spent at school and some more hours have to be reserved for writing home work and for studying. In former times the number of hours was even higher, up to 55 hours held at school per week. In such a case the week ended on a Saturday at around 2 o'clock pm.

Why should a person wish to „suffer" under such a demanding system? Actually, the rewards were very high. A general education plus a vocational training allowed the student to find good jobs in industry after having finished school. This system was also not meant to continue with additional years at university, but the final exam at such a „HTL" meant that your knowledge in the special technical field was well above an apprentice and good enough for a top income. It was not unusual that a student received a company car having passed the final exam. They could do this because they knew their new employees very well before they came to work in their enterprise.

As all these schools also had laboratories, not only was the theoretical, but also the practical knowledge guaranteed. The students were also required to work during the summer holidays for one month, two months altogether. Many of the students chose the same company twice and thus had already completed a probation period before they even entered normal employment.

Despite this emphasis on practical work, the students were also „educated" people. They also knew their classical writers and historical and geographical facts.

This keeps changing. The system is rather expensive and many students prefer to continue their education with further studies at universities or „Fachhochschulen". The discussion whether one shall continue with this type of education arises because the system is costly and, even more so, the above mentioned „Fachhochschulen" are serious competitors. Following a conventional education first, each person can wait much longer to decide what exactly to study. It is argued that 14 years students are too young to say that they would like to know more about chemistry and do nothing but chemistry for the rest of their life. (see 5.1)

2.1.4. The Austrian Kolleg

„Kollegs" cater to persons who have passed the Reifeprüfung (matriculation examination) or Reife- und Diplomprüfung (matriculation and diploma examination) at a general or technical and vocational secondary college of a different type, or who have passed the Studienberechtigungsprüfung (university entrance examination) or a Berufsreifeprüfung (special type of matriculation examination allowing unlimited access to university). By analogy with the Berufsbildende Höhere Schulen (higher-level vocational schools) there are „Kollegs" in the following areas: technico-commercial, industry and business and tourism. There are evening-course Kolleg forms for adults.

The maximum time of study allowed at a „Kolleg" or for specialist courses depends on the type of course (1-4 semester courses: plus two semesters at most; 5 or more semester courses: plus four semesters at most). This maximum admissible time may be exceeded when students are granted an extension.

Chemistry Kollegs are found in Vienna at HBLVA für Chemische Industrie[65] and in Graz[66].

63 http://www.htl-wels.ac.at/aktuelle_homepage/main_frameset.htm
64 http://htl17.at/
65 http://htl17.at/
66 http://www.ams.or.at/b_info/ychoice/A2858.htm

2.1.5. Fachhochschulen in Austria[67] - not for chemistry courses

In Austria the law concerning Fachhochschulen, the Fachhochschulstudiengesetz, was passed in 1993. The basic idea of this law is the same as in Germany which is to establish a branch of the tertiary system education (ICED level 5) which is more industry-orientated compared with universities.

In 2003/04 144 Fachochschule courses existed with about 22.000 students of which more than 50% of the students attend Fachhochschule courses in the field of technical sciences (economic sciences: 35%, sociology: 6%, tourism: 4%). About 7.400 students will start in autumn 2004. In total about 7.500 students have finished this type of education to date.

In Austria Fachhochschule courses were established mainly in fields that are not covered by universities. Some names of such Fachhochschule courses sound a little bit „exotic", even for a native German speaker. The reason for this can be found in the fact that universities play the leading role in the accreditation board for Fachhochschule courses in Austria. Thus universities successfully prevented the development of Fachhochschule courses in most of the classical fields of natural science. Hence there are no Fachhochschulen offering chemistry in Austria.

The main reason for this restrictive behaviour is a structural problem of Austrian education at level 5 and 6. In Austria 6 sites for chemistry at universities exist, 2 in Vienna, 2 in Graz, 1 in Linz and 1 in Innsbruck. Beside these 6, there are 3 traditional universities which have chemistry departments (Salzburg, Leoben and the Universität für Bodenkultur, Vienna)

The number of students has decreased in the last years and the rate of unemployment for people with a university degree in chemistry has increased.

Until now no solution for these structural problems has been found and universities have failed to adapt curricula to the new demands of the labour market.

The driving force of Bologna declaration in 1999 was to enhance mobility of students and employees in a common market. To reach this target the curricula in different countries within the European Community must be comparable in terms of credit points and possible degrees (Bachelor, Master, PhD).

In 2002/03 74 of these short time courses with a Bachelor degree were offered at Austrian universities. This number was increased to about 150 in 2003/04.

Starting in autumn 2004 about 80 Fachhochschule courses were be adapted to the new system:

- students will be awarded credits to make courses comparable (ECTS: European Credit Transfer System)
- Bachelor degree after 6 semesters
- Master degree after another 2 to 4 semesters

2.1.6. A trans-national co-operation in chemistry: EFF/HBLVA für chemische Industrie

The co-operation between EFF-Fresenius (Idstein, Germany) and HBLVA (Höhere Bundes- Lehr- und Versuchsanstalt, Vienna) was a step by step process :

Step 1: pioneer phase

Two students of the post-secondary course for chemistry at HBLVA went to Germany. After the comparison of curricula and an entrance examination (Einstufungsprüfung), they completed their course in 1999 within 4 semesters at EFF Fresenius.

Step 2:
thorough comparison of curricula and regulations

The existing curricula and regulations concerning examinations at HBLVA were adapted with the aim of making them comparable with our partners in the EU.

The main adaptations were:

- new definition of training and teaching aims in several subjects
- more weight on, and time in, the subject time table for applied mathematics
- diploma project (6 months in the final year, teamwork)
- new regulations for final examinations (similar to the Diplomvorprüfung at EFF Fresenius).

Step 3:
formal agreement between EFF Fresenius and HBLVA

This agreement enables students of HBLVA to achieve a higher qualification in chemistry at EFF within 4 semesters.

Basic principles are:

- the full responsibility lies within EFF in compliance with German law
- students have to fulfil the same preconditions
- the curriculum is the same as in Idstein. Starting in 2004/05 a new curriculum was installed. 3 optional modules will be offered: Marketing; Management; Bio-analysis and Biotechnology, out of which two have to be chosen
- teaching is performed by German and Austrian teachers after approval by HMWK (Ministry of Science and Culture of Hessen, Germany)
- all oral examinations (diploma-examination, disputation) take place in Idstein
- written examinations are held in Vienna

Step 4:
establishment of Fachhochschule course in Vienna

The main disadvantage of the co-operation before 2000 was that Austrian students had to go to Germany staying there for at least one year (high costs for accommodation...). Hence a Fachhochschule course (4 semesters) was established in Vienna. The first Fachhochschule course started at HBLVA in 2000/01 with 13 students.

67 www.Fachhochschul-plattform.at; www.fachhochschulen.at; www.Fachhochschulf.at

Entry requirements to the third year of Fachhochschule are minimum grades in the HTL- or Kolleg final examination and written examinations in 1 or 2 fields. Moreover, students must take part in bridge courses during their last year of Kolleg or HTL, and must successfully complete a course in Physics during their first semester at Fachhochschule.

The number of attendants rose from 13 beginning in the year 2000 to 23 in 2003. In total 41 students have finished the degree Dipl. Ing. (FH) until July 2004.

This co-operation is the first of its kind in Chemistry between both countries and is a result of the LEONARDO-project IDEAS (see 1.5.2.).

2.2. Country report Germany

2.2.1. Overview: Current situation

The German educational system is extensiveley described with graphics and annotations in a review published by DAAD and HRK.[68] Fig. 5 (p. 20) shows a scheme as used in the Diploma Supplement forms for Germany. The present report deals with such educational schemes that include compulsory practical experience in a working environment: It includes the Dual Vocational Training, Berufsfachschulen, Technikerschulen (ISCED 3 and 4) , Unversities of Applied Sciences (Fachhochschulen) and the Berufsakademien (ISCED 5).

Five main features are important for the current situation in the ISCED 3 and 4 context[69]:

- The traditional system of dual vocational training, alternating between a working environment in a company and a school, seems to be eroding: big companies outsource their vocational training into newly founded or outsourced training companies; the smaller companies face increasing difficulties in offering such dual training.
- New learning forms including project work have been integrated into vocational training. Industry makes solid marketing for chemistry related vocational studies and jobs[70].
- Highly gifted young people opting for a dual training starting into their professional career often feel bored when being trained together with less gifted ones; they tend to leave their first job soon to continue their studies. Many young people try to leave or avoid shift work: they add further training or studies to their first vocational training in an attempt to find more highly qualified jobs.
- There are initiatives to develop European standards and a European scheme for vocational chemical training, being based on the ECTS approach[71], including a LEONARDO project[72] which is linked to the FACE (see 1.5.2.). Some project members are active in both projects.
- Vocational Training based in schools (Berufsfachschulen) now contains a compulsory internship of at least four weeks; some of which are completed abroad (LEONARDO project PIVOT of Europa Fachhochschule Fresenius, see 1.5.1.).

Five main features are important in the ISCED 5 context:

- An increasing number of BSc and MSc courses are offered[73]. There is a clear political message from the government that they will have to replace the current Diplom-system by 2010[74]. The chemical and engineering community are working towards this aim[75]. Professional societies and social partners have published memoranda on this issue[76]. A national meeting organised by FACE, the Hochschulrektorenkonferenz, the social partners and GDCh has discussed employability aspects of the new degree courses[77].
- Accreditation has become a part of the review system, replacing, step by step, the control of the Federal States' governments. A special accreditation body for Chemistry and Bio-Science Studies, ACBC, merged into ASIIN[78].
- The clear distinction between classical universities and Universities of Applied Sciences (Fachhochschulen) begins to erode, because both institutions can offer BSc and MSc degrees which do not bear allusions to the delivering institution's status any more. There are strong tendencies against this within the classical „Scientific Universities" having a critical eye on the development. This also holds true for the sector of Chemistry. A recent model project draws the ultimate conclusion and will merge a Fachhochschule and a University in one single organisation[79].
- With their now 33 year old tradition Fachhochschulen are still renowned in industry[80] for their short/concise, near-to-the-practice alternating study courses. A recent discussion paper of a DECHEMA working group opts for a 7 semester BSc including the traditional practical semester. During the meeting of Hochschulrektorenkonferenz (see above), industry representatives have given an almost unanimous vote that the proved profile of Fachhochschule courses with their orientation towards practice be preserved in the new context, and that therefore the 6 semester Bologna minimum course duration be not imposed on institutions offering a practical semester in industry.

68 Christian Bode, Wener Becker, Rainer Klofat, Universities in Germany. München 1995. ISBN 3-7913-1496-3. There is an offprint with the tables and graphics
69 http://www.chemie-im-fokus.de/e-swf/index.swf
70 http://www.chemie4you.de/default.htm
71 http://www.bundesregierung.de/dokumente/,-589192/Periodischer-Bericht/Berufsausbildung-soll-auf-das-Hochschulstudium-angerechnet-werden.htm
72 http://www.bvct.de/Leon/projekt.htm
73 http://www.che.de/news.php?id=161
74 http://www.hrk.de/161.htm
75 http://www.gdch.de/oearbeit/press/2004/01.htm; http://www.gdch.de/taetigkeiten/ausbildung/info_neusg.htm
76 http://www.gdch.de/taetigkeiten/ausbildung/info_neusg/chemorg.pdf
77 http://www.hrk.de/de/download/dateien/gdch(2).pdf
78 http://www.asiin.de/
79 http://www.che.de/projekte.php?strAction=show&PK_Projekt=222
80 Cf. Hans Jürgen Brackmann, Warum die Wirtschaft das praxisorientierte Angebot der Fachhochschulen besonders schätzt. In: Fachhochschulen in Europa. Internationale Fachtagung „Information, Kooperation und Anerkennungsfragen". BMBF Bonn 1997, p. 36

- There are „dual type“ Fachhochschule courses, integrating alternating times in the company and in the university[81].
- With the Berufsakademie, a new type of course and institution was formed where students are employees of a company and work there half time, while they study the rest of the time (normally half a week for each task); see e.g. Studienakademie Riesa, member of FACE. There is, however, no Berufsakademie for Chemistry.

Following the Bologna Declaration[82], Germany has committed itself to[83]

- introduce a system of transparent and comparable degree courses, all of which will be documented in a Diploma Supplement.
- introduction of a two cycle course system consisting of a Bachelor and a Master course, with 6-8 and 4-2 semesters, respectively.
- modularisation and Credit Point System in all courses
- fostering of mobility of students and removal of hindrances
- fostering of European co-operation in quality management of education

2.2.2. „Duale Ausbildung“

The first level of German vocational education is based on a dual approach:

1. basic training in a school or a training lab or training production plant
2. training in a workplace in industry.

This is the basis of the German apprenticeship programme. While big companies may have both elements in their own training schemes or in special training companies founded by them as a form of outsourcing training activities, smaller companies normally cannot afford the basic training. Instead, they may share multi-firm training shops to complement their training on the job (see 3.2.5.).

Apprentices are supposed to enter the dual system training as early as at the age of 16. School training acquaints students with the most important theoretical concepts of science, in this case chemistry, and with basic skills needed in their jobs, including laboratory safety and environmental protection. Training on the job introduces students to the real world of industry at an early stage and helps them to develop the right attitude towards work. Important components of the right attitude are cleanliness, orderliness, punctuality, reliability, a systematic way of tackling problems - elements of good working habits.

School training being always oriented towards practice, the close relationship between theory and practice motivates apprentices to comply with both classroom and work-related components of this dual approach. The usual „practice shock“ experienced by young people starting jobs after an educational experience restricted to the classroom is thus avoided.

An excellent introduction for young people covering the various types of apprenticeship in the chemical industry is given at a website „chemie-4-you“[84].

2.2.3. Berufsfachschulen[85] (Assistentenberufe)

Berufsfachschulen are level 3 institutions offering a two year vocational training for young people having successfully completed grade 10 (mittlere Reife). They are an alternative to the dual system offered by companies. Chemistry (CTA) and Biology (BTA) are the options relevant for the sector, although some pupils from PTA-Lehranstalten (for pharmacy) are also employed in the pharmaceutical industry. CTA and BTA have to do a compulsory work placement since 2002.

Along with the studies, some schools offer courses for Fachhochschulreife (FHR), which, together with half a year of professional practice, give access to Fachhochschulen.

2.2.4. Fachschulen (Chemietechniker-Fortbildung)[86]

Fachschulen are institutions of further education, offering two year courses for people having successfully completed a vocational training course, especially in the dual system. They obtain, along with the course, access to Fachhochschulen (with an exam in Technical English as an additional requirement).

Their mostly excellent vocational training history gives them a good chance to obtain a deeper insight into theoretical foundations of their field, to broaden their spectrum of skills and knowledge which can be limited, depending on their training company; and to bring knowledge and skills acquired years ago up to date.

2.2.5. Fachhochschule in its context

On-the-job training as offered in vocational training of the dual system type (see 2.2.2.) combines learning with practical work and leads to productive achievement. From the very beginning the trainee is familiarised with changing situations at the workplace and is involved in the productive process. He or she thus sees the practical results of his/her endeavours. This gives him/her the necessary motivation, also the motivation to learn more. In Germany, the apprenticeship approach is somehow extended to higher education in science and engineering by the Fachhochschule model.

On a higher level of vocational training, more theoretic background information is needed while maintaining the close relationship of training to practice. This means that there must be specialists with a sound basic science education in

81 A good example is FH Niederrhein, s. http://www.hs-niederrhein.de/fb01/
82 The Hochschulrektorenkonferenz offers excellent expert service for university in this context, see http://www.hrk.de/de/service_fuer_hochschulmitglieder/155.php
83 http://www.hrk.de/161.htm
84 http://www.chemie4you.de/html/c4u_home.html; http://www.chemie-im-fokus.de/e-swf/index.swf (also covering Berufsfachschulen and Fachschulen)
85 http://berufenet.arbeitsamt.de/bnet2/C/kurz_B6261105.html
86 http://www.vdc-cta.de/chemietechniker.html

theory (knowledge) and practice (skills). Sound basic knowledge is indispensable for a successful adaptation of new elements. Practical skills including good working habits are indispensable for working safely and obtaining correct results. In order to meet the requirements of their later employment and to be fully motivated, the future specialists must have hands-on experience at an early stage of their professional training.

This is exactly where the Fachhochschule concept offers a model which integrates sound basic science training and practical aspects. In contrast to concepts like a classical B.Sc. education with no internship or sandwich structure, one could call the Fachhochschule an apprenticeship with emphasis on scientific understanding, or „a scientific vocational training oriented towards practice".

It is not by mere chance that founders of German chemical companies received their first training in an apprenticeship program offered by Carl Remigius Fresenius, founder of Chemieschule Fresenius in 1848. They were trained in his Institute on the job. In 1930, the school's curriculum for Chemical Technicians was accredited by the government.

The Fachhochschule concept is based on earlier experience with the Ingenieurschulen. Access to these Technical Colleges was restricted to practitioners with a preliminary apprenticeship and professional experience. These people received further qualification and training in the Ingenieurschule. While today's Fachhochschule is also open to young people with Abitur or Fachabitur degrees, it has preserved the orientation towards practice, short duration and the broad basic training approach of the old Ingenieurschule.

Currently, 20,000 or 3-4% of the employees in the German chemical industry are Fachhochschule „engineers"[87]. The high demand for these engineers and other practice-oriented professionals led Sontheimer to the conclusion that more Fachhochschulen should be founded on the expense of existing universities. This is the policy of German Federal States including Hessen.

A comprehensive but concise review of the general aspects of the current Fachhochschule situation is given by the Vice President of Germany's Rectors' Conference, Clemens Klockner in ref[88].

General trends are increasing numbers of female students, a strong decrease in the numbers of graduates per year and a small increase of the number of Fachhochschule beginners.

Another special „German" feature is that traditionally 90% of the classical universities' Chemistry graduates leave with a PhD (Dr.).

A complete search on chemistry and related courses can be carried out using the Hochschulkompass[92].

Four main features of Fachhochschule courses:

A. Practical training in the laboratory (Praktikum)

Definition:

A typical Fachhochschule student will spend up to 40% of her school life in laboratory sessions called Praktika. This reflects the importance which the Fachhochschule curriculum places on the development of practical skills. In many curricula, typically small amounts of laboratory time are devoted to experiments which see merely to make theory plausible. The purpose of laboratory practice in Fachhochschule curricula is not only to develop understanding but also the ability to perform experiments and to obtain correct results. This requires training - more training than can be given in short laboratory sessions.

Pedagogical components:

Laboratory sessions are carried out under the guidance and supervision of experienced instructors. They are normally preceded by an introductory seminar or private study of the student using written material supplied by the Fachhochschule.

People involved:

Instructors should have good practical skills in the relevant field. Transfer of know-how to instructors may require that an instructor comes to a Fachhochschule as a guest and is acquainted with the programme and trained by the colleagues.

The latest statistics of GDCh[89] report the following figures: **Table 3**

	Number of institutions	Number of students	Number of Beginners 2002	Number of Diplom Graduates 2002[91]
Fachhochschule	28	4,723[90]	1,298	527
"Classical" University	55	24,121	5,453	969 (1394)
BSc/MSc new	?	1669/176	928/?	None

87 It must be explained here for the non-German reader that the translation of "Ingenieur" by "engineer" may be or is utterly misleading: While in the anglo-saxon countries, the term describes someone like a technician doing repair and maintenance, in German (and in France) he or she is a tertiary level graduate of high scientific and/or technical renown. A Chemieingenieur is by no means restricted to unit operations and petrochemical production - he or she may well be a specialist in Organic Synthesis or Analytical or Environmental Science.

88 Bernd Wächter (ed.): Internationalisation in European Non-University Higher Education. A Project of the Academic Corporation Association.. ACA Papers on International Cooperation in Education. Lemmens, Bonn 1999. ISBN 3-932306-35-X.

89 Cf. http://www.gdch.de/ks/publikationen/statistik2003.pdf

90 Among which there are 41 % women!

91 in ( ) number of doctoral exams, mostly Dr. rer. nat.

92 http://www.hochschulkompass.de/

B. Work in industry (Praxissemester) (see also 4.)

Definition:

In a typical Fachhochschule education, students receive 2 years of basic science training. Beginning from the first contact they have with Fachhochschule, they are encouraged to do practical work in the chemical or related industries. Some do this before they study, some during semester holidays. Nevertheless, the semester following the first two years is completely devoted to practical work in industry, as an indispensable element of the curriculum.

Pedagogical components:

The Praxissemester exposes the student, after he or she has learned the basic subjects, to everyday work in industry. The purpose of this practical work is to prepare him or her better for the following 2 semesters with advanced courses. Practice-related elements of those will produce better understanding if the student can compare them to what he/she learnt during the Praxissemester. In addition, he or she will be better prepared for and maybe have established links for the Diplomarbeit (final year project) which is required in the future. At Europa Fachhochschule Fresenius, a teacher/professor of the Fachhochschule will tutor the student's work. The student has to give a daily written report of his or her work in the form of a laboratory journal. Students and tutors keep contact on a monthly basis. In most cases, tutors visit them at the work place. Students are asked to present their work and results and to discuss them with their fellow students and the tutor in a seminar, and to write up a report of some 30-50 pages.

C. Visiting faculty from industry (Gastdozenten)

Definition:

Being practice-oriented, Fachhochschule education needs close contact to and constant input from industry to keep its teaching up to date. While the first two years focus on sound basic knowledge, semesters 6 and 7 are devoted to advanced studies and more special topics among which the student may select his or her field of interest. It is in this phase that visiting faculty from industry will bring most benefit.

Pedagogical components:

Visiting faculty members will introduce and help to solve problems faced by industrial scientists. Students will be taught to take into account problem solving approaches that result in greater efficiency with respect to cost of production and energy consumption. The German approach has demonstrated that this sort of teaching is much more motivating than a mere learning of facts and theories.

D. Applied research in industry (Diplomarbeit - Final year project)

Definition:

Classical Fachhochschule graduation requires, besides the usual examinations, 5 months of applied research or development work in industry or a research laboratory which is then documented in the form of a thesis.

Pedagogical components:

In a typical Fachhochschule education, students receive 2 years of basic science training and 1 semester of work in industry. After two more semesters of advanced training, they must work on a specific R & D task, mostly in a company or applied research environment.

2.2.6. Berufsakademien (BA) and part time courses

Berufsakademien for the genuine field of chemistry studies do not yet exist. The Berufsakademie Riesa (Saxony)[93] has courses in Environmental Technology and Security/Risk Management. There are, however, companies thinking about this approach and models „in the drawer". A general survey of Dual Education forms on a tertiary level was published by BLK[94].

A model similar to a BA is run in Krefeld (Fachhochschule Niederrhein). Students are employees of Bayer AG and follow a truly alternating scheme between apprenticeship, work in the company and studies.

The time for distance learning courses and unconventional while-you-work part time courses has come, and new developments of this type will emerge in the coming years.

2.2.7. Fachhochschule is not a closed shop: entry and exit are open for qualified students

Europa Fachhochschule Fresenius (EFF) has, in the course of its development and encouraged and sponsored by EU project money, developed an open system of chemical qualifications that permits access to Fachhochschule for holders of vocational diplomas from Austria (see 2.1.6.) and Germany. It was recently extended to holders of medical laboratory vocational diplomas. Elements that enable pupils of such schools to enter Fachhochschule are minimum performance (grading) as well as entrance examinations and bridge courses.

In the past years, the number of Fachhochschule graduates who continued their academic career (heading for a Masters degree and/or a doctorate, in Germany and abroad) increased to about 25% of a year's graduates; other Fachhochschulen report the same trend.

2.2.8. German Tertiary Education in the Bologna process

During a congress the Stifterverband für die Deutsche Wissenschaft organised in 2004, arguments about Bachelor and Master courses in engineering studies were discussed. One key finding of the congress is that the new two tier system must not erase the profiles of different approaches to employability, such as the practically oriented types of courses offered by Fachhochschulen[95].

93 http://www.ba-riesa.de
94 http://www.blk-bonn.de/papers/heft110.pdf
95 http://www.stifterverband.de/pdf/positionen_oktober_2004_bacheloringenieure.pdf

In a joint position paper on Bachelor and Master courses in chemistry, organisations of the social partners and professional societies publish their opinions on the introduction of Bachelor and Master courses in Germany. They confirm that Fachhochschulen should continue to put emphasis on the employability aspects of their programmes: „Fachhochschulen will offer application and practice-oriented courses that lead to a first degree allowing direct access to the labour market“[96]. Before, VCI and GDCh had already issued a position paper[97], the industry and the professional society agree that „...the different educational aims and the basic proven profiles (of Fachhochschule and University courses) shall be preserved as an indicator seal of quality.“

During the Bonn conference on Bachelor and Master courses in chemistry organised with the help of FACE, speakers from the 30 industry colleagues present clearly say they want practically oriented Bachelors with an obligatory placement semester. They also strongly recommend better transfer of skills and competencies acquired during vocational training to the tertiary sector (see 3.9.)[98].

A recent study of VCI-Nachrichten and Fraunhofer-Gesellschaft[99] backs the results of the Bonn meeting, saying that companies still need much information about the new two-tier system. It will be an important task of Universities and Fachhochschulen to give it, and to integrate companies at an early stage when they re-structure their curricula.

2.3. Country report United Kingdom[100]

(William J. Geary)

The country report for the UK, instead of giving a broad view of all levels of qualification, has set itself the task to thoroughly cover the subject of sandwich courses in chemistry, for which the UK has a long tradition. Structures and problems discussed here are typical for all placement programmes.

2.3.1. Introduction

The Royal Society of Chemistry (RSC) is the qualifying body for chemistry in the UK, and accredits first degree qualifications at the level of either Graduateship or Licentiateship (GRSC or LRSC). The level of accreditation is determined against criteria such as range and level of chemistry topics covered, laboratory studies, project work, complementary subjects, standard of assessment and examination procedures etc. The list of accredited courses for 1998 covers some 74 institutions of higher education (principally Universities), plus 7 in Ireland and 4 in Hong Kong. The courses themselves total some 520 for the UK; however, this figure taken in isolation is misleading for several reasons. Firstly, it is the number of courses accredited, and a high proportion of these accredited courses are „sub-sets“ of the main chemistry degree, in which part of the chemistry content is replaced by a specialised scientific topic (e.g. environmental studies), a foreign language, or some other topic (e.g. business studies). [As an aside, it is interesting in the context of this project that over 50 courses (> 10%) specifically mention European studies]. Thus, many Universities offer a core chemistry degree, with several „satellite“ degrees attached to it; the fact that the satellite courses recruit numbers that in isolation would be non-viable can be managed within the enrolments for the overall portfolio of chemistry-related degrees offered. Indeed, it is probably more correct to refer to degree programmes. A more realistic figure for „mainstream“ degree courses/programmes in chemistry is in the order of 100, but even this figure is complicated by the recent introduction in most English universities of so-called „enhanced“ degree courses lasting four years instead of the traditional three and leading to MChem/MSci rather than BSc. Most universities offer both MChem[101] and BSc, with a significant amount of common teaching, and frequently a common entry, so there is an element of „double counting“.

To identify sandwich courses from titles in the RSC list is difficult and misleading; there are some 40 courses for which industrial training is specifically mentioned in the title, but paradoxically these probably recruit fewer students than courses for which industrial experience is not mentioned. The latter most commonly are entitled BSc Applied Chemistry. In order to understand the basic provision of sandwich courses in chemistry it is helpful to examine briefly the changes that have occurred in Higher Education generally over the past 40 years (approximately), since the two topics are totally interlinked.

However, it is perhaps first worth stating some relevant statistics taken from the excellent report[102] „Change and Diversity : the challenges facing chemistry higher education“. This report was commissioned by the Council for Industry and Higher Education and the RSC; it raises many issues that are relevant to the present project. Some key data are:

- the growth in admissions to University degree courses in chemistry 1986-1995 was 37%;
- the total annual output of UK-domiciled first degree graduates in chemistry was 3846 in 1995 and 3879 in 1996;
- over one third of these graduates go on to study for a higher (chemistry) degree [compare 10% for the graduate population as a whole];
- the estimated total of UK residents with HE/FE qualifications in chemistry who were in employment (1991) was roughly 102,000.

96 http://www.igbce.de/Upload/erklaerung_bachelor-master_chemie_68041.pdf (translation by L.Gros)
97 http://www.vci.de/template_downloads/tmp_0/Bacherl.pdf?DokNr=90719&p=101 (translation by L.Gros)
98 Some of the presentations are published at http://www.hrk-bologna.de/bologna/de/1945.php. Special thanks to FACE expert dr. Kurt Begitt, GDCh, for his significant contribution to this meeting.
99 http://www.vdi-nachrichten.com/library/content/download/obj242_IAO_BA_MA%20Studie_2004.pdf
100 Acknowledgement: The author is grateful to Dr SJ Gruber, Former Education Officer (Higher Education), the Royal Society of Chemistry, for helpful comments. However, the opinions expressed are the sole responsibility of the author. Moreover, the author is grateful to Dr AD Ashmore, Registrar of the RSC and to Dr Kristy Macdonald of the Education Department of the RSC for their considerable help and advice, particularly in accessing and interpreting data on qualifications awarded.
101 Note: the inception of MChem courses has profound consequences for sandwich courses; these are mentioned later
102 cf. ref. 18, p. 9

2.3.2. Changes in Higher Education structure and the development of „Sandwich“ Courses

Until roughly the late 1950's, higher education in chemistry could reasonably easily be divided into two sectors. The university sector, consisting of Oxford, Cambridge, London, and a substantial number of provincial universities (some with quite a long history [e.g. Durham], many with foundations based in the prosperity of the Victorian era [e.g. Manchester, Bristol], some relatively recent [e.g. Leicester]), essentially concentrated on training students in „pure“ chemistry. The subject gave its own rigour and scope for intellectual development, a primary objective being to underpin the department's research effort through provision of well qualified graduates. Industrial chemistry scarcely impinged on the course content, and, unless they had some personal motivation, undergraduates would have little or no direct contact with industry. (There were of course some exceptions - for example if the university had a chemical engineering department, or had founded a [separate] unit for technological work e.g. UMIST). The merger of the (then) Royal Institute of Chemistry with the Chemical Society to form the Royal Society of Chemistry initially had little impact on relations between universities and industry, though the present day RSC is much more effective. Overall, it is fair to say that the university sector as it was about (say) 1960, had virtually no influence on the beginnings and early development of sandwich courses, and it is at least arguable that even now - despite some of them offering industrial placements - the influence of these traditional universities on the sandwich system is minimal.

The other area of (higher) education in chemistry in the late 1950's is best described as the vocational sector. It consisted of a wide variety of institutions, of different sizes, different level and range of course provision, and different designations. Most if not all such colleges had their origins in the need to provide training in areas of chemistry relevant to their employment for students unable or unwilling to study full-time for a degree. Thus they were different from universities in several key aspects; they developed a portfolio of courses at sub-degree level, the great majority of their students attended on a part-time day/evening release basis, there was far less emphasis on research, and - crucially - they were closer to industry and more responsive to its needs. There was a spectrum of colleges ranging from very large Colleges of Technology (e.g. Salford, Newcastle, Birmingham), some of which had the title „Polytechnic“ (e.g. Woolwich, Battersea, Northern), [not to be confused with the Polytechnics designated in the 1970's], to small and very localised Technical Colleges. Although it is a fascinating study, it is not necessary for this paper to discuss in detail the changes in provision in the vocational sector. The larger colleges became Colleges of Advanced Technology, and subsequently (Technological) Universities, many others became successively Polytechnics and then Universities, and smaller colleges have been left to concentrate on lower level work. For example, the UK partner in this study has, since 1967, been successively Sheffield Technical College, Sheffield College of Technology, Sheffield Polytechnic, Sheffield City Polytechnic, and Sheffield Hallam University.

It is possible to identify several factors that in parallel with the institutional changes outlined above helped to initiate the development of sandwich courses. The larger colleges had experience of degree level work, the courses either being validated by a university (frequently London), or leading to an award of the professional body (Associate of the Royal Institute of Chemistry [ARIC], subsequently Graduate of the Royal Society of Chemistry [GRSC]). As institutional autonomy grew, so did the pressure for colleges to be free to develop their own (degree) courses, and this was facilitated by the setting up of a central validating body, the National Council for Technological Awards (NCTA). This body soon became the Council for National Academic Awards (CNAA), and the CNAA had a profound influence on the development of sandwich courses. Thirdly, political decisions led to steps to increase very substantially the numbers of students going on from school into full-time higher education, and whilst this was partly accommodated by the founding of new universities (e.g. York, Warwick, Essex), it crucially led to a rapid expansion in advanced technological/vocational education in the public sector. It was recognised in the colleges that new courses should draw on the strengths of the system, particularly industrial contacts and relevance, and that the interlinking of academic study and industrial experience was highly desirable. It was apparent also that whilst study by day release has many merits, to retain this system through to final degree level is extremely demanding for students, requires lengthy commitment to release by employers, and leads to imbalances in demand on academic staff and resources. Several alternative structures were developed; for example, a popular route to GRSC was to study by day release to „part I“ level (roughly Ordinary degree), followed by one year full-time to part II (final GRSC). Many colleges experimented with „block release“ courses - mixtures of part-time study and short (a few weeks) blocks of full-time study. Although the latter have merits, particularly for relatively short courses, they are difficult to sustain for the length of time needed for a degree course. It was recognised that a better and more efficient system is full-time study, interspersed by (a) period(s) of industrial experience. Thus sandwich courses in the form in which we now know them began to be developed in the early 1960's, and are now regarded by a significant number of universities (circa 20) as the „normal“ structure for their courses.

The data given by Mason[103], taken in conjunction with the list of RSC accredited courses, suggest that a quarter to a third of chemistry undergraduates [roughly 1000] are at any time on sandwich courses. This is a small proportion (approx 1%) when related to graduate chemists in full-time employment.

103 see ref. 18

2.3.3. Typical placement structures

At the time when sandwich courses were first being developed the normal duration of a degree course was three years, and in designing the early sandwich courses there was resistance to extending this by too much, and maximum use was made of the „long“ summer vacations. This was quickly recognised as being less than ideal, particularly in terms of the almost continuous demands on students, and the typical duration of a sandwich degree course became three and a half years, and (very quickly and almost exclusively) four years[104].

A. „Thin“ sandwich structures

In the early stages of the development of sandwich courses the preferred structures normally had two separate placement periods totalling one year in a four year course. Typically the first and the final years were spent in college, and the second and third years were divided more or less equally between placement and academic study:

Year 2: August - January (inclusive) placement,
February - July (inclusive) academic study

Year 3: Either as year 2, or with the periods reversed

(It will be apparent that there are other variants - for instance, the placement/academic split can be reversed in year 2 also). Individual colleges refined these structures to suit their own timetable constraints, to try to ensure staff availability for progress visits at appropriate times, to give students on years 2 and 3 the same vacations as colleagues on non-sandwich courses, and particularly to avoid the need for a mid-term changeover that is an inevitable consequence of a rigorous „6 months in, 6 months out“ system. Probably the most popular variant of the thin sandwich structure was:

Year 2: Autumn term placement,
Spring/Summer terms academic

Year 3: reverse

This structure was perceived as having the advantage of three 12-month periods of study (albeit one being a calendar year). However, experience of operating thin sandwich courses soon revealed problems that were more fundamental than those of timetabling. The benefits both to students and to employers of, particularly, the first period were frequently disappointing. A single year of academic study, much of which required major attitudinal changes to deal with the transition from school to university working, allowed very little time (frequently none) for overt preparation for placement. Students frequently started placement underprepared in both skills and attitudes, and employers found great difficulty during the rather short first placement period in giving students worthwhile and non-routine tasks, and in getting a reasonable „payback“ for their effort. The comment „he/she was just becoming really useful when he/she had to leave“ became commonplace. Some organisations felt unable to accept students for the first placement period, with a consequent imbalance in supply of placements. Students often were disappointed with their experience (even though they almost always returned to academic life more mature and resilient than hitherto), and this affected their attitude to, and preparation for, the second placement period. Although in practice the second placement normally was more satisfactory than the first, dissatisfaction with the thin structure from both groups of participants (students/employers) led to its replacement by the „thick“ structure, and at the present time it is believed that only one university offers a thin sandwich course in chemistry (S.J. Gruber [RSC], private communication).

B. „Thick“ sandwich structures

The so-called „2:1:1“ structure is now almost universally used. Assuming that an academic year typically ends by the end of June and starts at the beginning of October, it is apparent that there is a period of fifteen months between the end of year 2 and the beginning of year 4, and a twelve month placement period can thus be easily accommodated, whilst still allowing reasonable vacation periods for students. Provided that the University's regulations for the length of the placement period (normally 52 weeks) are met, the exact starting and finishing dates are open to negotiation. However, experience shows that industry prefers continuity with successive placements „end-on“ i.e. having a common finishing and starting date. There are many perceived benefits of a twelve month placement.

There is scope for the student to undertake a variety of tasks, yet at the same time probing more deeply into particular problems or techniques in a research project format. There are better opportunities for students to find out how the host organisation operates, to attend „in-house“ courses, to develop personal relationships, and so on. [In the nature of the „thick“ structure the student is a year older (typically 21) when starting placement than on the „thin“ structure.] Further, since there are two years of study before placement, there is more opportunity for pre-placement training. These benefits to the students are of course benefits to the employer also, and the „pay-back“ is far greater than for „thin“ structures. However, it should be recognised that there are problems as well as benefits, principally deriving from students being away from study for some fifteen months. Experience shows that quite frequently students have difficulty settling back into a satisfactory study regime, and - although they will rarely admit it - they miss the time keeping discipline of placement. These problems are particularly severe given that students are starting the final year of study, with less chance of recovering from a poor start to the year. Universities have tried to combat these problems in various ways, for example by providing structured academic work whilst on placement, and by bringing students back to College one or two weeks immediately before the final year for „de-briefing“ sessions. The biggest problem for industry is what to do with students who - for whatever reasons - are unsatisfactory. On the „thin“ structure, such students could be tolerated for the relatively short placement periods, but there may be resistance to keeping them on for a full year. On the whole, however, the „thick“ structure works well for all concerned, though we may ask the following questions for discussion.

104 Note : For much of the period covered by this review many colleges also offered Higher National Diploma (HND) courses, extending over two years full-time or three years sandwich, frequently with transfer arrangements with degree courses. In this review HND courses will not be considered separately from degree courses.

2.3.4. Organisation and conduct of placements

A. Name/Title

In early development use was made of terms such as industrial training, industrial placement, and (to recognise that not all placements are in industry) training placement. Latterly, to try to reflect the greater attention paid to making the placement period a truly integrated part of the overall course with its own clearly defined educational purpose, more sophisticated titles such as structured work experience have come into use. Recently, partly to emphasise the training aspects and partly to offer comparability with other subjects/courses the term professional practice unit has come into use. It is recommended to continue to use this term.

B. Staff requirements

Clearly, this depends on the number of students to be placed annually. At the simplest level, when placement is an optional extra to what is normally a full-time course, it is typical (and probably sufficient) for one member of academic staff to act as Placement Tutor. He/she acts as a focus and information centre for students seeking placement and for organisations seeking students, but is only marginally involved in any selection process.

At the other extreme, such as that in which the author was involved, all students on the relevant courses are required to undertake placement, and this requires a substantial staff input. The author was coordinating placement tutor for a portfolio of degree and diploma courses spanning chemistry, physics and biomedical subjects; this covered some eight courses and in the order of 250 students per annum. There were three other members of academic staff who were placement tutors for individual subjects/courses, two administrative officers, and secretarial assistance.

This group of tutors was responsible not just for arranging placements but also for making arrangements for, and monitoring the effectiveness of, staff visits to students on placement. All other placement activities e.g. debriefings, oral presentations, assessment etc, were also organised through the group. Particularly in connection with assessment, which has been a contentious and rapidly developing area (vide infra), the group had a substantial development role. This major input of staff time is a necessary consequence of the placement organisation (the University) taking a major role in obtaining satisfactory placements for all of its students. The alternative system, whereby the student is responsible for arranging his/her own placement, is less demanding of staff time but is less easy to control, has a higher risk of poor quality placements, and crucially is not liked by industry.

It is the firm belief of this author that if a University has a commitment to sandwich education it also has a responsibility to provide sufficient staff and material resources to ensure that as far as possible all students have a high quality placement.

However, the provision of staff on this scale raises the need to answer several questions, amongst which are

- What are the costs, and the cost effectiveness, of the placement year in relation to a full-time year ?
- Given the need to be creative (e.g. through research) what is a reasonable balance of time between placement and other activities for the placement tutors?
- If coordination of placement activities is seen to work well on a Faculty basis, is there a case for extending it to a centralised unit for the entire University?

C. Material resources

Whatever the level of staff input a fundamental requirement of an effective placement Unit is that students should have unrestricted access to information about available placements and the organisations offering them e.g. current literature, application forms, reports on previous placements. There should be interview rooms, current vacancy notice boards, fax and direct line telephone facilities. The administrative and secretarial staff, and at least one of the placement tutors should have offices in the Unit. Secure storage for sensitive/confidential information is essential.

There will be a regular need for tutor-student meetings (both large and small), so proximity to seminar rooms is valuable.

D. From application to acceptance - a chronological view

It is fundamental to a successful placement that both the student and the employer should not only be satisfied with the eventual outcome but should also feel that the process of selection/matching was equitable - the student should feel that he/she was given a fair range of openings matching his/her aspirations, and the employer should feel that a fair and appropriate set of applicants was offered. Based on experience, it is the writer's contention that this ideal is most likely to be achieved if the following apply:

- the placement tutor knows the student well - this may sound obvious, but there ways (see below) of optimising it;
- the placement tutor not only knows the employing organisation well in terms of type of work, but also knows key personnel well;
- without stifling individuality and self-expression in written applications, maximum use should be made of standardised formats for e.g. curriculum vitae;
- students are given thorough training in communication and interpersonal skills (e.g. CV preparation, interview techniques.)
- as part of the information they receive about a student, potential employers should be given a brief but frank assessment of the student's strengths and weaknesses, in terms both of academic ranking and personal characteristics. The latter may be contentious, but in the writer's experience is valued highly by employers.

Year 1[105]

The placement tutor should take as many practical classes with first year groups as his/her teaching timetable (which is in any case restricted because of the burden of placement duties) can permit. This point also is contentious - it is argued that administrative responsibilities should not determine the focus of teaching duties - but it is the writer's experience that this is the best possible way of getting to know students.

First week of summer term (mid to end April) : formal meeting (attendance mandatory) with entire first year group to present, and answer questions on, placement opportunities and procedures. Also distribute draft CV forms, with a requirement that they should be submitted before the end of term, either handwritten for typing by the placement secretariat, or to an acceptable standard on the student's own PC/WP.

The overall objective is for the Placement Unit to have a stock of CVs, roughly to a similar format and standard, for all students by the start of Year 2. There has been an increasing trend in recent years towards student generated CVs.

Year 2

It is necessary to recognise that however carefully the optimum procedures are followed, the complexities of matching perhaps sixty second year chemistry students to appropriate vacancies, preferably by Easter of the second year, is best described as organised chaos! Only the most general guidance can be given.

From early September the Placement Unit circulates all known and potential employers asking for details of vacancies for a start the following summer. Frequently there are difficulties for small and medium sized enterprises (SMEs) in making a commitment so far ahead, and this is a problem not only for the SME but also for those students wishing to join, or best suited to, an SME.

During the first two weeks (maximum) of term, the Placement Tutor interviews individually all students needing placement. The objectives are:

- to complete an appraisal of the student's personality with particular reference to oral skills, ability to withstand questioning, and interview potential;
- to ascertain the student's preferences (if any) for type of work, and particularly situations which he/she will not accept (e.g. companies involved in animal testing, nuclear power etc);
- to ascertain the student's preferences (if any) for the geographical location of the placement;
- to draw up a provisional list of placements to whom application may be made.

Difficulties that may arise at this stage include:

- accommodating the wishes of home-based students, particularly if they have domestic responsibilities;
- preparing an order of preference if there is interest in (and from) several organisations;
- establishing a protocol for accepting offers - should it be mandatory to accept the first offer received, how long can offers be held, is it tolerable to reject an offer, particularly if the vacancy cannot then be offered to another student, etc? [Note : it was the writer's view that unless there were over-riding objections the first offer should be accepted, even though to some extent this may conflict with the concept mentioned earlier of students being given a fair range of openings.]
- making arrangements for overseas placements.

The organisational problems which occur once the application stage is underway are formidable. Some organisations prefer application forms to CVs, interviews will be necessary either in the University or at the placement site, or both, students will need to miss classes etc. Performance at interview is crucial, and it is essential that students are fully briefed beforehand, ideally through reading reports from previous students. In the limit, however, success or failure is in the hands of individual students, and the placement staff primarily are facilitators.

Conditions of service are a potential problem. They may vary widely, according to the nature of the organisation and its geographical location. „Hidden" benefits such as holiday entitlements, subsidised meals etc need to be clearly established. It was a firm rule in the writer's Unit that contractual matters were negotiated by placement staff not students, though the outcome must be acceptable to students. More importantly, however, the nature of the work which the student will (or is likely to) undertake needs to be understood by all concerned. It is now common practice for some kind of formal written contract to be agreed.

The final stages of the Year 2 placement activities are concerned with ensuring that all students are clear about all aspects of their forthcoming placement, and this is normally achieved through briefing sessions at which students are given detailed information both orally and through documentation.

The Placement Year

There have been tremendous changes in attitudes to placement, the way it is run, its assessment and the use that is made of that assessment. The rate of change has itself increased greatly in recent years, and what was for many years a rather informal process has now become (particularly in the newer Universities) a highly organised regime. The progress made by an individual student, originally expressed in terms of increasing maturity as a consequence of exposure to unfamiliar (industrial) situations, has given way to predetermined learning objectives and outcomes, and much closer integration of academic and placement activities. Changes in assessment have been the most dramatic. Until quite recently assessment was at best semi-quantitative, against criteria such as ability to discuss results, practical skills, planning of work etc. Marks or grades were rarely used; a satisfactory placement was indicated by an endorsement of a final degree certificate, possibly by a separate certificate of placement, or even being used as a bonus for students on borderlines between final degree classifications. It was argued that

105 Note : the chronology which the follows is based on, and was developed for, a 2:1:1 system with a large throughput of students; it may not be entirely appropriate if other circumstances apply

the wide variation in the circumstances of the placements for a given group of students made valid comparisons dangerous. For example, although satisfactory in their own right, a placement in (say) a pharmaceutical research laboratory could not validly be compared with (say) one in the production department of an SME, or in a Forensic Science Laboratory. The writer believes that this argument has a lot of truth in it. However, the advent of unit based [modular] courses together with credit transfer systems has proved a catalyst for change. Most courses have their own characteristic assessment scheme, and it is unrealistic to attempt to summarise them. As a generalisation, courses for which placement is mandatory are most likely to have a scheme giving a more or less quantitative assessment of placement; it can be argued that any deficiencies in the assessment scheme will affect all students equally. For an optional placement year it is more difficult to incorporate a quantitative mark in a classification scheme, and assessment may be less rigorous. It is reasonable to use its scheme as a model, though it should be understood that the scheme is more rigorous than most. However, because of the complexity of the scheme the documentation is lengthy (ca 20pp) and is not reproduced here.

Briefly :

Performance Review	15
Written Report/Tutor Interview	15
Oral Presentation	10
Learning Portfolio	10
Written Review	50
Total	100

The mark is converted to a figure out of 20 for level 3 credits, there being a total of 120 level 3 credits for final degree classification.

Given the complexity of the scheme it is vital that the student keeps good written records of tasks and outcomes, and that the Work Placement Supervisor (WPS) plays a very full part - indeed it has been suggested that the scheme requires too much of the WPS.

It is also worth noting that several of the assessments are not made until the student is into the final year of his/her course, which may be a distraction for final year studies.

E. Placement in MChem/MSci courses

Virtually all Chemistry Departments in UK universities have now introduced so-called „enhanced degree courses“, labelled MChem or MSci, the traditional 3 year full-time course being extended to 4 years. The prospect of a four year „sandwich“ course becoming 5 years is too daunting for most students, and hence the curriculum has been repackaged.

F. Conclusions and future prospects

„Sandwich“ courses developed essentially pragmatically as academic institutions responded to the needs of employers and people who either worked in industry or had aspirations to do so. They are now a significant and distinctive part of chemistry provision in higher education in the UK. They remain popular with employers, and arguably are the most effective form of cooperation between UK universities and chemical industry (see ref 20, p40). Whether they are the most cost effective way is another matter, and a thorough study of the costs of sandwich courses might prove interesting.

The future for chemistry sandwich courses seems neither more nor less assured than that for full-time courses in the present climate of financial stringency. Those departments whose research base is most at risk (essentially the former Polytechnics) may find their industrial links a lifeline for survival, and it is surely in their interests to promote and develop placement as a distinctive feature of their courses. The feedback from industry should facilitate regular up-dating of course content. It is interesting to note that the two most recent closures of Chemistry departments in the UK are Swansea and Exeter, both middle ranking ‘traditional’ Universities. Many of the former Poilytechnic Chemistry degree courses have reinvented themselves as applied (forensic, pharmaceutical, biomedical) Chemistry courses and these have proved attractive to students. All have retained their placement structure.

The 2:1:1 structure seems firmly established, and the assessment of placement has probably become as well developed as is justified at the present time - indeed, care must be taken that assessment and the associated bureaucracy does not hinder a creative approach to placement.

It is the writer’s experience that there is a case for a centralised placement agency, concentrating particularly on vacancies in SMEs; the larger employers are better placed to make their own arrangements, and normally have contacts already in place.

Information storage, retrieval, and communication via the Internet have had a profound effect on industrial training procedures, particularly in helping to convey details of students to industry, and vice versa, and to this extent is to be welcomed. However a note of caution is necessary: there is no substitute for a good industrial training tutor who knows his/her students, knows the placements, and can make appropriate links between the two.

The Royal Society of Chemistry has made a welcome step by establishing a database of student work placement opportunities[106]. Companies supply details of vacancies, which can be accessed either electronically or by post/telephone.

Finally, in the context of the project FACE, it is hard to overestimate the merits of European placements, and it is essential that maximum effort is put in to their development.

106 www.rsc.org/industrialplacements

2.3.5. Developments of the past 5 years

In the past years, there have been profound changes in many aspects of education and training in chemistry, and several of these changes are affecting sandwich course (alternating studies) provision. This up-date reviews these changes, and considers the effects on course provision. Rather than making changes to the text of the original report, the author has preferred to write the up-date as a self-standing article, with cross-referencing where necessary.

A. MSci/MChem

The development of four year programmes of study leading to MSci or MChem has continued strongly, and such programmes are now the core provision for most Universities (principally those previously identified in the previous chapters as „the University Sector") offering „degree" level studies in chemistry. Virtually all of these programmes have been accredited by the Royal Society of Chemistry (RSC) as satisfying the academic requirements for the award of Chartered Chemist (CChem), and this is an important factor in their favour - not least from the viewpoint of recruitment. The 2002 list published by the RSC[107] includes forty two Institutions and (using the definition developed in section 2.3.1.) some sixty programmes. However, as suggested in the first report, very few of these programmes were developed as sandwich courses „'per se"' furthermore, the industrial training routes through essentially academic programmes probably are not highly populated. The net effect seems likely to be that the number of MSci/MChem sandwich graduates eligible from their studies for CChem will remain small.

Additional information provided by the RSC[108] lists ten Universities offering an MSci/MChem programme that is not accredited by the RSC, seven of these being from the „Vocational Sector", as defined in the first report. Information on course structure and content is not available for all these programmes, but it seems likely that all seven have integrated periods of (industrial) placement.

It is striking that the development of 4 year courses in the UK coincides with other country's policy to introduce Bachelor programmes (in fulfilment of the Bologna process aims) which are restricted to 3 years.

B. BSc Chemical Sciences

The great majority of MSci/MChem (four year) programmes mentioned in para A. above offer a BSc degree at the end of the third year. Additional information provided by the RSC suggests that additionally there are eleven HE Institutions offering only BSc courses in the Chemical Sciences. It has not proved possible to identify these with certainty, nor to determine whether they have a sandwich structure.

2.3.6. Closure of chemistry courses and departments

It is fair to say that the future of chemistry in higher education in the UK is in turmoil. The problem of chemistry being an expensive subject to run, coupled with the difficulty in recruiting a viable supply of suitably qualified students, has caused many Universities to consider the long term future of their Chemistry Department. Already there have been some closures, including the very prestigious King's College, London. This particular closure generated very forceful opposition, not least from the RSC.[109] However, it can be argued that the „traditional" University sector, by virtue of its size and the resources it commands, is better placed to withstand a few closures than is the „vocational" sector. The latter has been hit very hard by either total closures or amalgamations with other science departments; amongst the casualties are the Universities of Brighton, Portsmouth, Hatfield, Leicester (de Montfort), Sheffield Hallam, and Teesside. These closures in the vocational sector have received very little publicity, though the (cumulative) effects are very severe, most particularly in the loss of sandwich courses, all the hard-won expertise in running them, the supply of training places, and the goodwill of industry. The trend looks set to continue, unless pressure can be brought to bear on Government to recognise that this system is worth saving.

The review of sandwich courses in chapters 2.3.1 - 2.3.4. suggested roughly a quarter to a third of degree students in chemistry were following sandwich courses. The combined effect of a shift of emphasis from BSc to MChem, a reduction in BSc numbers, and Chemistry Department closures in the vocational sector, means that this proportion must now be significantly lower. A figure of 20% of the [MChem + BSc] annual output now seems reasonable.

2.3.7. Statistics/Numbers of graduates

Official figures (Higher Education Statistical Office) for 1998-99 for chemistry Higher Education courses are:

Total on first degree courses (all routes)	908,332
Total of these on sandwich courses	111,194 (12.2%)
Entrants to 3-year degree courses	207,900
Entrants to degree courses of >3 but < 4 years (probably mainly sandwich)	95,364 (31,6%)
No absolute figures for chemistry were found, but a best guess suggests	
Total on first degree courses (all routes)	14,650
Total on sandwich courses	5,800 (39,5%)

There are significant uncertainties because of the complexities of course provision.

107 http://www.rsc.org/members/accred,htm#institutions, MChem courses visited by institution
108 K. MacDonald, RSC, personal communication, Sept. 2003
109 D. Giachardi, Chemistry in Britain, May 2003, p. 7

A comprehensive list of accredited chemistry courses is available from RSC[110]. It also contains information about Chemistry with foreign language or with a year abroad and shows that these courses are relatively frequent. We were so far unable to get detailed information about enrolments, thought our experience in the mobility projects was that UK chemistry students are neither very mobile nor inclined to learn foreign languages. We did a study on obstacles in co-operation with Dr. G. Penny from Sheffield Hallam University (53 students) which revealed that 70% had thought of going abroad, but only 36% had done it. Main hindrances were were language, money and lack of contact.

A list of Enhanced First Degree Courses is also available from RSC.[111]

The RSC collects data for the Higher Education Chemistry Conference (HECC); these data cover all Institutions offering the particular qualification in question. Data are published also by the Higher Education Statistics Agency (HESA), but these relate only to courses covered by the F1 admissions code (Chemistry). Thus they exclude some courses not naming chemistry in their title, but for which chemistry can be a dominant component e.g. Natural Sciences at Cambridge University, and to some extent are lower than the HECC data. The most recent data are given in Table 4.

HE Awards in Chemistry-related courses **Table 4**

estimate	MChem & BSc	+10%	+20%	MChem	BSc
	(HESA)			(HECC)	
1999	3624	3986	4349	880	3106
2000	3420	3762	4104	1033	2729
2001	3285	3614	3942	1161	2453
2002	3215	3537	3858	1138	2399

For comparison, first degree graduate output (RSC) was 3846 (1995) and 3879 (1996).

Whichever set of data are considered, it seems clear that total [MChem/MSci + BSc], and BSc alone are decreasing, and that MChem/MSci numbers - having increased steadily as more courses came „on-stream“ - may now have peaked.

2.4. Country report Ireland: Teaching of chemistry at Tertiary Level[112] in the Republic of Ireland

(Gerald Higgins)

2.4.1. Introduction: Economic development in the Republic of Ireland

Over the last ten years Irish economic growth has far exceeded the EU average, particularly in areas such as computers, software and chemicals.

In September 2000, Ireland was ranked 5th in growth competitiveness in the World Economic Forum Ranking, up from 10th in 1999.

Some of the indicators of this economic growth are as follows:

- Total manufacturing output has increased 256%.
- Output of chemicals has increased 555%.
- Output of metals and engineering has increased by 403%.
- Output of food has grown by 104%.
- GDP per capita is now 95% of the EU average, now exceeding the UK.
- Annual growth rates in production are now around 17% on average.

Around 220 companies are now operating in the chemical and pharmaceutical industries, including many subsidiaries of multinationals. 8 of the top 10 pharmaceutical companies have plants in Ireland. Exports in this sector have grown from £73 million to £11,684 million in 25 years. This sector now ranks 8th in Europe in output. In Ireland, it is second in exports only to machinery (including computers) and represented 25% of the total exports in 1998. Employment in this sector has been growing at 20% per annum in recent years and in 1999 stood at 25% of the output of the German chemical industry.

A number of important factors have been identified to explain the dramatic growth in the Irish economy:

- Joining the European Community in 1972 with access to a larger market.
- Free second level education in 1967 (20 years later than most other European countries).
- Building 10 Regional Technical Colleges and 2 National Institutes of Higher Education (NIHEs) in 1972 with a technological/industrial focus.
- A traditional education system focusing on the basics where Maths and English are compulsory throughout all years of the school system.
- A large number of young people in the population, with over 25% in full-time education.
- Innovative tax laws to encourage inward investment from high-technology multinationals, tax-free industry zone at Shannon - first in the world.
- Aggressive wooing of new companies from the Industrial Development Authority particularly in pharmaceuticals and computers.

110 http://www.rsc.org/members/accred.htm
111 Enhanced First Degree Courses in Chemistry (MChem, Msci) are listed with the other accredited courses, see ref. 107
112 Editor's Remark: "Tertiary Level" or "Third Level" is not equivalent to the definition of levels as used on the FACE- homepage. In this article "Tertiary Level" or "Third level" is equivalent to Level 5 - 6 as used on the FACE homepage

- Availability of clean water and green field sites.
- Few smokestack industries to hinder growth of new industries.
- Young, well-educated, English-speaking adaptable workforce.
- Social partnership since 1987 restraining wage demands.

Ireland has grown from a small industrial base, where agriculture/food and tourism were the most important sectors to one where high-tech. industries such as electronics, software and pharmaceuticals dominate the economy, particularly exports. Many of the world's top pharmaceutical companies have production plants in Ireland, e.g. Pfizer making the world's supply of Viagra, Eli Lilly making Prozac, Schering Plough making Interferon, Bristol Myers Squibb making Taxol. In addition the giants of the computer industry - Intel, Hewlett Packard, Xerox, IBM, Dell, Microsoft have manufacturing plants or software/teleservices centres in Ireland. This expansion has been so rapid that despite special government initiatives in the last 2-3 years to increase the number of third level places in Information and Computer Technology (ICT), there is a large and growing skills shortage in this industry, as well as in other manufacturing industries, particularly at technician level. Net emigration has been replaced by net immigration, population growth instead of decline, almost full employment instead of high unemployment and recruitment drives in Europe to meet skills shortages. This amazing turnaround is due in no small part to the Irish education system. An OECD report in 1997 ranked Ireland top in Europe for its educated workforce and second (after Germany) for the skills of its workforce.

2.4.2. Chemistry in the Irish education system

In 1996-97, out of a total population of 3,621,035 26.5% were in full-time education as shown in Table 5. The total labour force in 1996 was 1,533,964.

	Number	% female
First Level	443,720	49.5
Second Level	339,231	51.3
Third Level	129,283	51.3
Total	912,234	49.3

Table 5 People in full time education
(Irish Department of Education Annual Report 2003)

A. First and second level

Most children start school at age 4. At age 12, they transfer to the junior cycle of the second level sector. This takes 3 years to the first national examination, the Junior Certificate, taken at age 15.

Most students sit 8-10 subjects and 90% take science, which is a single subject combining Biology, Chemistry, Physics and Applied Science.

Almost all schools now offer a Transition Year Option (TYO), which is a year between the Junior and Senior Cycles without any fixed curriculum, and around 50% of students now take up this option. The Senior Cycle lasts 2 years, from age 15/16 to age 17/18. There are three national examinations/curricula on offer: the traditional, academic Leaving Certificate (34 subjects) offered at Higher and Ordinary levels, with Foundation levels in Mathematics and Irish; the Leaving Certificate Applied Programme and the Leaving Certificate Vocational Programme. These last two have a more applied and vocational emphasis and are intended for the less academic students. However, the majority of students who stay on at school after age 15/16 (92% at age 16, 81% at age 17) take the traditional Leaving Certificate course which is the main means of selection for third level courses using the 'Points System' (see below).

Students usually take 7 subjects at Leaving Certificate level, three of which are compulsory (Maths, English, Irish) and the aggregate of grades on 6 (or 5) subjects are used to determine entry into third level. Science is represented by the following subjects: Agricultural Science, Biology, Chemistry, Physics, and Physics with Chemistry (a combined course). Most third level courses in science or technology require just one science subject and any science is accepted (except for medicine and pharmacy where Chemistry is a requisite requirement). The majority of students take Biology and Table 6 shows the numbers doing the various science subjects in 1999.

	Total	% Higher Level	% Cohort
Chemistry	6953	83.5%	10.75%
Biology	28750	60.3%	44.4%
Physics	9112	68.7%	14.1%
Physics + Chemistry	1370	69.9%	2.1%
Agricultural Science	2999	71.4%	4.6%

Table 6 Leaving Certificate Science Subjects (1999)
(Source: DOES Statistics);
Total Leaving Certificate: 64,761

There was a decline in the number of students taking science as a leaving certificate subject in the decade between 1987 and 1999. Chemistry has dropped by 20.8% to under 11% since 1987 and Physics from 21% to 14.5%. The same decline in numbers doing science has also happened at third level (ISCED 5 and 6), with a drop of 10%, in the last 2-3 years in degree and 30% in sub-degree courses.

B. Non-degree courses in chemistry

The second tier of third level education in Ireland is provided by the fourteen Institutes of Technology (IT's). IT courses are validated by the Higher Education and Training Awards Council (HETAC). The National Certificate takes 2 years to complete and the National Diploma 1 extra year. Twelve IT's[113] now provide degree courses in Chemistry or related fields: Athlone, Carlow, Cork, Dundalk, Galway-Mayo, Letterkenny, Limerick, Sligo, Tallaght, Tralee, Waterford, DIT Dublin, which are 1 year courses topping-up a National Diploma in Applied Chemistry. Several IT's also offer the possibility of transferring into year 3 of a degree course at one of the Universities after completing the National Diploma.

C. Third level (ISCED 5 and 6)

Entry into third level education is on the basis of marks obtained in the Leaving Certificate examination, usually in 6 subjects. Grades in the examination are converted into points. Courses in science with a lower demand attract points levels of 330-450 out of a total of 600.

The higher education sector comprises 7 universities[114], 14 Institutes of Technology[115], 5 teacher-training colleges and a number of private colleges. All now offer degree courses although the majority of courses in the Institutes of Technology are sub-degree level (certificates and diplomas, see B.). However, students can now convert diplomas into degrees in many subjects and at many institutions by doing one or two year add-on courses. Third level education has expanded dramatically in the last 10 years and nearly 50% of school-leavers now enter third level course of one sort of another.

The oldest institution is Trinity College Dublin, which is now more than 300 years old. Four University Colleges, which are essentially autonomous, make up the National University of Ireland, established 150 years ago: University College Dublin (UCD), University College Cork (UCC), National University of Ireland Galway (NUIG), and National University of Ireland, Maynooth (NUIM). The youngest universities are the University of Limerick (UL, University status in 1989) and Dublin City University (DCU, University status 1990), these having previously been called National Institutes of Higher Education (NIHE) and were established 25-30 years ago. The Institutes of Technology (previously Regional Technical Colleges (RTC's) were established later and are situated in most of the areas of relatively high densities of population.

Chemistry can be taken to degree level in all seven universities and also at 8 of the Institutes of Technology (which had some 250 degree students in the academic year 2000/01). Non-degree courses in Chemistry (certificate and diploma courses) are available in 12 Institutes of Technology (some 550 enrolments in the same year). There are also related courses in Chemical Engineering (at UCD) and in Chemical & Process Engineering (at Cork IT), and in Biochemistry or Industrial Biochemistry at various universities.

Several different types of degree courses are available in Chemistry in Irish Universities and colleges and these vary in their emphasis and degree of specialisation in Chemistry, and in the balance between the pure and applied aspects of the subject. Most courses have a four-year duration and these lead to an honours degree. However, three-year general (or pass) degrees are available in the NUI colleges (UCC, UCD, NUIG and NUIM), these generally being given to students not deemed as suitable to progress to an honours degree.

Some of the courses are termed 'denominated'; i.e. students are enrolled to do Chemistry from Year 1 and so nearly all the students entering the course will graduate as chemists. An 'undenominated' course, as offered in the NUI colleges and TCD, takes students into a Science degree course and this may lead to a single- or double-subject honours degree in Chemistry. The numbers opting for Chemistry in this system can vary from year to year, as students do not make their final choice of subject(s) until the end of Year 2. Nearly all the denominated course have an applied/industrial emphasis and may include a period of work experience of 6-9 months (for example in UL and DCU). The other type of course involves students opting initially for a Science degree, with the choice of specialising in Chemistry (or another science) in years 3 and/or 4. Students can thus delay their choice of specialisation until the end of years 2 or 3.

In some of the Universities, Chemistry may be taken on its own for one year (single honours) or with another science (double or combined honours). In these courses, mostly in the four NUI colleges, the first year has 25% Chemistry, the second year 33% Chemistry, the third year 33%-66%, and the fourth year 50% (double honours) or 100% (single honours). The total amount of Chemistry in such degrees ranges from around 35% to 70%. These courses emphasise pure (fundamental, basic) Chemistry as distinct from applied (industrial) Chemistry. The balance between theory and practical work, and between the different branches of Chemistry, also varies considerably from one institution to another. Chemistry, degrees on offer thus vary in the amount of Chemistry in the degree, reflecting the time spent in theory and practical classes, the weighting in examinations, and the balance between pure and applied Chemistry. In general, the content of the Chemistry courses in the Irish universities are very similar to those encountered in other universities in the EU, particularly in the UK. Most of the graduates will be eligible to become professional members of the Royal Society of Chemistry and it is therefore expected that this professional body will have recognised the Chemistry content of the degrees as being of the required level and having at least a minimum chemical content. For example, the Industrial Chemistry degree at the University of Limerick has a Chemistry content of 69.3%, two-thirds of which is pure Chemistry and one-third applied. On the other hand, the single subject honours degree at University College, Dublin, has a Chemistry content of 56.25%, all of which is pure Chemistry. All the four-year honours courses in Chemistry involve an individual research project (or projects) in Year 4 and this is carried out under the supervision of a member of staff and/or someone in industry or another institution.

Other degrees closely related to Chemistry and with substantial Chemistry content are also available, e.g. Biochemistry, Materials Science Chemical Engineering/Technology and Environmental Science.

113 http://www.learn-in-ireland.com/education/
114 http://www.instituteofchemistry.org/
115 http://www.learn-in-ireland.com/education/INSTITUTES_of_TECHNOLOGY.html

2.4.3. Industrial experience in chemistry courses

Industrial placement of chemistry students is in its infancy in Ireland with the exception of the University of Limerick (UL) and latterly Dublin City University (DCU) and University College Cork (UCC). Some industrial placement also occurs in some Institutes of Technology, particularly the Dublin Institute of Technology (DIT) at degree, diploma and certificate levels.

Since its inception as the National Institute for Higher Education (NIHE) in 1972, Limerick has operated a Cooperative Education Programme, whereby all students are placed in industry.

During 1990-2000, a placement rate of 100% was achieved primarily in the sectors of:

- Information and communication technology
- Manufacturing
- Pharmaceuticals/chemicals/healthcare
- Financial services

In addition, some 30% of placements were undertaken internationally in North America, Europe and Southeast Asia.

The main international markets for business placements are France, Germany, the Benelux countries, the Isle of Man and the USA. Assignments have been concentrated in the offshore finance, high-tech and traded services sectors.

Placements are typically 6 months in duration and assessment of the students' performance is conducted by a member of faculty, who visits the student and his/her employer.

In addition, the student must complete a co-operative education report before graduating.

University College Cork (UCC) has been operating an industrial placement programme for food science students only, for the last number of years.

Dublin City University (DCU) places all of its chemistry students in industry for a period of months. Dublin Institute of Technology (DIT) also obtains work experience for its science students.

Trinity College, UCD, NUIG and NUIM do not operate an industrial placement programme for its chemistry students.

A report commissioned by the Higher Education Authority (HEA) in 1999 on the initial employment, further study and training patterns of certificants, diplomates and graduates yielded the following information for science and food science & technology graduates (the only two categories identified).

There was a decrease in the proportion of Science Graduates engaged in Research Work or Further Academic Study in Ireland from 26.0% in 1998 to 22.4% in 1999. The proportion in Teacher Training rose slightly from 1.6% in 1998 to 2.2% in 1999. There was an increase of 1.9% in the proportion engaged in Other Vocational and Professional Training.

The proportion of Science graduates who gained employment overseas in 1999 was 8.3%. The proportion employed in Ireland fell by 0.3% over the same period. The emigration rate among respondents in the Science faculty rose from 12.8% in 1998 to 13.0% in 1999. The most important sectors of employment for science graduates in Ireland were the Insurance, Financial, Business and Commercial Computer Services Sector (25.6%) and the Chemical, Pharmaceutical, Health Care Sector (18.1%). These two sectors featured highly in overseas employment also (25.3% and 26.3% respectively).

Britain is not the main destination of those who gained employment overseas (19.5%), with the proportion of science graduates gaining employment in other EU Member States rising to 49.5% (37.6% in 1998). The proportion gaining employment in North America increased by 6.3% to 18.4%.

8.7% of Science primary degree respondents were in the IR£13,000 - IR£14,999 salary range. This compares with 10.9% in this salary band in 1998. The proportion of science primary degree respondents earning IR£15,000 - IR£16,999+ fell by 3.5%. The proportion in the IR£17,000 - IR£18,999 salary rose by 4.5%.

There was a decrease in the proportion of primary degree food science respondents gaining employment in Ireland from 46.3% in 1998 to 43.8% in 1999. The proportion seeking employment fell to 0.0% over the same period. 41.9% of those in employment in Ireland and 28% of those in employment overseas were in the Food Processing, Beverages and Tobacco sector. The highest proportion of primary degree respondents employed overseas were in South America and Australia and New Zealand at 33.3% each.

2.4.4. Further Education, labour market needs

Research was done to evaluate skills needed in the new sector of biotechnology in Ireland[116]. There is a web source for day courses and further education[117].

The Department of Education has set up a Skills Initiative Unit, whose purpose is to identify skills deficiencies in the workforce. Chemistry technicians are one such group and a two-year pilot programme has been initiated for chemistry technicians. This programme includes periods of practical experience in industry.

A report on skills in the life sciences[118], in which chemistry is included, was published in 2001 by Forfás, the national policy advisory board for enterprise, trade, science, technology and innovation. It operates under the auspices of the Department of Enterprise, Trade and Employment. This report and the reference it makes to previous reports is a good example of fine tuning education to labour market needs, a job which is always difficult, given the mid term life cycle of education programmes.

For the life Sciences, the Second Report of the Expert Group had identified four main areas where projections of labour demand exceeded projections of supply - Chemistry degrees, Biological Sciences degrees, Chemical and Biological Sciences sub-degrees and Chemical Engineering degrees. It recommended that 200 more degree graduates per annum should be produced in the Biological Sciences;

116 http://www.csuchico.edu/csuperb/OECD_IRE_Pdf.pdf
117 http://www.daycourses.com/vec/
118 http://www.forfas.ie/futureskills/reports/futureskills3/3exec_skills.html

80 more in Chemistry, and 10 more in Chemical Engineering. The Report recommended that the new places required to meet this increased output be introduced on a phased basis.

In response to the recommendations made in the Second Report, the HEA requested proposals from third-level colleges to create additional college places as a first phase response to the Expert Group's report. The proposals accepted will lead to an increase intake of 81 students into Chemistry programmes (50 into the universities and 31 into the Institutes of Technology), and 74 into Biological Sciences programmes (50 into the universities and 24 into Institutes of Technology) for the academic year 2000/01. A proposal to increase intake into Chemical Engineering by 12 from academic year 2001/2 has also been accepted. These proposals will meet 81% of the overall projected requirement for additional Chemistry degrees; 30% of the overall projected requirement for additional Biological Sciences degrees; and the entire projected requirement for additional Chemical Engineering degrees.

Demand

Two factors have had a significant impact on the demand projections. Firstly, after another year of strong growth in the Pharmaceuticals sector, the base level of employment on which the current projections are founded is now about 10% higher than in the previous year - this increases the volume of demand projected by about 3%. This has a material impact on the projections of demand for chemists, biological scientists, chemical engineers and science technicians. Secondly, increased experience with the formation and development of indigenous Biotechnology companies has led to a more conservative view of what can optimistically be expected of the sector. There have also been many major developments in Bioinformatics in 2000, and a significant rise in interest from companies in the Biopharmaceutical sector, both of which generate demand for high-level skills. Significant growth is expected in these sectors and their specific skills needs will be reviewed by the Expert Group in the future.

Based on the updated sectoral growth projections, the projected demand for life science graduates is for an increase in demand from the Pharmaceuticals, Chemicals, Plastics, Rubber and Medical Devices sectors from 744 graduates in 2000/01 to 1,103 by 2005/06. The corresponding increase for the Food, Drink and Tobacco sectors is from 324 to 339, with a decrease in demand for the indigenous Biotechnology sector from 68 to 181.

Supply

The number of graduates with certificates is falling significantly in both Chemistry and Biological Sciences. This trend is expected to continue, resulting in the possible discontinuation of some courses. The numbers of graduates with certificates in Instrumentation Physics has also been falling, but appears to have recovered in 2000.

The number of graduates with diplomas has remained steady for Chemistry and has fallen for Biological and Food Sciences in recent years. However, as rates of transfer from certificate to add-on diploma programmes are already high, diploma numbers are expected to fall in both Chemical and Biological Sciences. The fall may, however, be partially mitigated if students from the Accelerated Technician Programme and the new Institute Trainee Programme progress to further study in significant numbers after receiving certificate-level qualifications. The number of graduates with diplomas in Instrumentation Physics has also been falling in recent years, but appears to have held steady in 2000.

The supply of degree level Science graduates (excluding Computing) and degree holders in Instrumentation has been improving, partially due to the increased transfer rate from sub-degree courses and the addition of a new add-on degree in Instrumentation Physics in 1999/2000. However, the positive trend in the degree-numbers graduating from the Institutes of Technology now faces reversal. Most of the relevant degrees are one-year add-on courses whose intake depends on the supply of diploma-holders. If the supply of diploma holders falls as anticipated, this will adversely affect the intake, leading to a reduction in the number of degree graduates.

Skills gap

The Expert Group reiterates its concern at the falling numbers of school leavers interested in studying Science at third-level, and the likely impact this will have on the numbers of graduates qualifying in Chemical and Biological Sciences in the years ahead. The situation is compounded by the fact that there is an overall decline in the number of students taking the Leaving Certificate due to demographic changes. The Expert Group welcomes the initiatives taken by the Minister for Education and Science to address the fall-off in participation in the Physical Sciences at both second-level and third-level, especially the establishment of the Task Force on the Physical Sciences.

Due to changes in industry demand and the measures already undertaken plus changes in output, no further intervention is required at present to increase places on Chemistry, Food Science, Agricultural Science or Biological Sciences degree programmes, provided that the existing output can be maintained from the universities and Institutes of Technology. A further intervention sufficient to produce at least another 24 degree graduates per annum is required in Chemical Engineering in order to meet projected future demand. The relevant industry sectors have identified a shortage of Instrumentation Physics graduates. However, the extent of the shortage has not been quantified accurately.

The Expert Group will continue to monitor skills needs in Chemical and Biological Sciences, in particular the effects of (i) any changes in demand within the overseas and indigenous Biotechnology and harmaceuticals sectors and (ii) the fall in third-level applications. The Expert Group recommends that:

- No additional places be introduced on Chemistry or Biological Science degree programmes, provided that the existing output from Universities and Institutes of Technology can be maintained.

- Given the addition of a new add-on degree in 1999/00, no further increase in Instrumentation Physics places should be made.
- Provision should be made for the supply of at least another 24 degree graduates per annum in Chemical Engineering, bringing total annual output to 110.

In conclusion one can say that the successful Irish economy in the sector can count on a well-balanced adaptive education system.

2.5. Country report Spain: An example for a country without a tradition in industrial placements

(José Obiols and Carlos Pellicer)[119]

2.5.1. Introduction and background

The present chapter is a description of the state of the teaching of Chemistry in Spain, with special emphasis on studies involving the student spending a period with industrial firms in the sector as an important part of the curriculum.

In order to properly understand the current situation of the structure of education in Spain, it is important to remember that for almost four decades, from the early 1940s until the late 1980s, Spanish society grew under a single, authoritarian political regime, which was imposed following a civil war brought on by a disordered situation in which different tendencies regarding social models were juxtaposed.

This particular political situation held Spain in isolation from Europe and, in the same way, the educational system was part of a State monopoly at all levels, but particularly so as regards higher and university education. Primary and secondary education (Bachillerato) was provided by Schools and Public Institutes, whose budgets were controlled by the State, and by Private Schools, most of which were run by religious orders, whose budgets were covered almost exclusively by the fees paid by their pupils.

Higher education was provided only by Universities and the State-run Escuelas de Ingenieros del Estado, with virtually no connections to the business and industrial world.

The State, via the Ministry of Work, also ran Escuelas del Trabajo for the education of junior management and better qualified labourers, particularly for State-owned industries.

All curricula and even the programmes for particular subjects were laid down by the Ministry of Education, as a mechanism of ideological control. As a result, private initiatives involving the participation of industry, commerce, or other areas of business activities students would later be joining, were made very difficult.

With this background, it is understandable that in the year 2000, despite the evolution to democracy, the State's Public Administration still continued to be behind a significant proportion of the educational system, particularly as regards the design and structure of curricula, as well as the financing of centres and teaching staff as State employees. For example, the number of students enrolled in Private Universities was only around 10% of those enrolled in Public Universities. However, the annual enrolment fees at a Private University was approximately 6000 Euros, as opposed to around 1200 Euros at a Public one. This significant difference comes about because neither the Private Universities nor the students that decide to enrol at them receive any help or financial support from the State.

In the last twenty years, to cope with the present-day needs of businesses, there has been a growth in the training on offer, albeit in postgraduate and master's courses provided by institutions run by private foundations backed by business organisations. Most of these studies are in Business Management and Administration, and seek accreditation by establishing agreements with other institutions of international prestige and by employing, as teaching staff, professionals working in, and thus having proper knowledge of, real world business problems, many of whom have been trained at centres in other better developed countries.

With Spain's joining the EU and the influx of multinational companies, the climate of higher education has been evolving not only towards new opportunities but also towards closer ties between Universities, Schools or Institutes and commerce and industry. However, differences remain in the financing of private centres where the student faces high enrolment fees and public centres, also described as „Official" centres, where the enrolment fees are largely covered by public funds.

2.5.2. Current situation

The Ley Orgánica de 1/1990, October 3rd 1990, concerning the general structure of the educational system (LOGSE), is the basic point of reference on the organisation of education in Spain. It has not yet been fully implemented. Another important point of reference is the Ley orgánica 11/1983, 25th August 1983, concerning University Reform (LORU), which made provision for university autonomy and the creation of private universities.

The LOGSE scheme for the system of education in Spain is for it to be obligatory until the age of 16, when the Enseñanza Superior Obligatoria (ESO) cycle finishes, and its present structure is that shown in the diagram on the next page. The diagram also shows how each cycle is accessed, dotted lines indicating the less frequent routes of access, continuous lines the most frequent.

119 A book which is in print will review the Spanish point of view in Spanish: Leo Gros, Mercedes Manresa (editores) Estudios con Practicas en la Empresa : Porque los Necesitamos. Informaciones - Argumentos - Buena Pratica. Barcelona 2005. It contains this text, interviews with industrials, case studies of student careers and an evaluation of the benefit of work placements.

There is also special entry for access to studies in training cycles as well as to university from the labour world.

After obligatory secondary education (ESO), i.e. after the age of 16, there are two possible paths for further education, one leading to obtaining higher university degrees and the other leading to insertion into a profession in the world of work, the latter path being that particularly examined by the present report, especially as regards Ciclos Formativos.

The LOGSE establishes two stages of Formación Profesional (professional training), FP Básica and FP Específica:

- FP Básica (FPB) is for all students aged 12 to 16, and consists of introducing a practical sense into all the areas studied in the ESO cycle. It also extends into Bachillerato (BUP).
- FP Especifica (FPE) is professional training proper, and provides in its turn two options, curiously with no connection between them.
  - Ciclos Formativos de grado Medio (CFM) directed towards completing the ESO cycle.
  - Ciclo Formativo de grado superior (CFS) directed towards a post-BUP profession.

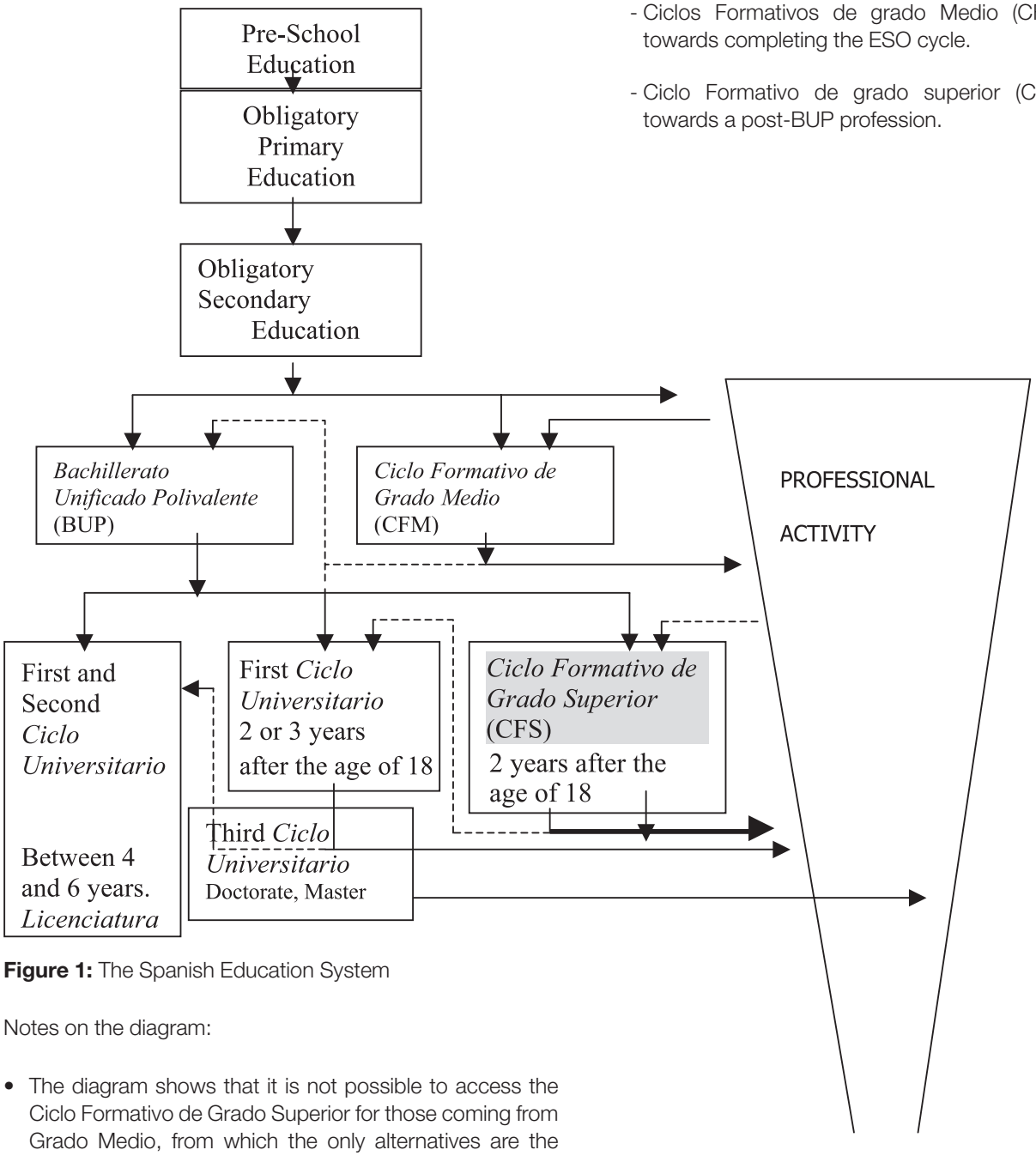


Figure 1: The Spanish Education System

Notes on the diagram:

- The diagram shows that it is not possible to access the Ciclo Formativo de Grado Superior for those coming from Grado Medio, from which the only alternatives are the labour world or doing Bachillerato Unificado Polivalente.
- CFS is highlighted, as being the only one including work placement in its curricula and providing greater preparation for the world of work.
- It is interesting to note the lack of symmetry between scientific and technical degrees as regards obtaining academic qualifications with which to join the labour world:

The Licenciado degree can only be obtained after having completed the First and Second Ciclo Universitario, there being no possibility of obtaining a professional qualification after the First Cycle.

In contrast with technical degrees in the various fields of engineering, the Ingeniero Tecnico degree is awarded on completion of First Cycle studies, with the opportunity to obtain the Ingeniero Industrial de grado superior degree by following the option of continuing with and completing the Second Cycle. Alternatively, the student can enrol at an Escuela Technica Superior de Ingenierato Industrial, in which case the Ingeniero Industrial, grado superior degree is awarded but only on satisfactory completion of all the subjects corresponding to First and Second cycles, in this Escuela.

Regulation of the curricula covering the different stages, the certification of obligatory studies and the awarding of professional degrees are laid down in the corresponding legislation, both at a general level by the State and at an operating level by the Autonomous Governments holding authority regarding education. It is the job of the State Administration to deal with correspondence within the European Union of recognised professional qualifications in order to permit the free transfer of workers within member countries.

In some university curricula, the students have to provide evidence of having spent time in businesses, although it is not something under the direct control of teaching staff, which is to say that it is more an appendix to the student's training than a principal part of curricula. Examples are to be found in the Licenciatura en Farmacia and the Diplomatura en Industrias Alimentarias.

With regard to the field of Chemistry, the Tarragona-based Universidad Rovira y Vigili is an exception among the other universities in that it includes in-company training in the curriculum of its Escuela Técnica Superior de Ingeniería Química. This possibility does not extend to the Faculty of Chemistry, where it is merely optional.

The location of this university close to the largest petrochemical complex in Spain, where a large proportion of production is concentrated, with the presence of big national and international companies, facilitates the placement of students in the said companies.

The duration of the training period in industry is from four to six months and is considered an obligatory subject, with corresponding credits and a report by the firm on the extent to which the student has profited from it. The Escuela has a member of staff in charge of organising everything concerning work placements.

The reform laid down by the LOGSE in 1990 and in the 1995 decree were intended to make the new Formación Profesional Específica a multipurpose, continuous education. It provided for both a solid general base, specialisation that was in accord with the needs of the labour force and practical knowledge of new technology. However, it failed to end the low social status enjoyed by Formación Profesional (FP), which continues to be regarded as being second-best to the new Bachillerato Unificado Polivalente (BUP). In this sense, studies coming under the FP umbrella are still considered a second choice, often reserved for less able students and taught by less qualified teachers.

Data which corroborates this comes from the difference between the number of students doing BUP and those doing Ciclos Formativos, which in Spain shows a preference for Bachillerato, while in the majority of European countries the reverse is the case, with significant differences.

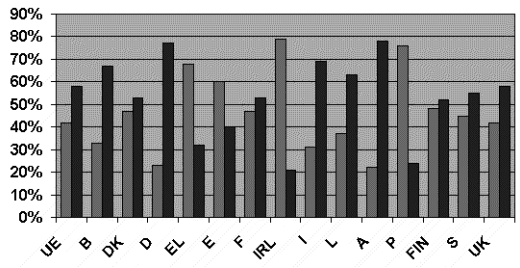


Figure 2: Percentage of students in BUP (grey bars on the left of each pair) vs. professional education (dark bars on the right of each pair); European Commission data 1994-95.

Other statistics for Spain, according to the Ministry, show that in 1999 there were 533,040 students doing Formación Profesional studies, 16% less than in the previous year, and 31% less than ten years earlier, which is hardly a positive sign for this type of education, so closely related at least in theory with the world of work.

Of these half million students, 35% are in Ciclos Formativos compared with 63% in Formación Profesional Básica.

In fact, the LOGSE has not yet reached the half-way point of its implementation, except in certain autonomous communities, since between them Catalonia and Andalucia have 37% of CF students, and if we add Valencia, Madrid, the Basque Country and Galicia, we have 77% of CF students.

The decline of Formación Profesional is something which should and does worry society and its political leaders, as it is not a good thing that the sort of education most clearly directed towards the labour world should lose out both at secondary and higher levels. Nevertheless, the number of centres offering FP is increasing (by 5% in the year 1998-99). Of 3,058 centres teaching FP, half offer Ciclos Formativos and the rest traditional FP (dating to the previous, 1970 reform). The Government continues to champion this kind of education given that, of the centres offering the new Ciclos Formativos, 79% are public centres, with a significant difference in fees compared with private centres, including those maintaining an agreement with or being subsidised by the Government.

The statistics from the labour market are not so off-putting for those that have done FP, which suggests that things could change in the medium term. The labour market (businesses and the public sector) distinguishes clearly that someone with CF grado medio is similar to someone with only very basic studies as far as the unemployment rate is concerned (21%), while someone with CF de grado superior at around 17%, is on a par with those with a university degree.

One conclusion that the Ministry draws in commenting on the figures is that whether present students join the labour force depends less on their training than on the degree of their professional competence. That suggests a promising future for Formación Profesional Específica, which is clearly oriented towards providing knowledge, skills and work experience.

The Real Decreto 797/1995, 19th May 1995, launched a general reform of formación profesional, and took in the structure of industry not just in Spain but also in Europe.

This was not the end of the reform. On the 19th of July 2002, the „Ley Organica“ on Vocational Education was published. With this law, practical work placements became obligatory for vocational training.

The white paper is being prepared jointly by experts from the Ministries of Education and Work. The objective is to bring what is being offered by education into line with the changing needs of the labour market, in order to improve job placement, making FP truly an instrument of job creation.

The law establishes information and communications technology, languages, prevention of work-related risks and team working as priorities.

Businesses will have a major role in determining the necessary qualifications for each professional field, which will generate a reorientation of the training being offered. The role of businesses will not be limited to providing places for in-company training, but will also be to participate in the preparation of teaching staff and the incorporation of professionals from the private sector into teaching.

Public funds provided for ciclos formativos will be redirected primarily towards the qualifications most sought by the labour market, thus ending the present discrepancies between the supply of cycles as chosen by the students and the demand generated by businesses.

The intention is to integrate the three axis of public training within a single centre:

Formación Reglada, Formación Ocupacional and Formación Continuada. The creation of a Catálogo Nacional de Cualificaciones Profesionales is also envisaged, covering virtually all the occupations existing on the labour market, making for more than 500 qualifications instead of the 135 offered by the present FP.

The skills required to carry out each professional activity will be accredited by a Certificate of Qualification which will be obtainable via any of the three training axis mentioned previously, i.e. the skills acquired during Formación Reglada, Formación Ocupacional and Formación Continuada will be considered equal.

2.5.3. Primer Ciclo Universitario in chemistry

Primer Ciclo Universitario (First Cycle University) studies parallel what CFS have to offer, since both have very similar professional objectives in order to provide for immediate placement on the labour market. But unlike the CFS, Primer Ciclo Universitario studies do not include compulsory in-company training.

Primer Ciclo Universitario studies in Industrial Chemistry allow the Ingeniero Técnico Industrial degree to be obtained and are covered by the curricula of 27 Universidades Politécnicas y Científicas in Spain, all of them public.

The curricula for Ingeniería Técnica Industrial, with specialisation in Química Industrial, spread the total study programme over 6 semesters, which are given over three academic years. They are primer ciclo universitario studies, principally directed towards providing the students with the skills with which to transform raw materials into industrial products, to create both organic and inorganic products, and to control processes. They also provide for access to a second cycle, although the principal exit route is into the world of work.

The curricula, published in the official BOE of 6/10/1995, designates a duration of 2,250 hours over three years. Each ten hours is considered one credit, and each subject is assigned a certain number of credits, each centre being able to offer its students optional credits according to the characteristics of the industrial and social background in which they find themselves.

As an example, the distribution of credits between the different subjects and semesters, according to the curricula of the Escuela Universitaria de Ingeniería Técnica Industrial, Barcelona, is as follows: **Table 7**

Subject / Semester	1st	2nd	3rd	4th	5th	6th	Total	%
Mathematics	6	12					18	8,6%
Physics	4,5	4,5					9	4,3%
Chemistry	6	4,5	6	3,5			30	14,4%
Engineering			3	10,5	9	6	28,5	13,7%
Materials	3	6					9	4,3%
Physical Chemistry			3				3	1,5%
Electronics			3				3	1,5%
Computing	12						12	5,8%
Experimental Chemistry	3	6	4,5	7,5	7,5		28,5	13,7%
Finance and Organisation			9	6			15	7,2%
Final project						22,5	22,5	10,8%
Optativas (special subjects)			4,5	4,5	4,5	4.5	18	8,6%
Libre elección (optional subjects)			13,5	6	3		22,5	

This curriculum is directed towards providing the theoretical base, via lectures and laboratory training, but without introducing placements in industry. Although in some centres where Ingeniería Técnica Industrial is taught work placement in industry is recommended to students, in most cases the students have to look of their own accord for a firm where they can do their training, since the schools only provide a few places, through local industry and the teaching staff's personal contacts.

2.5.4. Ciclos Formativos in chemistry

The Ciclos Formativos specialising in Chemistry constitute a specific group within the professional groupings.

The objective of Ciclos Formativos de grado medio (CFM) is to provide students with the skills required for a particular profession in which they can develop those technical skills within the limits of the job's autonomy. The ultimate objective is the access to the world of work for those students with less chance of success in Bachillerato. This cycle can be accessed on completion of obligatory secondary education (ESO), or from the workplace. It provides the Técnico de Grado Medio qualification in the specific subject of the cycle.

The duration of the cycle is 1,300 hours, of which 960 are in the educational centre itself and 340 in the workplace. Thus 26% of the time in CFM has to be devoted to training in Centros de Trabajo (CFT).

The specialisations related to Chemistry currently being taught are:

- Técnico medio, laboratory
- Técnico medio in manufacturing pharmaceutical products
- Técnico medio in paper pulp processing
- Técnico medio chemical plant processes
- Técnico medio in plastic and rubber processing

The objective of Ciclos Formativos de grado superior (CFS) is to provide the students with the skills required for a particular profession in which they will take on, if necessary, responsibilities for management and personnel. These studies are accessed on completion of Bachillerato, as an alternative to first cycle university studies, although also allowing for access to these. The qualification is Técnico Superior, in the specific subject.

CFS are programmed in accordance with the demand for trained professionals at any particular time and in each particular geographical area.

Within the field of Chemistry, the following qualifications and specialisations are offered:

- Técnico superior in analysis and control
- Técnico superior in pulp and paper industries
- Técnico superior in chemical processing industries
- Técnico superior in clinical analysis
- Técnico superior in plastics and rubber
- Técnico superior in environmental chemistry.

There is a strong concentration in Catalonia of what is on offer as Ciclos Formativos de Grado Superior in Chemistry, with specialisation in Analysis and Control being the most popular.

Ciclos Formativos de Grado Superior include training in the workplace, although there are in fact variations between each centre.

In Catalonia, the curriculum for the Chemical Analysis and Control CFS, the one which is most popular, was laid down by Decreto 31/3/1995 (7th November 1995), following national guidelines for Spain. The subjects are organised into credits, some with conceptual content and others with practical orientation, in order to respond both to the training and the technical skills that the professional qualification comprises.

This Ciclo lasts 2,000 hours, of which 1,590 are training in the educational centre and 410 training in the workplace.

The skills required of the Técnico Superior in Analysis and Control include organising and supervising activities in the laboratory, carrying out measurements and physical, chemical and microbiological tests on industrial raw materials, chemical products, food, the environment, etc., in accordance with proper laboratory and safety procedures.

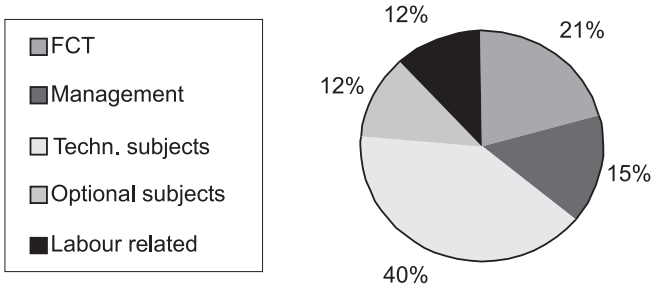
The duration is as follows, always remembering that 10 classes hours make for one credit.

- In the educational centre:
  - 120 hours: Organisation and quality control in the laboratory.
  - 90 hours: Obtaining and handling data.
  - 150 hours: Physical tests
  - 150 hours: Basic laboratory techniques
  - 150 hours: Instrumental analysis
  - 150 hours: Microbiological analysis.
  - 90 hours: Safety and chemical environments in the laboratory
  - 150 hours: Manufacturing processes
  - 180 hours: Product quality control
  - 60 hours: Labour relationships
  - 60 hours: Labour regulations
  - 90 hours: Project.
  - 150 hours: Optional matters according to social environment in each school.

• In the workplace:
  - 410 hours in an industrial production firm.

In the following pie-chart, the corresponding credits are grouped into thematic areas, with the distribution by number of hours being shown in percentages.

Figure 3 Time distribution in Analysis and Control CFS



Workplace training or Formación en Centros de Trabajo (FCT) accounts for 20% of the total hours of the Ciclo, and in most cases takes place simultaneously with studies at the educational centre, with the student attending the workplace in the mornings for some 6 hours a day during one semester, approximately, and attending class at the centre in the afternoon.

The Government's Real Decreto 1497/1981 (19th June 1981) concerning Programas de Cooperación Educativa, regulates agreements between Universities and Businesses for the student's integrated training through the combination of theoretical knowledge with practical experience, thus facilitating joining the labour force.

The criteria stipulated by the Real Decreto are:

- Universities and Schools can establish agreements with Businesses for Cooperación Educativa programmes. For Ciclos Formativos, grado medio and superior, the Autonomous Governments are responsible for the application of the Real Decreto.
- In-company training is to be carried out in the last two years of the course of study and with a maximum duration of 50% of one academic year.
- The firm enters into no labour contract and there is therefore no salary, although the firm may help with a grant.
- The insurance the student has through the University covers any possible accident in the workplace.

Formación en Centros de Trabajo (FCT) is one of the things that distinguishes Ciclos Formativos, and allows the student to adapt to, by being responsible for and participating in, functions to be found in the activities of industry, either in a control and analysis laboratory or in a production plant.

Centres try to come to agreements with companies so that the student can participate directly in the organisation, drawing up instructions for work, writing reports, classifying documents, managing resources and supply etc. All that is in addition to experimental work relating to the speciality of the Ciclo Formativo being studied.

The specific objectives for the student, doing Formación en Centros de Trabajo are:

- To acquire experience of the profession. Applying the knowledge acquired at the educational centre to real situations.
- To acquire a better understanding of the world of work through social and labour relationships in the company.
- To acquire experience of the production world. Immersion in an industrial organisation.

The FCT credit means that previously the school has to carry out the following activities:

Searching for and selecting firms.

Supplying initial information to the pupils.

Matching the student's preferences to what work is available where.

Giving specific preparatory sessions for the placement.

Evaluation of the in-company training is the responsibility of the teaching centre, and uses the reports provided by the person responsible in the workplace.

Evaluation criteria for the learning activities are based on the following skills:

- Autonomy: working independently, without help.
- Initiative: taking decisions on proposals or actions (innovation).
- Problem solving: facing contingencies through organisation and the application of a particular strategy.
- Adaptability: actively facing new situations in the workplace deriving from changes in technology and organisations.
- Organisation: creating the right conditions for using resources.
- Working in a team: collaborating in a co-ordinated fashion.
- Taking responsibility: being involved in the job, ensuring the correct functioning of resources.
- Relationships: communicating with proper tact
- Valuing working conditions: taking an interest in work safety and hygiene.
- Being involved in and committed to the profession: keeping oneself informed and up-to-date with regard to professional procedures and knowledge

There is a study about the relationships between vocational training and employment in Spain[120].

120 www.estudiodeformacion.net, www.ceoe.es

2.5.5. Conclusions

From the above, and from consultations with people in firms in chemical industries, as well as university institutions, the following can be put forward as the principal conclusions:

A. Only the curricula of Ciclos Formativos, grados Medio and Superior include obligatory training in the workplace, with 26% of the duration of CFM, 20% in CFS, devoted to it.

B. The curricula of First and Second Ciclos Universitarios, both in scientific and technical degrees consider training in industry optional. Only in very rare cases are these trainings obligatory.

C. Formación Profesional studies are not very highly regarded in Spain. Knowledge of Ciclos Formativos is low. Society and the business world place greater value on university degrees.

D. Companies do habitually accept students on placements, whether they are optional or obligatory (FCT).

- The interest of the companies is in seeing potential future employees.
- The duration of the placement is approximately one semester.
- FCT is scheduled by the school to be simultaneous with the academic programme, although firms prefer to take on students at the end of their studies.
- Firms normal appoint a tutor for each student's FCT, who carries out a final evaluation. But teaching centres do not normally follow their students' progress.

F. Such collaboration between Industry and Formación Profesional centres is still in its infancy in Spain, although concern and projects to bring the resources of education into line with the true needs of the labour market, following the European model, can be seen.

2.5.6. FCT (Formación en centros de trabajo)[121] (Mar Sanglas)

FCT is a name for practical work experience which vocational education pupils do in companies situated near their school. School and company sign a collaboration contract. The work experience is an integral part of the vocational training course. For this contract there is an official model. It ensures that pupils of secondary vocational training (beyond the obligatory school period) can carry out non-paid practical education periods during which they gain practical experience in addition to their theoretical studies.

Once the „terms of trade" are established between company and school, the contract is completed and signed. There is a government office within the „Dirección General de Formación Profesional" which has to authorise the contract. All partners of the contract receive a copy of the document.

The duration of the practical training in the company depends on the curriculum of the school. It ranges between 300 and 700 hours. It is normally organised as daily 4 hour or weekly 20 hour units if the pupil follows school course units at the same time. Intensive training can be performed in the form of 7 hours a day up to 35 weekly work placement hours.

In the Escuela Joan Pellegrí, a vocational training course (grado superior) in Analytical Chemistry, a minimum of 410 placement hours is obligatory. The course tutor of the school and a responsible person of the „school-industry co-operation department (part of the administration)" of the school work together with a responsible person in the company, looking after the planned activities of the pupil.

The pupil is given a booklet which he has to use during his placement. It documents information about the school, the company and the pupil, as well as enrolment certificate, time table, tutoring and activity plan, and the evaluation meeting held every two weeks. This booklet is handed out to the pupil after completion of his or her placement, so that he has a proof of his first experience at the work place.

Our experience is that the work placement should be timed in the second year of two year vocational training courses (like in the above mentioned course in Analytical Chemistry. Nevertheless, in many cases pupils start the work placement in their first year on demand of the company. In this case, the Dirección General de Formación Profesional has to be contacted before.

Those pupils who start earlier normally come from a university where they have passed some course units, or from another vocational training course where they already had some work experience.

Pupils are selected for a specific placement by the course tutor and the instructors of the laboratory course units, taking into account the ability and the attitudes needed to realise the tasks to be assigned to him or her. Questions of distance between home and company and of transport (does the pupil have a car?) also play a role.

Once the placement has started, there is a tutoring contact every two weeks or even weekly, controlling the booklet in which the work done, hours completed, hours missed and relationship with other colleagues are laid down.

The experience of Joan Pellegrí school is that our pupils generally are very satisfied with their work experience. In some cases they obtain a job offer at the end of their vocational training in the company where they did their placement. Of the 25 pupils who finished their course in June 2004, by now 55% have found a job, 5% continue their education and 40% are searching for employment.

121 written by Mar Sanglas, Escuela Joan Pellegrí, see http://www.joanpelegri.com/

2.6. Country Report Finland

2.6.1. The Finnish chemical industry[122]

Facts and figures

The third largest branch of industry in Finland after the forest industry and the metal, engineering and electronics industry in terms of both gross output and value added, the chemical industry consists of an extensive grouping of industries. The high technology intensive sector has developed specialised products vying for global market leadership. Close co-operation with other Finnish industries has been a driving force. The success in the international competition is best proof of the Finnish chemical industry's ability to commercialise research and development innovations. The branch ploughs back to research and development almost three per cent of its gross value of production. Emergence of new research intensive companies is a notable current trend. Systematic work for a continuous improvement of the environmental and safety performance represents another vital investment in the future. The results are impressive.

Knowledge and education

The Finnish chemical industry competes with a high level of expertise and skills. The industry is building the future through active involvement in a number of initiatives aimed at fostering scientific and mathematical skills in schools. Co-operation between authorities and industry in the area of vocational education and training has resulted in an educational system that flexibly meets the needs of the different branches. Co-operation aimed at safeguarding the supply of qualified personnel and development of personnel skills is one central strategic focus for the industry.

Education and training strategy

Owing to a generation change over the next ten years, the Finnish chemical industry will need a lot of innovative and competent young people at all levels in the new millennium. The challenge is to safeguard the supply of qualified personnel and the continuous development of people working in the industry. The Finnish chemical industry anticipates the needs of skills and takes stand on and wields influence on educational policy decisions. The sector's joint education and training strategy was published in 1999.

The core messages of the strategy

- Science and technology are needed in all areas of society, but these subjects seems not to be favoured by the young people. The science curricula must be developed on all levels of school to create genuine interest in science and technology. Other actors in the society - for example the public media - must also emphasize the significance of science in all areas of life.
- Companies and industrial branches are linked and co-operate in many ways. Networking and communication also between disciplines and subjects in the curricula must be strengthened.
- High quality resources must be available on all levels of education.
- The availability and qualifications of chemistry teachers will be a critical factor in the coming years. The universities and other educational institutes must focus on education and training for chemistry teachers.
- To safeguard the high qualifications of graduates, the funding of universities must be based on quality and not only on the number of graduates.
- The education system must be developed further to serve better the needs of industry.
- The evaluation of needs must be done by the industry and communicated clearly to the educational authorities.

Chemistry today!

Chemistry today! is one of the channels through which the Finnish chemical industry contributes to the joint action programme LUMA - a programme for the development of mathematics and sciences covering the years 1996-2000 launched by the National Board of Education of Finland. The project Chemistry today! was initiated in 1998 by the Chemical Industry Federation of Finland to sharpen chemistry teachers´ awareness of chemical industry and current research. Chemistry today! is being implemented and funded together with the Ministry of Education, the National Board of Education and the Finnish Association of Teachers of Mathematics, Physics, Chemistry and Informatics MAOL.

Training seminars to acquaint teachers with current chemical industry and research

The Chemistry today! initiative was launched in 1998 with the hosting of events in six Finnish cities. Two more events were arranged in 2000. During these the two-day events teachers listened to presentations by top experts from industry and research institutes. They visited local companies and in most cases had the opportunity to engage in hands-on work in the company lab. About 700 teachers participated in the events. The feedback from the teachers was highly positive, sending a clear message that this kind of co-operation between the chemical industry, government and the teachers' association is needed to support chemistry teachers in their day-to-day work. The aim is to make the Chemistry today! Training seminars a top annual event for chemistry teachers.

One of the major goals of the training seminars was that every teacher would get new ideas to apply in the classroom. How can modern chemistry be presented in schools in an interesting and inspiring way? Many of the workshops in the training seminars were specifically focused on how to enliven particular points of the theory of chemistry with real life examples.

122Source: http://www.chemind.fi/english/education/index.html

A research project that was carried out in 1999 aimed at gathering information to develop the initiative further. Participants in the training seminars were asked to fill in a questionnaire in which they detailed their views on chemistry teaching and education-industry partnerships. The data were carefully analysed. The results form a solid basis for developing the initiative further.

2.6.2. Vocational Education in Finland[123]

„Initial vocational education is arranged both in educational institutions and in the form of apprenticeship training.

There are 75 initial vocational qualifications, in a range that includes the following sectors: renewable natural resources, technology and transport, commerce and administration, hotels, catering and home economics, health and social services, culture, leisure activities and physical education.

According to the relevant legislation, the purpose of vocational education is to give students the vocational skills they will need in working life and the skills required to earn a living on a self-employed basis. The initial vocational qualification takes three years to complete and also qualifies the student for further studies in higher education.

Vocational education institutions generally choose their students based on their school grades, but some institutions also hold separate entrance exams. Subjects required in all vocational studies are: the mother tongue, the second national language, a foreign language, mathematics, physics and chemistry, physical and health education, social studies, entrepreneurship and workplace studies, and arts and cultural studies. The qualification also includes a diploma project.

It is characteristic of Finnish vocational education that, in addition to theoretical studies in the classroom, there are practical study periods in the workshops of the educational institution and on-the-job training at actual workplaces. Initial vocational education is arranged by the municipalities, joint municipal boards and private organizations, and is free of charge to students. Vocational training programmes are built on the comprehensive school curriculum. Matriculated students can also opt for initial vocational education and training; their studies are shorter owing to credit transfer.

Apprenticeship training means that the education provider, the employer and the employee enter into a fixed-term employment agreement on the training. This thus takes place alongside work. It is also possible to take a qualification in the form of a competence-based test, where students can demonstrate through a practical test that they command the skills and knowledge needed for a given occupation, regardless of how they acquired that knowledge. Students may take part in competence-based tests without preparatory teaching, straight out of working life.

The programmes consist of 120 credits, including at least 20 credits of on-the-job learning: 90 credits of vocational studies, 20 credits of core subjects and 10 credits of free-choice studies. On-the-job learning is guided and target-oriented training given at the workplace; it provides part of the work-based skills included in the qualifications. The core subjects are the native language (Finnish/Swedish), the second national language (Swedish/Finnish), mathematics, physics and chemistry, social, business and labour-market subjects, physical and health education, and art and culture. The programmes give eligibility for further studies: the graduates can apply for admission to polytechnics or universities.

Adults already active in the labour market can demonstrate their knowledge and skills in competence-based tests and thereby gain initial vocational, further vocational or specialist qualifications. Preparatory training is available in vocational institutions and in apprenticeship training. Vocational institutions also provide continuing training geared to upgrade knowledge and skills in response to the needs of the labour market.

There are over 200 providers of vocational education and training: one half of them are municipalities, the other half private providers of education. Although the number of institutions is roughly the same, the admission capacity is significantly greater in municipal than in private institutions. The Finnish government maintains five special-needs institutes and the Sámi training centre.

Vocational education and training is co-financed by the government and the local authorities. Teaching and meals are free for students.

Finnish institution-based vocational training has its roots in the „Sunday“ schools intended for apprentices and journeymen, which date back to 1842. It was then that His Imperial Highness, the Czar of Russia issued his decree concerning the „preparation of craftsmen and manufacturers in Finland“. Towards the end of the 19th century, vocational institutions began to be established in different fields. The present institutional network, which covers the whole country, is the result of legislation passed in 1958. According to it, local authorities had to maintain one place in vocational education per one thousand inhabitants. At present some 45% the age group continue in initial vocational education and training after compulsory schooling or the matriculation examination.“

2.6.3. Polytechnics in Finland[124]

The Finnish higher education system consists of two sectors: universities and polytechnics. The polytechnics are more practically oriented, training professionals for expert and development posts. There are 29 polytechnics in Finland; most of them are multidisciplinary, regional institutions, which give particular weight to contacts with business and industry.

123 Taken from http://www.minedu.fi/minedu/education/vocational_edu.html
124 taken from: http://www.minedu.fi/minedu/education/

Polytechnics are developed as part of the national and international higher education community, with special emphasis on their expertise in working life and its development. The polytechnics also carry out R&D relevant to their teaching and to the world of work.

The polytechnics award professionally oriented higher education degrees, which take 3.5 or 4 years. The entry requirements is either an upper secondary school certificate or a vocational diploma. At present about 70% of all entrants are matriculated students and 30% vocational graduates. The Ministry of Education confirms the degree programmes. There is no tuition fee for degree studies.

The polytechnics have two categories of teachers: principal lecturers, for whom the requirement is a postgraduate (licentiate or doctorate) degree, and lecturers, who must have a Master's degree. Both categories of teachers must have a minimum of three years of work experience."

The higher education system as a whole offers openings for 68,4% of the relevant age group (universities 31,4%, polytechnics 37%). Polytechnics also arrange programmes for mature students.

Finnish polytechnics, which are either municipal or private, are co-financed by the government and the local authorities. The Ministry of Education and each polytechnic conclude a three-year agreement on target outcome to determine the objectives, intakes, and project and performance-based funding.

2.6.4. Universities in Finland[124]

There are altogether 20 universities in Finland: ten multifaculty universities, three universities of technology, three schools of economics and business administration, and four art academies. Geographically, the network covers the whole country. The University of Helsinki is the largest and the Academy of Fine Arts the smallest. University-level education is also provided by the National Defence College, which comes under the Ministry of Defence.

The basic mission of universities is to carry out research and provide education based on it. The underlying principle in university education is the freedom of research and university autonomy, which gives them extensive latitude for independent decisions. All Finnish universities are state-run, with the government providing some 65% of their funding. Each university and the Ministry of Education conclude a three-year agreement on target outcome to determine the operational principles. The most important legislation governing the universities are the Universities Act and Decree, the Decree on the Higher Education Degree System and field-specific Decrees, which lay down, among other things, the responsibility for education in a given discipline, degree titles, and the structure, extent, objectives and content of education.

Universities select their own students, and the competition for openings is stiff. All fields apply numerus clausus, in which entrance examinations are a key element. Universities offer openings for about one third of the age group. The annual number of applications is nearly 68,000, and only 28,000 candidates are admitted. Universities and polytechnics offer a place to over 60% of the age group.

The number of university students grew by nearly 40% over the past decade. At present there are 170,000 university students in Finland, of whom 21,900 are postgraduate students. The largest fields of study are technology, the humanities and the natural sciences, and the smallest are fine arts, theatre and dance, and veterinary science.

The degree system was overhauled in the 1990s with a view to international equivalence, larger freedom of choice, and comprehensive degrees allowing flexible combinations of study modules from different fields and establishments. In the new degree system, it is possible to study for a Bachelor's or Master's degree in 20 different fields of study. The Bachelor's degree (120 Finnish credits) can be taken in three years and the Master's (160 Finnish credits) in five years. Graduates can go on to study for a postgraduate degree, the licentiate and the doctorate. The annual number of degrees in Finland is 16,550, of which 12,100 are Master's degrees and 1,200 doctorates. The average duration of studies is 6.5 years.

The university has the longest tradition in Finnish education. The first seat of higher learning, the Royal Academy of Turku, was established in 1640 during the era of greatness of Sweden-Finland. In 1828 the university was transferred to Helsinki and renamed the Imperial Alexander University. It was the only university in Finland up to the early 1900s, when the first specialised higher education establishments, the University of Technology and the School of Economics and Business Administration, were founded. The twenties saw the establishment of the University of Turku and the Swedish-language Åbo Akademi University (Turku). The expansion was rapid from the sixties to the eighties. In the most recent reforms the Academy of Fine Arts was upgraded to the university level (1993) and the College of Veterinary Medicine was incorporated into the University of Helsinki (1995).

2.6.5. Vocational teacher education

Vocational teacher education is intended for teachers who work or intend to work at polytechnics and institutions of vocational education. The education offers a general pedagogical qualification for teaching at all educational levels.

The aim of vocational teacher education is to provide the students with

- the knowledge and skills needed in the guidance of the learning process of individual

students

- the competencies to advance their own teaching area, taking into account the development

of working life and professions.

The extent of vocational teacher education is 60 ECTS credits. It includes studies in the basics of educational sciences and in vocational pedagogy, and a teaching practice, among other studies. Further information on modes of study and their implementation is available on the Internet site of Vocational Teacher Education Colleges.

The teacher education college will check your qualifications. According to Act 356/2003, a person with the education and work experience required for a teaching post at a polytechnic or an institute of vocational education can be admitted to vocational teacher education.

The qualifications are determined by the following legislation:

- The Decree on the Qualifications of Educational Staff 986/1998
- The Polytechnic Act 351/2003
- The Decree on Polytechnics 352/2003.

Vocational teacher Education is arranged in:

- Helsinki: The Helia School of Vocational Teacher Education, www.helia.fi/en/vocationalteachereducation
- Jyväskylä: Vocational Teacher Education College of Jyväskylä, www.vte.fi/eng/teach/applying.html

2.7. Country Report Poland

(Marek Frankowicz)

2.7.1. Overview: Current situation of practical elements in Polish chemical education

Poland's membership in the EU was thoroughly prepared over years. The education system is currently undergoing major changes, including legislation and revision of curricula. The country actively takes part in the Bologna process. For the sector of chemistry and for practical work experience, positive as well as negative elements can be observed.

Positive elements:

- There is tradition of practical placements for chemistry students, still realised at the majority of technical universities (study areas: chemical technology and chemical engineering) and at some general universities (short cycle - bachelor studies). Such placements are usually of 1-month duration (for Bachelor studies in applied chemistry - up to 3 months).
- Since 1991, Polish chemistry faculties organise regular meetings of deans and correlate their activities. There is very positive climate for joint actions - we had many Tempus projects, now we enter LEONARDO DA VINCI activities. The Polish Chemical Society is also playing a role as a 'driving force' and co-ordinating joint actions (e.g. a few years ago PCS received a grant to organise a national exchange program for doctoral students).
- Polish chemistry faculties have recently passed successfully both academic accreditation (a kind of „quality mark") and state accreditation (verification of teaching standards imposed by law). It has given us much information about our chemistry studies, weak and strong points etc. A report on tertiary chemical education will be prepared in the near future.
- There are many practically-oriented courses in regular chemistry curricula, especially at technical universities. Chemistry faculties are also very active in creating interdisciplinary specialisations, such as environmental chemistry, biological chemistry, chemistry of new materials, forensic chemistry, food chemistry etc.

Negative elements:

- Polish legislation is not yet adapted to recognise alternating (sandwich) education of longer duration (e.g. one or two semesters in industry). The educational standards elaborated by the Central Council of Higher Education which are the basis for state accreditation do not allow for introduction of alternating studies
- Polish chemical industry, which traditionally was one of the national key sectors, is in transformation. Many enterprises are restructured and privatised. There are many signs of revival of the chemical sector, but it is still difficult to find a sufficient number of practical placements for students. The university-industry co-operation develops mainly by direct bilateral contacts between individual Higher Education institutions and chemical plants. Much remains to be done to make significant progress at the national level.

2.7.2. Student vocational placements - legislation
(Marek Frankowicz)

Before 1989 chemistry students carried out 1-month practical placements, usually after III or IV study year. Since 1968 students were also obliged to carry out so called „working placements" lasting 1 month just before beginning and 1 month after completion of their studies. Vocational experience (work before commencement of studies) could also gain additional points during entrance qualification.

After 1989 practical placements were often treated as relicts of „ancient regime". The condition of Polish industry and the lack of means for organization of student placements resulted in their restraint or even disappearance at many universities. It is characteristic that curricula standards elaborated by the Central Council for Higher Education and published as a regulation of the Ministry of Education, Science and Sport did not cite vocational placements as mandatory but at the most as „recommended".

A different situation is in the case of 3-year vocational studies. Higher Vocational Schools Act of 26 June 1997 declares[125]:

Article 3.

1. Main duties of a higher vocational school are:
   1) education of students in the fields of study and (or) vocational specialisations and their training in future profession,
   2) education designed to enhance specialisation knowledge and vocational skills,
   3) education designed to gain new skills in given vocational specialisation,
   4) teaching students in the spirit of respecting human rights, patriotism, democracy and responsibility for the benefit of society, country and own working place.

Article 5.

1. Vocational studies cover a period of at least 6 semesters of teaching and at least 15 weeks of practical placement.
2. School senate can define conditions of releasing extramural students from the duty of placement if such students work professionally according to the field of study and (or) vocational specialisation.

As all BSc studies are automatically qualified as „vocational studies", even if they deal with purely theoretical study fields, the above cited acts effected an appearance of compulsory practical placements in the standards of vocational studies.

Information on practical placements, appearing in published standards for chemical and related studies, is given in Table 8. It is clear that the attitude is arbitrary in the case of uniform MSc studies. However, in the case of vocational studies practical placements have to be conducted according to the above acts.

A new model for Polish higher education is being elaborated at present. It is being done at various levels, both under the guidance of national authorities and in the academic community. A particular role is being played by the Central Council of Higher Education which is legally responsible for educational standards. The latest document issued by the Central Council[126] states that:

„All decisions on the fields of studies and educational standards must take into account trends and characteristics of changes occurring in higher education and scientific research in Europe known as the „Bologna process" and „Lisbon strategy". According to the assumptions of the said processes changes occurring in the society, economy and job market should also be taken into account."

Table 8: Vocational placements in educational standards. Type of studies: V - vocational, M - 5-year MSc studies

Field of studies	Type of studies	Placements	Suggestions
Chemistry	M	Curricula should cover (depending on the specialisation and type of school) industrial, laboratory or pedagogical placements.	
	V	Each school defines a form, range and duration of the placement, taking into account requirements of a body awarding vocational eligibility resulting with the completion of specific area.	
Chemical Technology	M	No obligatory form of placements is defined for this study area.	Curricula should provide 8 – 12 week placements, including specialisation and diploma placements.
Material Engineering	M	Curricula should provide 8 – 12 week placements, including specialisation and diploma placements.	

125 source: www.menis.gov.pl
126 source: www.rgsw.edu.pl

Field of studies	Type of studies	Placements	Suggestions
Chemical and Process Engineering	M	Curricula should provide 8 – 12 week placements, including specialisation and diploma placements.	
	V	Placements of 12 week joint duration are carried out during studies.	
Medical Analytics	V	1.Practical vocational teaching in diagnostic laboratory (180 hrs). 2.Two 1-month holiday placements after I and II study year in laboratories of: general analytics, clinical chemistry, hematology, microbiology, parasitology, blood group serology.	
Biotechnology	M	Obligatory vocational placement – 4 weeks after IV study year.	
Biology	M	Curricula should cover appropriate laboratory and field placements.	
Environment Protection	M	Curricula should provide – according to specialisation and type of school - vocational and diploma placements.	
	V	Each school defines a form, range and duration of the placement, taking into account requirements of a body awarding vocational eligibility resulting with the completion of specific area.	
Physics	M	No obligatory form of placements is defined for this study area. Each school defines a form, range and duration of the placement, taking into account requirements of a body awarding vocational eligibility resulting with the completion of specific area.	
Technical Physics	M	Curricula should provide minimum 8 week placements, including specialisation and diploma placements.	
Pharmacy	M	Curricula cover compulsory placements: • 1 month in a public drug store (after III year) • 1 month in a hospital drug store (after IV year) • 6 months in a public or hospital drug store after MSc diploma.	
Product Determination Science	M	No obligatory form of placements is defined for this study area.	
	V	Vocational placement minimum 6 weeks.	Vocational character of the studies should be reflected among the others in: 1. vocational placement 2. specialisation courses defined by a school.

Studies can be called vocational ones only then if the educational standards and curricula contain appropriate amount of vocational courses or vocational placements.

Educational standards must contain:

1. general characteristics of studies
2. profile of the graduate
3. minimum curricula
4. information on vocational placements offered in the case of vocational studies
5. other necessary information."

In the near future the suggestions of the Central Council will be considered by academics. Faculties of Chemistry will play a particular role there as they are engaged in various actions on the European level (project TUNING, „Chemistry Eurobachelor", etc.). We hope that the experiences gained from participation in the project FACE and dealing with the practical aspects of chemistry education will be properly used in that discussion and will help to elaborate a modern model of education, in accordance with the European standards.

2.7.3. A questionnaire for the Faculties - a summary
(Iwona Maciejowska)

In June 2004 all chemistry and chemical technology faculties at Polish Universities and Technical Universities were polled on the practical aspects of chemical education. Out of 35 surveyed faculties, 15 returned questionnaires.

The investigated schools offer various forms of practical training:

- Industrial placements (70%)
- Visits in industrial plants (70%)
- Laboratory classes in industrial plants (15%)
- Other forms, such as diploma practices in university and industrial laboratories (23%)
- Only some places offer continuous practices few hours each day or 1-2 days a week for chosen IV-V year students. Students get acquainted not only with technology of production of eg. drugs but they also undertake various paid tasks. Such kind of a placement lasts 1 - 6 months.

Only 15% of investigated faculties participate in the Leonardo da Vinci mobility programmes, although 100% of faculties declare interest in such projects.
At present, industrial placements are available only in limited range at the following fields of university studies:

- Chemistry
- Material engineering

and compulsory in the following fields of Technical University studies:

- Chemical engineering
- Chemical technology

Vocational placements are also compulsory at BSc level studies at higher vocational schools.

Duration of the placements varies from 2 to 5 weeks. According to the employers it is too short and does not allow students to obtain real knowledge of technological processes nor to gain experience necessary for routine investigations.

University students are obliged to find a placements themselves. In many cases, therefore, they practice in small enterprises in their home locations, as in the case of optional placements school does not reimburse the costs of accommodation and travel.

It is a sad fact that less than 10% of university chemistry students commence vocational practice. Some chemistry faculties do their best to assist them in these activities, yet their number does not exceed 30%.

In some cases students learn about the all operations conducted by chosen enterprise, in others they work only at one place, e.g. in a laboratory.

It is significant that generally all involved parties are satisfied with vocational placements:

- Students, because it enhances their opportunities at the job market;
- Tutors, because students gain better knowledge and skills;
- Employers, because they are able to better know their future employees.

However, there are the following drawbacks:

- Costs and organisation of accommodation for students;
- Finding an institution willing not only to accept students but also to prepare suitable programme of practice.

A high percentage (30%) of Faculties which do not declare a willingness to collaborate with career offices is disturbing, as these units are authorized to help with organisation of student placements.

It must be noted that all data in this paper are derived from the previously mentioned results of 15 questionnaires. Therefore, it is logical to conclude that the situation of practical training of Polish students might be even worse, taking into account that remaining faculties which did not respond to the survey expressed thus their complete lack of interest with the problem as well as a complete lack of experience to be shared.

2.7.4. Vocational placements in the eyes of students
(Anna Chahaj, Pawel Kozyra)

Vocational placements which are an integral part of university studies create a possibility of obtaining suitable qualifications, much in demand by employers. The jb market is usually open for educated persons, young, and at the same time, with professional experience. Although everybody agrees that the inclusion of vocational placements into an educational study system is profitable both for the graduates and for the employers, yet such placements are at present a rarity at Polish universities.

One of the arguments for initiating organization of a system of placements at the Jagiellonian University was the results of two important assessments of Higher Education Institutions in Poland. Firstly, a multi-parameter survey , organized by „Perspektywy“ and „Rzeczpospolita“ magazines awarded first place to the Jagiellonian University. Secondly, a survey focused on ccessibility of the job market for graduates commissioned by „Newsweek“, gives the Jagiellonian University 65-th position!

In the view of these facts it seemed necessary to ask the most interested persons - students - what they think about the introduction of changes aimed at increasing their ability to obtain and sustain a job, to obtain information on their previous experience with practical placements and what are their professional goals.

An anonymous questionnaire was circulated in May 2004 among the students of I - IV year at the Faculty of Chemistry, Jagiellonian University. m A total of 300 questionnaires were passed around, 233 were collected; I year - 54, II year - 75, III year - 75, IV year - 28.

The results show that 60% of the students commenced various temporary jobs, mainly for earning some money. The number of such persons increases with the study period (only 44% of the I year students and 86% of the IV year ones). It is interesting that merely 11% of students worked in the institutions connected with their studies. Furthermore, the latter result is probably overstated, as some of the investigated students included - by mistake - pedagogical placements carried out in the framework of a pedagogical course (and which - by assumption - were not the subject of the questionnaire).

A majority of investigated students declared a willingness to continue studies at the second study level (usually at the BSc level) or at the PhD level of chemistry studies (2/5). The second group declares a willingness to work in industry (1/3). The number of students willing to work in the sector of services (1/8) or education (1/20) is much lower, while undecided persons make 1/5 of the whole investigated group.

It should be noted that the only group of students, trained during studies both practically and theoretically for future jobs, are the teachers who have to complete pedagogical practice in order to obtain suitable qualifications. Even though initially students do not declare a willingness to work as teachers, yet subsequently a large number of graduates find work at schools.

When asked where they would prefer to carry out their work placement, students disagree. The most acceptable sites are those which are situated near to the student's family or home, only very few persons would like to find a placement outside the European Union.

Vocational placements bring on other essential experiences , besides finding a place to live. According to the investigated students, the most important ones are the costs of subsistence - students are ready to disburse averagely 250 PLN per month. Surprisingly, the best financial abilities are revealed - almost equally - by the inhabitants of big and small towns and villages, and the worst ones are shown by the inhabitants of the suburbia of big cities (140 PLN per month, at average).

Another inconvenience in the eyes of polled students would be the necessity to move, resulting in the problems of adaptation at new place and limited contacts with their families. The hierarchy of difficulties awaiting them during placements, both in Poland and abroad, is as follows : expenses> necessity to move> adaptation> homesickness. Besides, 1/4 of the polled students feared the language barrier during practices abroad.

According to the surveyed students, practical placements should involve chemistry and related areas, e.g. pharmacy and the cosmetic industry. It should be noted that women are more interested in the latter (grade 4.1) than men (grade 2.6 on the scale 1 - 5, while 5.0 means „I'll be happy with it"). It is interesting that some persons (1.46) declare a willingness to commence practice totally unconnected with their study area. The average optimal duration of the placement is one semester, although students are not unanimous and their preferences vary from 1 month to six months (2/3 of the academic year).

From this survey it can be concluded that chemistry students would welcome the possibility of a one-semester placement either at the location of their home university or abroad, provided that the placement does not involve an additional burden for them. It seems to be quite logical, especially taking into account the fact that in many western countries student's work (including that during practical placement) is remunerated and the employer guarantees accommodation and subsistence. It is true that students gain some experience working during their studies yet, usually, they have jobs loosely connected with their education, which very slightly increases their chance of finding a job in line with their schooling.

In summary it can be stated that there is a need to organize vocational placements for the students of university chemistry studies, as that would improve the graduates' chance on the job market and thus it would increase attractiveness of the studies.

2.7.5. Organisation of placements at the University of Mining and Metallurgy in Krakow - the Role of the Career centre

(Grazyna Czop-Sliwinska)

The University of Mining and Metallurgy (UMM) in Krakow educates students at 15 faculties and 108 specialisations. In the academic year 2003/2004 over 29 000 students were tutored.

Compulsory placements

Vocational placements are an element of curricula at the UMM. The number and duration of practices varies from faculty to faculty. At some it is sufficient to carry out one summer holiday practice (of at least 4 weeks), and at others students are obliged to carry out more than on practice, also during one academic year.

Summer holiday practices are individual ones (each student is directed to a chosen placement), and practices carried out during the academic year are team ones.

Offers

Student placements are sometimes arranged by the UMM-employer agreement. Often students themselves are obliged to find a placement. The Career Centre at the UMM is also involved in that process. The Career Centre gives lectures for first year students, introducing topics connected with the job market, methods of effective job search and introduction of job spheres which correspond with the education offered by individual faculties. Career Centre also organizes seminars and conferences with the participation of various employers. Furthermore, as the next step, the Career Centre helps individual students to prepare application documents, advises on how to talk to future employers etc.

Workshops organized by the Career Centre cover such issues as: interpersonal communication, assertiveness and creative thinking, planning professional pathway, anti-stress techniques and strategies and professional self-presentation. Information on placement offers is put on the internet page.

Optional practices, professional apprenticeship

Experience gained at the above mentioned placements is extremely valuable for graduates entering the job market. Very often such placements are the best type of test for the future employer, being more reliable than other complicated recruitment procedures. Optional placements are aimed at the students of last two years of study. They can be carried out both during holidays and during the academic year. The employers usually adjust their duration to the student's free time (e.g. student can attend practice activities for 10 months on specified days, chosen so that it does not interfere with the education at the UMM).

The quality of education plus the above mentioned additional activities result in a very high ranking position attained by the UMM. In the recent Newsweeks's ranking „Diploma which gives you a job" (April 2004), UMM is first on the list of technical universities and second among all higher education institutions in Poland.

2.7.6. Vocational Training during Environment Protection Studies

(Ewa Kulis)

During the spring semester of 2004 an investigation into on the practical training of environment protection students was carried out simultaneously with the survey of chemistry faculties. The results served to reveal the similarities and differences between these two fields of study.

At present, in Poland, there are over 20 Higher Education Institutions teaching environment protection. Eight institutions responded to the questionnaire. Compulsory student placements are organized at all investigated schools. However, the duration and time is different in each.

It is evident from the survey that students greatly value the possibility of practical placement, especially in big industrial units. Students gain experience during vocational practices and learn, among other things, about management structures in environment protection.

Student placements are usually organized during holidays after year IV, although there are some faculties where practices are organized during year II or IV of study year. The duration of student placements varies from 2 to 4 weeks on average , although there are some institutions where they last longer.

One of the important elements of student placement is its social aspect. In some cases students receive 7 PLN per diem if the practice is not in the place of their residence. The school also pays for travel and accommodation (but not more than 10 PLN per day).

Student practical placements are very well assessed both by students themselves and by the authorities of hosting institutions. The employers draw on the intellectual and working potential of the students and are able to practically estimate their future employees; students very often find their future employers.

Another - and equally well assessed - method of practical training is visits and classes in various industrial, scientific and similar laboratories, as well as field practices.

As regards participation in the Leonardo da Vinci mobility schemes, very few faculties benefit from that type of help.

Over 50% of investigated faculties cooperate with the Career Offices. These units organize practical placements for students and graduates, eg. via programmes EKO-practice, EKO-career or EKO-apprenticeship. Furthermore, the Career Offices help students and graduates to find suitable job offers, they also organize meetings with representatives of various enterprises etc. At the investigated faculties up to 50% of the students declared interest in the activities of a Career Office.

The results of the survey show clearly that practical training plays very a important role in Environment Protection studies. It allows students to make use of their theoretical knowledge acquired during studies. It also allows them to become acquainted with practical methods of environment protection applied in various institutions, as well as to estimate their own potential by experiencing tangible problems.

2.7.7. Vocational placements in Technical University chemistry studies

(Jan Hupka)

A background

Practical placements were obligatory for the students of Faculty of Chemistry, Gdansk Technical University, up to the middle 1990s. Then, for many reasons, mainly financial, they came to an end.

In the last few years students search, on their own, for places offering vocational placements. This situation is induced by the increasing competitiveness of the job market, where previous experience is highly regarded.

Field of studies	Number of students, I-V year	Number of students, IV year	Students who completed practices	
			Number	%
Environmental Protection & Management	189	47	3	6.4
Biotechnology	540	58	35	60
Material Engineering	247	16	9	56
Environmental Protection	438	48	28	58
Chemical Technology	442	41	24	59

Table 9: Number of students of the Faculty of Chemistry, Gdansk Technical University, who completed practical placement.

Organization of practical placements

A tutor (placement curator - Dean's proxy) elaborates the programme and supervises its delivery. Placement curators at each chair supervise reporting. The Faculty arranges all student placements.

Practical placement can be carried out in Poland or abroad. Practices are carried out mainly in summer, after VIII semester. If the practice is realized during the academic year then it must last 180 hrs, but no longer than 4 weeks. During the summer break students must choose first practices located in places of their residence. If the student resigns from an offer in the place of his residence then the faculty reimburses only the costs of insurance and, sometimes, travel.

Programme

Practical placements should cover the following:

- Getting familiar with the host institution
- Getting familiar with the work cycle at one of the departments
- Getting familiar with the organization of technology department
- Solving problems
- Getting familiar with selected issues (material management, production control, safety at work, environment management)
- Getting familiar with the issues of process steering and work organization.

Reporting

Report must contain description of the student's activities, with particular attention paid to new skills acquired during placement, such as:

- Registration techniques of the samples
- Operating equipment unavailable at the university
- Organization and management of specialist laboratories
- Analytical and preparative procedures
- Analytical computer techniques
- Technology of vaccine production, etc.
- Participation in research programmes
- Safety at work issues.

Summary

Students express, in the reports they submit, their satisfaction with new skills acquired during practical placements. Academic staff usually encourage and motivate students to carry out the placements. The employers seem to be happy with the interest expressed by the students.

2.7.8. Didactic collaboration between the Faculty of Chemistry, Jagiellonian University and the Institute of Forensic Science in Krakow

(Malgorzata Herman, Pawel Koscielniak)

Why the Institute of Forensic Science?

The Institute of Forensic Science in Krakow is a unique research unit of the Ministry of Justice. Its main responsibilities are to elaborate expert opinions for courts and public prosecutor's offices, as well as to conduct research in toxicology, forensic science, reconstruction of road accidents, hemogenetics, psychology.

The institute staff is also involved in extensive training activities. In recent years, the Institute of Forensic Science was one of the coordinators of an international; project „National Training Program for Forensic Science Experts", aimed mainly at the employees of the Justice Department and Border Services.

Close cooperation between the Faculty of Chemistry, Jagiellonian University, and the Institute of Forensic Science is a natural consequence of the vicinity and similar fields of activity of both institutions.

Didactic cooperation

Common didactic activities began in the 1990s . The first courses consisted of a series of lectures on toxicology. Students also had a possibility to visit well equipped laboratories of the Institute and to encounter real forensic problems. The First MSc diploma, „Determination of the trace concentrations of methanol in blood and its diagnostic importance", was awarded as a best diploma of the year in forensic science.

In 1997, a new, and unique in Poland, didactic module „Forensic Chemistry" was created at the Faculty of Chemistry, JU.

At first, almost all classes and courses were delivered at the Institute of Forensic Science. In time, academic staff of the Faculty of Chemistry, JU, took over some duties and in 2000 a new laboratory - „Laboratory of Forensic Chemistry" - was created at the Department of Analytical Chemistry, FCJU. It is the first - and as yet unique - laboratory of such a profile in Poland. Now, „Forensic Chemistry" is one of the so called specialization panels at the FCJU. It enjoys great popularity among the students - the number of candidates wishing to continue chemistry studies in that field considerably exceeds the limit of 10-14 places. Although academic staff of the FCJU play more and more important role in shaping and developing that panel, yet staff of the IFS are still the core of the didactic team and the Institute itself is still a place where students learn the majority of forensic chemistry material.

Curriculum

The specialisation programme covers two main forensic science disciplines: forensic toxicology and criminalistic physicochemistry.

Graduates - young practitioners of forensic sciences - are good research students, and the results of their investigations are presented at numerous international conferences (e.g. meetings of the „European Academy of Forensic Science) and published in eminent journals.

Conclusions

Cooperation with the Institute of Forensic Chemistry is, without doubt, a good prospect for the FCJU development. Introduction of forensic chemistry to the studies curriculum increases interest in chemistry studies. It is clearly seen during the admittance procedure - and specialisation in Forensic Chemistry seems to be especially attractive for students.

2.7.9. Field practices at the Faculty of Chemistry of the University of Nicolaus Copernicus as an example of practical education

(Andrzej Chmarzynski, Boguslaw Buszewski, Stanislaw Biniak)

Field practices carried out within the framework of Environment Protection specialisation are at present compulsory for the 5-year MSc students during VIII semester and for complementary 2-year MSc students during II semester, and they number 60 hrs/semester. Students receive 3 Credit Points (CP). Field practices consist of classes in the environment and of tours in various institutions dealing with the environment restoration or its exploitation.

The main purpose of the classes in the environment is to learn about complex environmental dynamics. Technical tours help students to learn about various technologies and functioning of the operation of the institutions visited. They are an important element of the tutoring scheme, being the sole contact of the university students with industry. The additional possibility of contact with industry is by optional practices in institutions dealing with the environment restoration or its exploitation. Such practices are organized by students themselves and they are „worth" 2 (for 40 hrs) to 6 (for 120 hrs) Credit Points.

Field practices organized at the Faculty of Chemistry, Nicolaus Copernicus University, cover the following, main groups of subjects:

- field analytics - environmental analysis
- atmospheric air hazards and methods of air protection
- water and wastes
- environment protection against waste materials
- chemical pollution of soil.

Technical tours were organized in:

- Municipal Waste Dump and BIOGAZ company
- Municipal Sewage-Treatment Plant
- Sanitary Waste Incinerating Plant
- Heat and Power Station
- Environment Protection Inspectorate
- Air Research Centre in Legionowo.

2.7.10. Interdisciplinarity of the MSc diplomas vs vocational placements in the „environment protection“ studies: Inter-faculty Studies at Warsaw University and at Wroclaw University

(Ewelina Kantowicz, Elzbieta Lonc, Anna Okulewicz)

Introduction

The problem of interdisciplinary university education has not been solved satisfactorily, both in Poland and abroad. An example of this is the rhetoric question concerning the curriculum of environmental science studies, asked at the opening and closing of the international conference ESSENCE (Venice, 2001).

The interdisciplinary character of numerous MSc diplomas was criticized by the National Accreditation Commission, assessing environment protection studies in 2002-2003.

The aim of this paper was to:

- compare the results from the previous analyses with those from 2002-2004 and determine the tendency of any changes,
- undertake the task of defining interdisciplinarity of environment protection studies.

Materials and methods

Environmental protection MSc theses were compared: 157 degrees obtained at Wroclaw University and 141 ones obtained at Warsaw University in 1999-2000, and 150 theses carried out at Wroclaw University and 181 ones carried out at Warsaw University in 2001-2004. In the latter period, vocational placements became obligatory.

The theses were divided into 3 groups:

A - „how to reach the goal, what is the environment condition?“

B - „what are the properties of the described object?“

C - „what are the relationships between environment condition and properties of the described object ?“

Results

Table 10: Environmental protection MSc theses as per Faculty.

Faculty	**No. of theses**	**%**	**No. of theses**	**%**	**No. of theses**	**%**
	1998-2000		**2001-2004**		**1998-2004**	
Biology	29	26	41	22	70	24
Chemistry	2	2	11	6	13	4
Physics	3	2	1	1	4	1
Geography	45	39	77	42	122	43
Geology	5	4	5	3	10	3
Economics	13	12	21	11	34	12
Law & Administration	8	7	18	10	26	8
UCBSP*	5	4	5	3	10	3
Administration	2	2	1	1	3	1
UGd*	2	2	-	-	2	1
AGH*	-	-	1	1	1	-
Total	**114**	**100**	**181**	**100**	**295**	**100**

UCBSP - University Centre of Environment Investigation
UGd - Gdansk University
AGH - University of Mining and Metallurgy in Krakow

Table 11. Subject and methodology of environment protection MSc theses done at the Wroclaw and Warsaw Universities.

Wroclaw University			Warsaw University		
Type	**Number**	**%**	**Type**	**Number**	**%**
1999-2000/2001-2004			**1998-2000/2001-2004**		
A	18/62	14/41	A	53/99	47/55
B	49/38	38/25	B	32/47	27/26
C	62/50	48/33	C	29/35	26/19
Total	129/150	100/100	Total	114/181	100/100

Conclusions

Looking at the interdisciplinarity of environment protection studies through MSc theses, two levels can be distinguished:
1. interdisciplinarity of organization of education
2. interdisciplinarity of results of education.

2.7.11. Job market for chemists

(Iwona Maciejowska)

Job market

Are the reports on the poor condition of the Polish chemical industry true or false? Does the job market for the chemistry studies graduate exist and flourish or will students have to seek work outside Poland? What is the purpose of „producing" thousands of chemistry graduates each year? In order to answer these questions, the Career and Promotion Office (CPO) at the Faculty of Chemistry, Jagiellonian University, analysed job offers.

There are 4 main sources of public job offers:

1. Regional Job Offices

2. press announcements

3. employment agencies

4. internet.

The CPO carried out an analysis of the so called „frame" press announcements published in the Monday annex to „Gazeta Wyborcza" (Krakow region) from 1 January to 31 May 2004. During that period there appeared:

- 33 announcements where one of the requirements was graduation from the university in chemistry studies;
- 19 offers for chemists with the engineer title (so called technical chemistry education);
- 3 offers for the graduates of food chemistry;
- 9 offers for persons with general natural sciences education;
- 2 offers for the graduates of chemical secondary schools.

The above data do not mean that, for example, there is no occupation for the graduates of chemical secondary schools in Poland, but rather that the employers do not utilize press announcements as a main form of search for employees.

From among these 69 offers 15 concerned Krakow and its whereabouts, 5 - Western European countries, and the rest various places all over Poland.

Between June and September of the same 2004 year about 100 graduates will be produced at the Faculty of Chemistry, Jagiellonian University and many hundreds at the Krakow Technical University (chemical and process engineering, chemical technology) and at the University of Mining and Metallurgy (material engineering, chemical technology , etc.).

Expectations of the employers

The employers expect, besides graduating from the anticipated field of studies, a number of important - from their point of view - traits such as ability to apply specific investigation methods, expertise in various computer operational systems and software, or knowledge of public tenders and quality management (ISO standards and GMP system) and the rules of safety at work.

The offered positions were following:

- directly in production - 5 offers
- process engineer - 4
- in the line of commerce - 11
- in laboratories - 17
- manager - 9
- others (designer, safety at work officer, teacher, expert, assistant in the press office).

However, regardless of the position offered or the type of work, employers expect that the graduates have other abilities, e.g.:

- knowledge of foreign languages - 65%
- knowledge of computer software - 30%

and the so called „soft abilities“:

- ability to communicate orally and in writing - 26%
- team work - 30%
- analytical thinking and problem solving - 18%
- self-dependence - 15%
- interpersonal skills - 9%
- good work organization - 8%.

The percentage of employers expecting graduates to have „soft abilities“ may seem to be high (a lot of students are still convinced that academic knowledge is sufficient to acquire a job), or surprisingly low in comparison to the data published by AIESEC in 2000 (ability to solve problems - 91%, team work - 86%).

The majority of employers consider that the main fault of the educational system is not only that the studies are too much inclined to theory (and that is the opinion of students themselves) but also that the tutoring is too one-sided and in too narrow areas of specialisation.

Experiences and expectations of the students

Do chemistry students, burdened with numerous classes and lectures, have a chance to commence additional duties (part-time jobs, summer placements, social activities) during academic year? The answer is not a simple one.

Survey of 60 (about 50% of the population) V year students of the Faculty of Chemistry, Jagiellonian University was carried out in two consecutive academic years (2001/2002 and 2002/2003). The questions dealt with vocational experiences of the students and with their plans and expectations as to the future professional career.

A Surprisingly large percentage (68%) of students worked part-time in various periods. The most popular were: private lessons, child care, participation in various polls and promoting actions, fruit picking, work in hotels and restaurants, fast foods etc. Although such experiences are not closely connected with the line of studies yet they are commended by the employers as the ones which prove students' integrity, self-dependence and motivation.

Vocational placements (excepting schools) in places like The Institute of Forensic Expertise, Environment Protection Inspection Office, etc., were carried out by 26% of the surveyed students. Unfortunately, some 46% of the students did not acquire any experience connected with the future job in industry or at school.

The most welcome jobs will be in the cosmetic or pharmaceutical industry or in other chemical enterprises (not necessarily in the laboratories). Employment as a researcher at the university or a school teacher is not very popular. However, taking into account the job market situation, more and more students (recently - 80%) decide to acquire teacher qualifications.

An astonishingly large number of the surveyed students (46%) expressed willingness to work in non-chemical positions. The same percentage of students would do that only in the case of definite necessity, and 14% only as a last resort. On the one hand, it may demonstrate students' rational estimation of their chance at the job market, and on the other hand it should compel The Faculty of Chemistry to broaden its educational offer by new courses, loosely connected with chemistry.

Students are aware that there is a necessity to improve their qualifications and go outside chemistry. A majority of them learn foreign languages (71%). Computer and informatics courses are quite popular (38%). The surveyed students are happy to commence post-diploma or extramural studies connected with: economics: marketing, accounting, commercial strategies; medicine: pharmacy, medical analytics or techniques; or technology: chemical or processing engineering.

Finally, it is worth stressing that the awareness of universities' responsibility for their graduates was clearly stated in the declaration of the Conference of European Rectors Union in 1998.

2.8. Tertiary Education in the Czech Republic

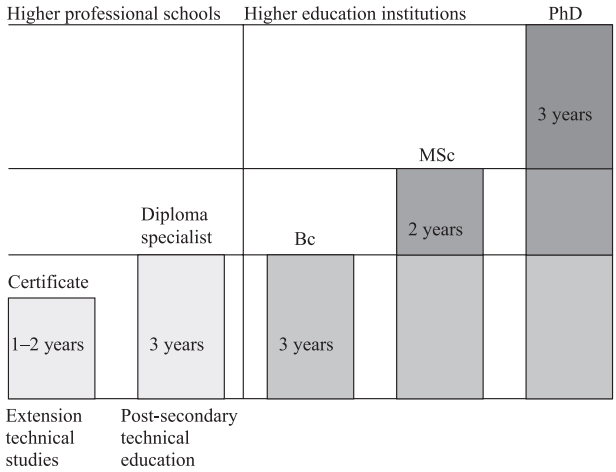
An increase in the number of educated people is a the priority of every country and gives evidence about its culture, maturity and economic development. The population in the Czech Republic has shown a steady increase of interest in education.

In accordance with one of the main goals of the educational policy of the Czech government it is necessary to make possible for the half of the population group of 19 years age to participate in one of the existing types of tertiary education before the year 2005.

2.8.1. Tertiary Education

The diagram (Fig. 4) shows schematically the system of tertiary education. The legal condition for entrance into the tertiary education level is a school-leaving certificate, no-matter if it is obtained at secondary school or other type of school. In reality, the technical secondary schools are traditional in the Czech Republic and they have enjoyed a good reputation. The education is practically oriented and focused on future employment in industry positions at the middle manager level of working. Thus, only a small percentage of secondary school-leavers continue their study at universities.

Figure 4: Scheme of the tertiary education system in the Czech Republic



- Post secondary specialised study following the secondary school leaving exam „maturita“ examination and finished with a certificate and practised in a form of short, study cycles on a modular basis (with the length of study of one or two years) provides a specialised knowledge at a higher level than secondary education. The modular structure of this post-maturita study will allow those who successfully finish it and will decide to continue in their study, to use these modules in higher professional study and reach an appropriate level of qualification.

- Higher professional study will remain as a type of short study, providing special qualification to the graduates of secondary schools. It will exist as a three year study leading to a complete qualification with a description „diploma specialist in a subject of.....“ (abbr. DiS). It is necessary to establish the possibility of transferability between the programmes of the higher professional study and the Bachelor study programmes. Three year programmes, which are capable of satisfying an accreditation procedure successfully, could be transformed into Bachelor programmes.

- Bachelor study, which is defined as a study using contemporary specialised knowledge and methods together with the essential theoretical base and creative activity, will represent in accordance with the Bologna Declaration a diversified set of programmes with more or less applicable orientation to ensure a reasonable chance of employment in the labour market, but also a further study in Master programmes.

- Master study is oriented to acquiring theoretical and practical knowledge based on scientific, research and other creative activities. It will be designed, in line with the development of Bachelor study programmes, primarily as a continuation study to these programmes. Similarly to previous cases its structure will be modular in order to enable as large as possible transferability within the tertiary sector of education.

- Doctoral study as the highest level of tertiary education is primarily concerned with research and development and independent creative activity.

2.8.2. Institutional structure of Tertiary Education sector

- Higher education institution of university type. These offer all types of higher education study programmes and different types of study within the frame of lifelong learning. Master and especially Doctoral programmes of study demand that the courses of instruction make effective use of existing research capacities not only of these institutions but also utilise the capacities of other research and development institutions. This applies foremost to the Academy of Sciences of the Czech Republic, which has an irreplaceable scientific potential for preparation of young scientists in Doctoral study programmes. The strategy of research and development in higher education institutions is based on the National Policy of Research and Development from the year 1999.

- Higher education institutions of non-university type. These offer mainly Bachelor programmes and courses of further education. Their future role is envisaged within multidisciplinary educational institutions, which are expected to saturate the educational needs of a specific region. Offering a broad range of study branches, their combinations, availability and variability together with sufficient number of students, are necessary to maintain the quality and efficient use of finances. An integral part of their activities are joint projects with firms, consultancy and training activities, projects of applied research, international co-operation.

- Higher professional schools. These provide higher professional three-year study and post secondary study. These schools can also provide Bachelor study programmes but only in co-operation with a higher education institution. It is possible for higher professional schools to apply for a change in status and become a higher education institution of non-university type provided their study programmes are accredited as Bachelor programmes. In certain regions higher professional schools may find their main role in provision of further education.

The Czech system of higher education currently comprises 24 public universities, 4 state institutions of higher education (of which 3 are universities) and 27 private non-university institutions of higher education. Chemistry has been taught at 3 universities having the Faculty of Natural Sciences: Masaryk University Brno (ca 1300 students), Palacky University Olomouc (ca 2000 students), and Charles University in Prague (ca 4000 students); 2 universities have a Faculty of Chemistry: Brno University of Technology (ca 500 students), University of Pardubice (ca 500 students) and moreover, Institute of Chemical Technology, Prague (3200 students) is specialized in chemistry only and consists of four faculties: The Faculty of Chemical Technology, the Faculty of Food and Biochemical Technology, the Faculty of Chemical Engineering, and the Faculty of Protection of the Environment. The number of students at higher education institution of non-university type is about 2000 divided into the following study programmes: economics, 67%; law, 6%; informatics, 6%; technology, 6%; art, 15%. Only one of the private non-university institutions, Prague Institute of Technology, offers BSc study in chemistry, namely specialisation in Protection of the Environment.

Higher professional schools are a smaller and mainly new part of the tertiary education sector. Education of three years duration in average is practically oriented and long-term practical training is an integral part of the study. At present, there are about 180 of these higher professional schools with ca 8000 students (Fig. 2). It is supposed that some of the existing higher professional schools - both state and private ones - could be developed into non-university higher education institutions. Concerning chemistry, only the High Chemistry School of Pardubice is established but the study programme was not opened until the school year 2004/2005, probably due to the low number of students interested. The average number of graduates was 18 in each of last three years. It was found that the present higher professional schools network structure is not acceptable. The network was initiated under too liberal conditions and it does not correspond with the future needs of higher professional schools in terms of their number, size, structure of study fields and their regional location.

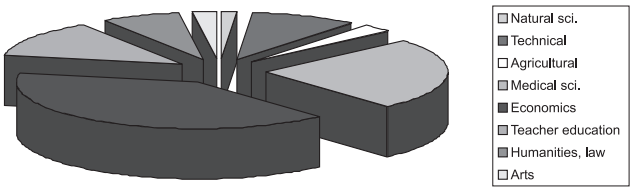


Figure 5: Number of graduates at higher professional schools by discipline, school year 99/00

In the Czech Republic, there is a well-established system of higher professional schools of chemistry offering education at the upper secondary level. Altogether 7 institutions are spread over all regions: Masaryk´s Secondary Chemical School, Prague; the Private Secondary Chemical School Kolín; the Secondary Chemical School Otrokovice; the Secondary Chemical School Pardubice; the Secondary Chemical School Lovosice; the Secondary Technical School of Chemistry of Academician Heyrovsky, Ostrava; and the Secondary Chemical School Brno. Study programs cover field of analytical chemistry, chemical technology, protection of environmental, pharmaceutical substances, management, and computation techniques. Graduates have been widely accepted by industry as shift or works foremen and they also can work in laboratories.

In the chemistry curricula, practically oriented courses form a regular part of the study programmes. Especially the Technical Universities arrange work placements for their students. The drawback is that the placement is short; a maximum of 3 weeks is the most usual duration. Czech legislation does not recognise „sandwich“ study programmes in which the duration of placement would be substantially longer, usually one or two semesters.

2.8.3. Education and unemployment rate

Analysis shows that education has a large influence on the risk of becoming unemployed in the Czech Republic (Fig. 3). Unskilled and skilled people have a significantly higher risk of becoming unemployed than academics. People with just elementary education have been the most frequently unemployed (43%), while the percentage of university and college graduates who had been unemployed for some time was relatively low at 9%.

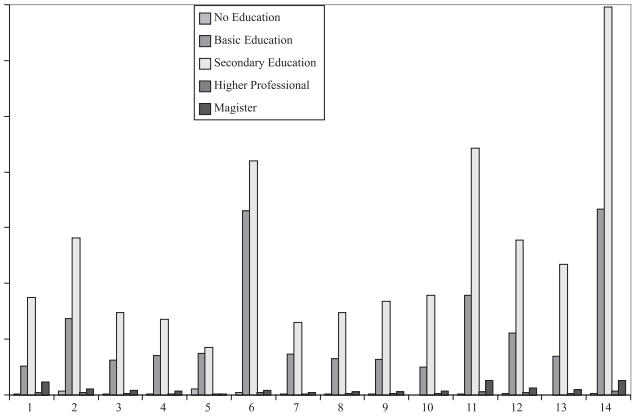


Figure 6: Unemployment figure, Czech Republic, December 2003 (1-14: different regions)

The rate of unemployment reached 10.3% at the end of 2003 (542 420 job-seekers), representing a growth of 0.5% compared with the same period in the previous year. The highest rates of unemployment were recorded in the northern regions of Bohemia and Moravia, reaching over 20 percent in some areas. The lowest unemployment is in Prague - at around 3%.

In addition to other factors, the level of education attained plays a large role in job opportunities. Unemployed people with higher or university educations find it easier to get work. For those who have only completed secondary school, the subjects they studied become important. When everything is taken into account, it becomes clear that the tertiary education system represents a powerful tool for a higher chance for people to compete in the labour market.

2.8.4. Weak points of the present system of Tertiary Education

- Low possibility of transfer among programmes and, moreover, very high drop out. About 35% or more of the students who entered the first year do not finish their study. In technical and technology studies, the drop out rate is often around 60%. The reasons of failure are different: students are not successful in entry into the study of their first choice and they try again; they leave for a lack of interest; the study is too difficult; they find a job; they fail.
- Usually those who fail leave without the possibility of entering a different programme. No certificate is awarded in this case.
- Another important task is lifelong education; skills must be continuously updated and many people will need access to them from outside the education system in an acceptable and equitable way.

2.8.5. Perspectives

- In accordance with one of the main goals of the educational policy of the Czech Government it is necessary to make it possible for half of the population group of 19 years age to participate in one of the existing types of tertiary education before the year 2005.
- The total number of students in the tertiary education sector will reach 250 000 (about 195 000 in Bachelor and Master programmes, 15 000 students in Doctoral programmes, 30 000 students in higher professional schools and 10 000 students in private higher education institutions) in 2005 contrary to the present number of 223 000, which represents the increase of 12% compared with the present state).

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Ministry of labour and social affairs of the Czech Republic
http://www.mpsv.cz/

2.9. Tertiary Education in the Slovak Republic

(Jitka Moravcová)

2.9.1. Tertiary Education in the Slovak Republic

Since 1990, the education at universities in the Slovak Republic has been subject to the Czechoslovak Federal Act on Universities (1990 and its amendments, in particular from 1996). Nowadays, the legislative framework of higher education in Slovakia is well established. The Higher Education Act of 1990, its Amendment of 1996, as well as Decrees from the Ministry of Education on PhD Study (1997) and the Act on Further Education, provide for the different forms of education, equal access to education and life-long education.

Currently, there are 24 universities in Slovakia (as at August 31st, 2003), out of which 16 universities are state universities (4 technical universities, 1 agricultural university, 1 economic university, 1 veterinary university), 1 church university, 3 universities of arts, 2 military academies, 1 police academy and one private university of management. The new Act on Universities of 2002 classifies public, state and private universities according to the scope of their activities as academic and non-academic/vocational universities and research universities. In fact, all public and state higher education institutions in the Slovak Republic (SR) are of university type. At present the non-university higher education has not been developed in the SR, even though some experiments have been carried out in the beginning of 1990s.

The only private institution of higher education available offers only a bachelor study programme, being fully covered from private resources coming mostly from student tuition fees. Foundation of additional private higher education institutions is envisaged.

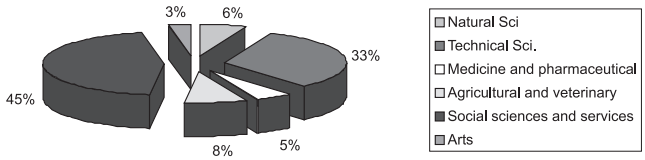
Basic quantitative data on university students in the Slovak Republic is given in Table 12. It can be seen that the number of new entrants into the higher education sphere is going to reach 50% in the near future. **Table 12**

Year	1993	2001	Year	1993	2001
18-Years cohort (A)	93654	88935	Full-time students	61834/86.0%	95619/68.0%
Graduates from secondary schools (B)	44552	56038	Full-time students		
New entrants (C)	20778	37033	Part-time students	10082/14.0%	44942/32.0%
C/A (%)	22.2	41.6	Part-time students		
C/B (%)	46.6	66.1	Total	71 916	140561

The plans for higher education are contained in the Outline of Further Development of Higher Education for the 21st Century, which was approved by the government in 2000. First of all, access to the first cycle of tertiary education should be increased.

Integrated bachelor/master programs are still recognized by the Accreditation Commission in subject areas such as medicine, pharmaceuticals and veterinary science, all of which are explicitly excluded by law from the 'Bologna' format. Only in exceptional cases and after authorization from the ministry may universities combine programs of the first and the second levels into one long program. Forestry, architecture and certain fields of study at military higher education institutions particularly favour integrated programs.

Figure 7 shows that only a small portion of students participates in study programmes of the natural sciences. **Figure 7**: The number of full time students at universities classified according to the study fields.



Moreover, chemistry curricula, in particular in technical universities, contain practical training as an integral part of study programmes but the duration of placement is not longer than 3 weeks. In the period 1998-2002 more than 2000 Slovak students took advantage of the Leonardo practical placements and exchanges, of which 17-20 percent were higher education students.

In the Slovak Republic, there are also higher professional schools of chemistry ensuring the education on upper secondary level but the number of students is extremely low: Secondary Chemical School Bratislava (ca 250 students), Secondary Chemical School _ala (ca 90 students, but the first course was not open in 2004), Secondary Chemical School in Humenné (ca 250 students including food chemistry), and Marie Curie-Sklodowska Secondary Chemical School in Svit (20 students will be admitted in 2005).

2.9.2. Education and the unemployment rate

Labour market statistics in the Slovak Republic show a slight increase in the labour force but a continuing rise in unemployment along with a decline of employment. In 2000 the unemployment rate was 19.1%. Youth unemployment was also very high, over 35% in 2000. While the activity rate has remained stable (around 70%), the employment rate has followed a declining trend in 2000 (56.3%, down from 58% in 1999). This is partly explained by the growing participation in education for the first age group and the lower old-age retirement threshold (60 for men and 55 for women) in force as regards the second age group.

The employment rate of university graduates measured by branch of study, is annually analysed by the Ministry of Labour. Only a small percentage of university graduates are employed in research and development. The success on transition from the stage of education to work is a result of controling the supply and demand of the labour market. The imbalance between the supply and demand means that a certain proportion of graduates is forced into be economically inactive. However the unemployment rate among the graduates is very low, being under 2,5% of total number of unemployed.

2.9.3. Weak points of the present system of Tertiary Education

- Absence of higher professional schools that can be transformed into non-university type higher education institutions.
- High drop out of students without receiving any certificate.
- More efficient system of lifelong education as a means of increasing prospects of higher competition in the labour market.

2.9.4. Perspectives

- Substantial restructuring in numbers of students enrolled in available study programmes of higher education.
- The improved transferability should lead to the reduction of number of higher education students, who fail and do not finish their study programme.
- Higher education students will have chance after finishing their Bachelor study of continuing in a Master programme at their home or other institution of higher education.
- New forms of study, which can contribute to diversification of study opportunities.

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2.10 A Glimpse at the situtation of Chemical Education in Hungary, Romania and Bulgaria

2.10.1. Tertiary Education, work experience and foreign placements in Hungary [127]

(Peter Moson)

The Hungarian Minister of Education has signed all documents related to the Bologna process. According to the decision of the last ministerial meeting in BERLIN (2003) there is an acceleration in the process. It has been declared that the new 2-cycle training forms (B.Sc, M.Sc in engineering) will be introduced in 2005.

However there are many open questions related to the system (colleges, universities), the objective of B.Sc (general or specialized), length (B.Sc 180-240 credit points) etc.

The Hungarian higher educational practical placements of the last fifty years can be divided into 3 periods. Before 1990 under the state owned economy the internship meant a low efficacy physical, professional work for both professors and students. In 1990s, in the period of transition to a market economy and privatisation, there was an important decline in higher education - economy relations. In recent years the return of economic growth has led to a strengthening of the university - enterprise contacts (e.g. representatives of enterprises have become members of university senates) and to an increase of internships, based on new /EU/ and on old Hungarian experience. This process has been supported by international, European (e.g. LEONARDO DA VINCI), and national programs as well.

The national higher educational „Requirement of Qualification“ regulates the practical placements of different training forms (e.g. a compulsory internship lasting for at least 6 weeks in the technical /engineering/ programs is required). However there is no general rule about the details of the internships (e.g. they can be evaluated by a). some ECTS credit points, b). as a criterion subject for the diploma, or c). only allowed in a passive semester).

The higher educational placements longer than 8 weeks can by supported by a part of the vocational education tax paid by enterprises.

In the case of foreign mobility there are some problems to solve. The salary level of the Central European countries is much lower than the average of the European Union. Some additional financial support is necessary. Communication, language and management skills of Hungarian students are not enough for the complete organisation of a practical placement. Some help (administrative, tutorial, preparation etc.) is needed.

Budapest University of Technology and Economics (BUTE, www.bme.hu, founded in 1782) is a research university with 15.000 students, 1000 staff. Most of the students are enrolled in 5 year engineering programs. BUTE has been offering education in 4 foreign languages (English, French, German, Russian) since 1980-90-es.

BUTE has been participating in EU Leonardo mobility projects since 1999. There are 2 types of placements organized by the university at the moment:

- Blue collar. As an example the main characteristics of 2 successful projects are presented. The BUTE French Filial (engineering) is a first cycle (semesters 1-4) training in French with participation of 30-50 students per year. After graduation the participants receive a certificate delivered by INSA de Rennes and BUTE. The program contains a criterion subject practical placement of minimum 1 month in a French enterprise. In 2001 24, and in 2002 15 students carried out this placement in the framework of Leonardo projects. The participating enterprises were identified by the French employee of the BUTE Industrial Relations Office. The working place corresponded to the students' studies. The length was 13 weeks in summer after the 2nd semester. Practically all students were visited at their working place at the beginning of the placement (2 weeks after the start). The students prepared a written report (ca. 20 pages in French), and defended it in an oral presentation before a „jury“ containing enterprise - and university specialists. All information was available on the internet.

- Engineering placements organized by BUTE Leonardo Institutional Coordination. Since 1999 BUTE has applied successfully for such Leonardo mobility projects. Either the participating students prepare their diploma work in the 10th semester (30 ECTS), or the internship is in 6-10th (passive) semesters. There was a development of the organization of these placements. Here only the main elements are listed. In these internships the project work must correspond to the needs of enterprise and to the competence of student. As these needs are not known at the Leonardo program application time (more than 1 year before the start of the activities) intermediary organizations (foreign university, consulting firm, LEO-NET Network) are involved. The students need not be from a foreign language filial, so language and cultural preparation are offered.

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127 More detailed information can be found at http://tutor.nok.bme.hu, or in the following publications:
Sol, Charles, Moson, Peter: "Strengthening the Links between Enterprises and Universities. Alternative Training of Engineers." Proceedings of International Conference on Engineering Education (ICEE) Technical University of Ostrava, August 10 - 12, 1999, Czech Technical University in Prague, August 13 - 14, 1999 (See: http://www.fs.vsb.cz/akce/1999/icee99/Proceedings/index.htm
Sol, Charles, Moson, Peter: "Alternative Training of Engineers. Extension." Proceedings of International Conference on Engineering Education (ICEE 2000).
"Evaluating Student Industrial Placements Abroad. A Practical Guide (Methodologies, Case Studies, Guidelines)." 2001. Leonardo project MESIPA(Methodology to Evaluating Student Industrial Placements Abroad). Coordinator: Claude Maury (CEFI, France). 200 p.; (see: http://www.cefi.org).
Maury, Claude, Moson, Peter: "Evaluation of Students Industrial Placements Abroad". Proceedings of ICEE 2001 Conference. August 6-10, 2001. Oslo / Bergen, Norway. (ISBN-1-588-74-091-9). See CD, http://fie.engrng.pitt.edu/icee or http://ineer.org
Moson, Peter, "International Education at Budapest University of Technology and Economics", International Conference on Engineering Education (ICEE 2002, Manchester Aug. 18-22, 2002). See: http://www.ineer.org.
P. Moson, Student Echange programs (academic, practical placements) in Europe. In: International Conference on Engineering Education Proceedings (ICEE 03 Valencia July 21-25, 2003). ISBN 84-600-9918-0.

According to the needs of enterprises the internships are longer (20 weeks or more) during a full semester (usually in Spring). Two tutors (university - enterprise), follow continuously the activity, some written materials (reports, diploma work etc.) are prepared as well. Sometimes special questions (copyright, confidence etc.) have to be regulated. The internet is widely used both for the management of the project, and for communication purposes.

BUTE has taken part as partner in other projects which have made an important contribution to the development of its strategy related to university - enterprise relations (e.g. the adaptation of the 'know how' of alternating education of engineers developed by CNAM, France in the framework PHARE, TEMPUS projects; alternating education in chemical engineering - participation of BUTE in the FACE Leonardo project; evaluation of practical placements abroad in a Leonardo pilot project coordinated by CEFI, France).

The Hungarian higher education system has adapted successfully the EU practice methods (similar legal conditions, increase of the numbers of students, introduction of ECTS, participation in EU programs -Socrates, Leonardo etc.). However there are some financial and administrative problems, which have to be addressed. The foreign academic exchanges are regular parts of Hungarian higher education. There are many foreign internships as well, but here the system is in an experimental phase.

Hungary has signed the Bologna declaration. It is ready to join the European Educational Area. It requires the nationwide introduction of the B.Sc, M.Sc academic training forms, and the related practical placements. Another task is the development of the evaluation, assessment, quality assurance of training methodology. At this moment there is no clear strategy, or final decision in the realisation of these activities.

The LEONARDO DA VINCI PROGRAM played an important role in the adaptation of EU practice. It has relatively good financial conditions in mobility, but the number of scholarships is restricted (about 100-200/year for the whole Hungarian higher education). A simpler application procedure could give the possibility of long term planning of mobility (and their integration in the educational programs). The increase of the number of scholarships evidently would lead to even larger impact.

2.10.2. **Romanian Education System** (Joan Panzaru)

The Romanian educational structure consists of a vertical system of schooling. Five main components represent the fundamental pillars of this system: pre-school education, compulsory education, upper secondary education, vocational education and training and tertiary education.

Pre-school education (gradinita) is not yet part of the compulsory cycle.

The compulsory cycle of education (called scoala generala) consists of four years of primary and four years of middle school education.

Upper secondary education consists of three main alternatives. The so-called academic option consists of the four or five-year high school (liceu) programmes. The vocational school (scoala profesionala) option can include two, three or four-year programmes. Finally, the apprentice school (scoala de ucenici) includes one, two and three-year programmes. Each form of secondary education confers access to one or more levels of continuing education.

According to the legal provisions, the educational process is conducted in Romanian. The ethnic minorities have the right to organise upper secondary education in their mother tongue. There are also schools in which the teaching/ learning process is carried out in international languages.

Post-secondary education (also called tertiary non-university education) provides an opportunity for advanced vocational training for the graduates of secondary schools. Programmes may be recurrent or specially arranged to meet the needs of specific employers. Such training may be formal or informal with formal training being most closely related to the post-secondary schools.

The vocational school is primarily concerned by the PHARE VET RO 9405 reform programme and provides the core of qualified workers for relevant trades in the labour market. The apprentice school is a pre-qualification level for the students who do not pass the capacity exam (from compulsory education to upper secondary education) or drop the compulsory elementary school. It is a vocational education system that trains the workers for occupations, groups of occupations or trades of traditions that derive from the priorities of local or regional social and economic development.

Tertiary Education

Education and research institutions achieve university higher education: universities, institutes, academies, conservatoires and university colleges. As a rule, any higher education institution includes a number of faculties, departments, colleges, chairs, research, design and production units.

University education institutions are divided into two types. These are: universities and other higher education institutions.

Universities of tradition (comprehensive universities) offer study programmes in more academic fields. As a rule, universities comprise philology, law, and science faculties. The major national universities offer study programmes in most of the academic fields.

Other types of higher education institution. These institutions offer study programmes in fewer academic fields, and as a rule their mission is vocational education (agricultural and forestry science universities, technical universities, academies, conservatoires, military academies, technological higher education institutions).

Function of their financial system, Romania has two categories of higher education institutions: public/state higher education institutions and private higher education institutions. The major difference between the public and private higher education concerns funding issues. Public higher education institutions are mostly state financed. Tuition fees and other individual incomes represent a secondary and complementary financing source. Private higher education institutions are mainly self-financed: tuition fees, sponsorships. They are eligible to participate in competititons conducted to obtain funds from the state budget, such as development funds, research funds, and postgraduate scholarships.

University higher education is organised as follows:

• short-cycle study programmes take two or three years and are organised in university colleges (colegii universitare). College graduates may continue their education in long-cycle programmes on the approval of the University Senate;

• long-cycle education is conducted in universities and in other similar institutions, institutes, academies, conservatoires, and in authorized or accredited faculties and specialities;

• postgraduate study programmes (the second phase of tertiary education) ensure an in-depth specialisation in a field of study or the expansion of a candidate's basic speciality in other fields. Universities organize postgrduate education and postgraduate schools accredited for this purpose and are offered under the form of advanced studies, master's degrees, postgraduate academic studies, doctoral studies, specialisation studies and continuing education.

Student evaluation is undertaken throughout the semester and also in the final examination, at the conclusion of a study discipline. Universities organize three student evaluation sessions in one academic year: a three-week session in January; a four-week session in May-June, and a two-week session in September. The same examination may be taken three times. If the examination is failed at the third attempt, the student must repeat the study programme for the discipline in question.

Graduates of short-cycle higher education (colleges) who take the final examination are awarded a college graduation diploma (diplom_ de absolvire). Long-cycle higher education graduates having passed the final examination (examen de licen__) for a university diploma, are granted the title of licen_iat in the studied profile and specialism and are awarded a diplom_ de licen__ (licence diploma). Graduates from medicine and stomatology higher education institutions are awarded a physician's diploma (doctor sau medic); graduates from veterinary medicine are awarded the veterinary doctor's diploma (doctor-medic veterinar). Graduates of master's programme are awarded a master's diploma (diplom_ de master) and graduates of doctoral study programmes are awarded a Doctor's Diploma (diplom_ de doctor).

Romanian students start learning Chemistry during the compulsory cycle of education through upper secondary education and may even choose specialisation courses during tertiary education. The University of Bucharest, one of the leading institutions in Romania, offers a series of long-cycle education programmes and postgraduate study programmes and enrols about 335 new students each year in Chemistry. It offers 14 specialisations among which are: Applied Enzymology, Biosensors, Catalysis and Catalytic Processes, Chemistry, Chemistry - Physics, Coordination Chemistry, Environmental Chemistry, Environmental Quality Control, Natural and Synthesis Multifunctional Organic Compounds, Optimizing Chemico-Analytical Control and Quality Assurance, Physical Chemistry and Applied Radiochemistry, Radiochemistry, Technological Biochemistry, Therapeutic Chemistry. The Faculty of Chemistry's research centres offer students in tertiary education the opportunity of continuing their research work in several centres such as: the Centre for Theoretical and Applied Inorganic Chemistry, the Centre for Catalysis and Catalytic Processes, the Applied Analytical Chemistry Centre, the Research and Development Centre for Bioanalytical Techniques, the Automated Analysis Research and Development Centre, the Pilot Centre for Information Technologies and Virtual Instrumentation, the Centre for Theoretical and Applied Physical Chemistry, The Centre for Applied Organic Chemistry, the Centre for Environment Protection and Management of Waste.

2.10.3. Formal education in chemistry in Bulgaria

(George Andreev)

Schools, for students from the age of 14 to 18, have 2 hours of Chemistry a week. From the age of 16 to 18, students may chose to specialise in Chemistry and do 5 hours a week. The sizes of such classes vary between 25 and 30 pupils. Primary and secondary education is still free of charge at the moment.

Vocational schools train laboratory technicians.

Some companies offer internal training and apprenticeships. This type of training is very limited, however, because only a few enterprises of considerable size exist in Bulgaria. In general, one can say that companies prefer to outsource such training. This is cheaper and might also be more effective. Therefore some of the companies send employees to special training programmes at universities.

In order to enter University education, special entrance exams must be passed. Grades achieved in related subjects (in case of Chemistry these are Physics and Mathematics) are taken into account when deciding whether to admit a student for a special subject.

At university level, students complete 8 semesters of courses. They graduate with the title of bachelor. A tuition fee of 120 Leva (about 60 Euros) per semester has to be paid.

All courses are held in Bulgarian. Abstracts and laboratory instructions are also always written in Bulgarian. It was planned to implement master courses in English, but this was never carried through.

There are no work placements in the whole University education system in Bulgaria. Bulgarian students are taken on 2-week-long trips to visit industrial plants and learn about the „real life“ at work“

3. The educational level context: Level Reports

3.1. The ISCED scheme of educational levels[128] and the scope of this chapter

When faced with the question how to compare different education systems, FACE partners agreed to use the International Standard Classification of Education - ISCED - in the 1997 revised version. UNESCO designed ISCED „... to serve as an instrument suitable for assembling, compiling and presenting comparable indicators and statistics of education both within individual countries and internationally. It presents standard concepts, definitions and classifications. ISCED covers all organized and sustained learning opportunities for children, youth and adults including those with special needs education, irrespective of the institution or entity providing them or the form in which they are delivered."

Within the scope of FACE, courses range from ISCED 3 to ISCED 6. A brief definition taken from the ISCED 1997 scheme will introduce the reader to each educational level discussed in FACE.

The present chapter does not pretend to be comprehensive, nor does it repeat everything that was said in the country reports in part 2. It will rather focus on selected educational forms from different countries which have proven successful and might serve as good practice examples for other countries.

3.2. Level 3: Secondary Vocational Education

3.2.1. ISCED description

Level 3 corresponds to the final stage of secondary education. The duration of the programmes is substantially different and can range from 2 to 5 years of schooling. „This level of education typically begins at the end of full-time compulsory education for those countries that have a system of compulsory education. More specialisation may be observed at this level than at ISCED level 2 and often teachers need to be more qualified or specialized than for ISCED level 2. The entrance age to this level is typically 15 or 16 years. The educational programmes included at this level typically require the completion of some 9 years of full-time education (since the beginning of level 1) for admission or a combination of education and vocational or technical experience and with as minimum entrance requirements the completion of level 2 or demonstrable ability to handle programmes at this level."

The education at this level may either be terminal, ie preparing students for entry directly into working life and/or „preparatory", i.e. preparing students for tertiary education. In the various countries different categories exist for the field of chemistry. FACE classifies them like this: general education (not covered here), school based vocational training, vocational training alternating between school and company („dual system"), multi-firm training institutions.

There is an old and in some aspects outdated overview of VET for the Chemical Industry which merits a revision. It was issued by CEFIC in 1979 and contains descriptions of the terminology, activity, education required, nature and length of training and certificate of several levels of production and lab related vocational training forms[129].

3.2.2. School based VET-courses

In many countries, there are schools offering VET for chemistry and related fields. German Berufsfachschulen offer two-year courses leading to a national diploma Technischer Assistant in the fields of Chemistry, Biology, Biotechnology, Pharmacy (2,5 years) including an industrial placement of 4 weeks minimum. The course comprises .... total hours, out of which .... are science related. The holders of such VET-qualification easily enter the job market; some gifted students continue their studies in tertiary level courses.

In the UK, there is a reform going on for the 14-19 year olds. „Following a lengthy review process, the GNVQ is currently being phased out and replaced in stages over several years by the GCSE in vocational subjects, the Vocational Certificate of Education and the Key Skills qualification[130]." „Foundation, Intermediate and Part One GNVQs are being replaced by General Certificates of Secondary Education (GCSEs) in vocational subjects. Introduced in September 2002, and aimed primarily at 14- to 16-year-olds in full-time compulsory education in school, GCSEs in vocational subjects are currently available in a range of subjects, similar to those of the GNVQ and aim to provide an introduction to a broad vocational area and enable progression to further education, training or employment. The advanced level GNVQ was replaced by Vocational Certificates of Education (VCEs), the 'vocational A-level', in September 2000. These are available in six- and 12-unit awards, roughly equivalent to one or two traditional (general/academic) A-levels respectively. Their introduction aimed to provide greater flexibility and allow students to combine study for VCEs with that for other qualifications. ...Three-unit advanced-level GNVQs, were also replaced by the three-unit VCEs in four vocational areas. A new key skills qualification was introduced in 2000 which replaced the previous system whereby the key skills of communication, application of number and information technology were tested as part of the GNVQ at intermediate and advanced levels. The GNVQ and its successors are intended to offer a comprehensive preparation for employment, as well as a route to higher-level qualifications, and are designed to develop knowledge, skills and understanding in broad vocational areas." Science is among the VCE's. In a career adviser's guide, the Royal Society of Chemistry says: „The routes to careers are many

128 http://www.uis.unesco.org/ev.php?ID=3813_201&ID2=DO_TOPIC
129 Vocational Training for the Chemical Industry (in DE, FR and EN). Dr. Curt Haefner Verlag, Heidelberg, 1979.
130 http://www.eurydice.org/Eurybase/Application/frameset.asp?country=UK&language=VO

and varied and obviously depend on the qualifications that can be obtained, ranging from GCSE, GCE, GNVQ and VCE, A and AS levels to, in Scotland and the Irish Republic, SCE, SH, CSYS, SVQ and the ILC; baccalaureates such as the EB, IB and WB (Welsh Baccalaureate), NVQ, ONC/D, HNC/D, to degree and post-graduate qualifications. Whilst there are careers available using chemistry qualifications below those of HNC/D and degree, they tend to be in support roles or use the qualifications to aid chemistry related jobs"[131].

The Royal Society of Chemistry (RSC) points out that „....while the RSC welcomes the emphasis given to vocational routes, it says further thought needs to be given to their nature. The RSC would like to see vocational qualifications much more to do with what scientists do in the workplace"[132]. It remains to be seen whether the new qualification scheme is just a pathway to tertiary education or also to employability in the sector.

In Spain, the Ciclo Formativo de Grado Medio (CFM) with a total of 1300 hours contains 340 placement hours. This placement is strictly organised in co-operation with regional enterprises and a good example for a relatively long and obligatory practical part in a school-based VET. The French Brevet de Technicien (BT) course provides the qualification of „Specialist Technic" in a precise field. After having completed this stage, there are two possible paths; one leading to insertion into a profession in the world of work and the other leading to continue the studies; BTS (Brevet de Technicien Supérieur) and after studing in the IUT (Technologic University Institute) (superior studies of short cycle). Northern European equivalents are the Estonian „kutseoppeasutus" 3-year course and the Finnish „Ammatiiopilaitos" (2-3 years). Poland's Basic Vocational Schools have 2-3 year-courses, in Romania there is the Scoala profesionala (3-4 years).

There are some indications that school-based forms of chemistry VET will become of increased importance wherever and whenever chemical industry tends to outsource company based VET (see 3.2.4.) for cost and structural reasons. Countries which do not have them may want to introduce them as one element of basic chemical education giving direct access to the labour market.

3.2.3. Combination of General and Vocational Education[133]

A specific form of VET combines general and chemical education in school based courses leading to an A-level-like (Matura, Abitur) general qualification and a professional training in an integrated form. One such course is the Höhere Technische Lehranstalt, HTL, found in Austria and in countries of the former Hungaro-Austrian tradition like Czechia and Slovakia (Higher Secondary School). From their 9th year of school, pupils are introduced to chemistry with theoretical and with a high number of laboratory hours. At present, HTL is becoming more and more attractive in Austria as compared to general secondary schools. Their practical work experience during studies is limited to a „Ferialpraktikum" and a final year project in Austria, and to three weeks in industry in Czechia and Slovakia.

In Germany, this form was developed in the 1980s, yet with much less science hours, so that in a reform, an additional 14th year of school mostly devoted to chemistry was introduced. While their Austrian counterparts are well accepted in industry, German school leavers from these courses usually continue their studies at tertiary level.

FACE experts think that this special form gives relatively young pupils a chance to become familiar with chemistry at an early level and could become one general alternative in European chemical education to pure vocational courses.

3.2.4. „Dual System" courses

There is a long tradition in Germany for company-based VET, with different course types, mainly oriented towards production (Chemikant) or to laboratory work (Laborant). Learners are contracted by a company and trained in company-owned training plants or labs, at the workplace and - for up to two days per week - in state owned schools offering theoretical and general subjects. The courses normally end after three years, with an examination and a diploma of the regional Industrie-und Handelskammer (IHK, Chamber of Industry and Commerce) having special examination boards for this purpose. To our knowledge, this is a unique model in Europe. Its particular advantage is that it combines work experience and school learning from the beginning of the study time. Holders of such diplomas are sought after. Some of them, especially Chemikanten, tend to enter further education courses or tertiary studies after some years of work experience, primarily to escape the burden of shift work.

It seems that with increasing structural and financial pressure on companies, especially SME's, the dual system loses impact. Alternatives are school based courses or multi-firm training institutions.

A study of BIBB Germany for the sector of building elucidates the advantages and disadvantages of the dual approach[134] in an international context.

Main advantages are:

- the mix of learning sites is positively influenced by practical experience
- trainers in schools learn latest developments in work life
- social partners have better chances to shape VET
- productive work of the apprentices motivates them and lowers costs for the companies offering apprenticeships
- multi-firm training shops as additional partners can balance deficits in practical training (esp. in SME's)

131 http://www.rsc.org/pdf/education/careers_advisers_guide.pdf
132 http://www.rsc.org/lap/educatio/eic/2003/column4_mar03.htm
133 Dietmar Frommberger, „Doppelqualifikationen" in der Berufsbildung in Europa: Ausgewählte Beispiele sowie Reflexionen aus deutscher Sicht. In: Dieter Münk (Ed.): Perspektiven der beruflichen Bildung und der Berufsbildungspolitik im europäischen und internationalen Kontext. 13. Hochschultage Berufliche Bildung 2004. ISBN 3-7639-3248-8. Bielefeld 2004, p. 105 ff.
134 http://idw-online.de/pages/de/news37645

Main disadvantages are:

- company based apprenticeships depend on economic situation, that causes problems
- if the work place offers limited resources, not all curricular requirements can be fulfilled
- between schools and companies, there is a lag in putting to practice technical innovations
- training and learning offers differ between companies, which causes quality problems in VET

3.2.5. Multifirm Training Institutions

(Dietmar Lohmann)

Structural changes in industry in the last twenty years include destruction of big, multinational companies. Some sold part of their production to focus on „core business" such as „life science", others were pulverised into small units, economically independent and fully responsible for their survival in a competitive market. This and increasing economic pressure on SME's, together with the breakdown of old industries in the former eastern countries led to a sincere loss of classic company based training places. Creativity in the sector was needed, and besides out-sourced training shops of former big companies, new training companies were formed that offer those parts of VET which companies do not want to or SME's are not able to deliver.

While the state-approved occupations have a wide educational orientation, many companies are often able to cover only some selected segments of the educational field because of their specialisation. In many cases these companies lack the capability to fulfil the requirements of vocational training to the full extent. Nevertheless, in order to enable such companies to train their apprentices, the Vocational Training Law provides for the possibility (§22 - paragraph 2) of completing some parts of an apprenticeship in so-called „intercompany training centres".

A successful example for such a training company is SBG in Dresden (DE), member of FACE. The Saxon Training Company for Environmental Protection and Chemical Occupations Dresden, Ltd (Sächsische Bildungsgesellschaft für Umweltschutz und Chemieberufe Dresden mbH) is a training centre providing vocational education and training based on more than 50 years of experience. This educational institution, which was privatised via a non-profit-making organisation in 1992, has its roots in a training centre for the varnish and paint industry, and was founded in 1949. As a result of its activities, the Saxon Training Company is firmly positioned in the German dual vocational training system and operates on the basis of the Vocational Training Law (last amendment Art. 9 from 23.12.2002).

The Saxon Training Company for Environmental Protection and Chemical Occupations Dresden, Ltd has the status of such a centre. It is a recognised training centre for natural sciences and environmental technological occupations (chemical laboratory technician, biological laboratory technician, physics laboratory technician, varnish laboratory technician, specialist in water supply technology, specialist in waste water technology, specialist in waste and recycling management, specialist in pipeline-, drain- and industrial service). In addition it is the leading institution for the Training Cooperation of Saxony for Chemical and Chemistry-related Occupations and of the Training Cooperation of Saxony for Supply, Sewage Management and Waste Management, which were both initiated by the Saxon Training Company. In this function it coordinates primary training for more than 100 companies and institutions and organises some parts of practical training in the form of intercompany courses.

Besides primary training, the company is engaged in further and advanced education and training for certified industrial craftsmen/craftswomen in chemistry, water supply, sewage management, waste management and municipal sanitation.

The Saxon Training Company for Environmental Protection and Chemical Occupations Dresden, Ltd actively organises a broad range of project-related seminars and workshops.

The profile of Training Cooperations is presented in the following overview:

Table 13

trainer's basis	**primary training for chemistry and chemistry-related occupations**	**school for certified craftsmen/craftswomen**
in-service qualification of the companies' employees authorised for vocational training main tasks: • organisation and development of training location cooperation • didactic and psychological competence • updating and extension of knowledge on natural sciences and technology • organisational aspects of vocational training • preparation for qualifying examination	Cooperation training in the following occupations: • chemical lab technician • varnish lab technician • physics lab technician • biological lab technician • chemical plant operator • chemical industry worker • ET-occupations (specialists in sewage technology, water supply technology, waste and recycling management, pipeline-, drain- and industrial service)	certified industrial craftsmen/craftswomen in: chemistry water supply sewage disposal pipeline network waste management and municipal sanitation

Other institutions of this type are e.g. bbz Chemie in Berlin[135] and bvct Halle[136].
When BAVC, the German Chemistry Employers' Association, ask for regional partnerships in VET (regional competence centres), they express a need for such institutions. It seems that they are or may become European model institutions especially for SMEs in the sector.

3.3. Level 4: Post-secondary, non-tertiary Vocational Education

(Walter Zeller)

3.3.1. ISCED description and general considerations

Under the definition of the ISCED Levels one finds the following words describing Level 4:

„Level 4 covers programmes that straddle the boundary between upper secondary and post-secondary education. Level 4 programmes cannot be considered as tertiary programmes, because often they are not significantly more advanced than programmes at ISCED 3, but they serve to broaden the knowledge of participants who have already completed a programme at level 3. The students are typically older than those in ISCED 3 programmes."

A typical student at level 4 will be over 18, having successfully finished a higher, secondary education but s/he will not attend university. He or she will probably be employed, but it could easily be that their job is not very safe, perhaps they even do something at their work place which is a bit outdated and will soon become redundant. Some courses at level 4 will also be tailor made for the unemployed so that they can find a job in the future.

These facts also explain why the category of level 4 does not only refer to hobby courses or courses held for special interests. Such courses might enhance personal development, but are also a relevant part of life-long learning and have a significant importance for the labour market.

Level 4 courses will help to direct young people into the job world when they have finished compulsory, respectively. general education and find it difficult to follow their interests on the labour market.

3.3.2. Examples in European countries

When considering that Level 4 guarantees employability to a great extent, it is not surprising that many chemists are educated to this level in various countries and a considerable number of courses is offered on the FACE homepage. We find courses in Estonia, Finland, France, Germany, Hungary, Romania, Spain, Sweden and Austria.

In Austria the so-called „Kollegs" match the definition of this level. Everybody who has passed a „Reifeprüfung", the final exam of a higher general education in this country, may attend this type of school. These people will all be older than 18 and will wish to receive an initial vocational education in this type of school.

The duration of this course will be two years. As a general knowledge of the humanities has been acquired in secondary education (level 3), the chosen subject area is solely dealt with throughout the duration of the course. In about 39 hours per week (continuing restructuring makes it impossible to give precise figures) theoretical knowledge is taught, but some 10 hours out of these 39 are held in the laboratory to teach practical skills. During the summer months the students also have to work in industry to collect additional practical experience. This is part of a common concept of Austrian vocational training and education that work placements should increase the employability of any student.

After having fulfilled all these requirements, the students are awarded a diploma. They can now join the work force and they will most likely be employed because this type of education has a good reputation in this country and also abroad. Their jobs will mainly be in middle management in the beginning.

In Austria „Kolleg"-courses are mainly held in colleges of initial vocational training (HTLs); private institutions would hardly hold such courses. In contrast to this fact Estonia, Finland, Hungary offer these courses in buildings of private educational institutions, of universities or schools, as well.

In France, the „Brevet de Technicien Superieur (BTS)" provides the students with skills required for a particular profession. They are also prepared for management positions. Similar modes can be found in Spain. The „Ciclo Formativo de Grado Superior" (CFS) also prepares the student for management and personnel responsibilities. The award is called „Técnico Superior". In Italy, there is a Formazione Professionale Post-Maturitá in regional schools. Sweden offers an „Advanced Vocational Education" in close collaboration between the labour market and various educational organisations. A third of the training consists of practical, workplace-based training.

The post secondary course of a „Chemietechniker", a kind of chemical engineer, is a degree course in Germany which requires two years of study at a German „Fachschule", together with vocational training and work experience. In some cases this course will allow the student to continue his or her studies at level 5. Including an examination in English, the Chemietechniker diploma gives access to tertiary education like the Fachabitur.

Level 4 has expanded rapidly in Romania since the 1990s. Many of these studies are organized by universities, but also public institutions, non-profit institutions or trade companies provide such courses. Many of these courses are not free, but must be paid by the beneficiaries. Level 4 education, however, does not offer immediate qualifications because these study cycles may have of duration from 3 months only, to 3 years.

135 http://www.bbz-chemie.de/bbz/index.htm
136 www.bvct.de

3.3.3. Number of students

In Austria about 70 young people begin a „Kolleg"-course, but not all finish. The reasons for the relatively high drop-out rate are manifold:

- some students might find out that the subject area taught is not quite to their interest and liking;
- others might notice that they cannot combine a full study programme with their private duties and obligations, e.g. when having started a family or simply when young children have to be looked after;
- another group might find a job rather unexpectedly while attending school and then prefer to earn money instead of learning,;
- and, finally, for some students, the course will simply be too difficult to follow and understand.

After the classes have shrunk rapidly by approximately 30 per cent - usually by around Christmas time - the dropout rate becomes very low.

3.3.4. Situation on the labour market

As the age of the students is comparatively high, employers will anticipate that the maturity of these applicants is also quite high. Additionally, the level of education is lower than at universities and therefore also the entry salaries will be lower. These are two good reason for employing anyone who has finished a Level-4 course successfully.

Level-4 courses can also be targeted more precisely towards the needs of industry and thus reduce unemployment. Industry itself can demand what type of work force it wants. Practically oriented course will therefore be of most interest.

3.3.5. Will there be level-4 courses in ten years?

The importance of vocational education has increased in Europe and the more the economic situation is difficult, the more people will try to receive practical education which can be quickly and successfully turned into an income. For this reason level-4 courses will become more and more important because an initial vocational training in Europe below the age of 18 is not too common.

So far, in most countries the state pays for this education just as it does for other kinds of education. Due to highly restricted budgets this will have to change and young adults attending level-4 courses will have to find ways and means of financing their education. Some students will work in lowly paid, so-called „Macjobs" (unskilled labour, unsocial hours of work, low pay) and thus try to pay for their schooling. Others will depend on their parents' support and others again will receive some financial aid from their own family.

Politicians will, however, have to think of ways to make it financially viable for anybody to attend such courses and especially to think of ways which are fair to everybody. People who have to work to finance their studies will find it more difficult to be successful at school than unemployed persons who receive some funding for being unemployed. Loans which have to paid back when the student has found a job, will be one way out of this dilemma. It could also be that industry itself pays for such courses. They could do this when they then receive a work force trained for their own special needs. Finally, it could become the responsibility of trade unions and chambers of commerce to keep the cost of unemployment for the whole society low and thus to propagate such courses. All in all, there will be a mixture of the many ways that offer themselves to make studying possible at an adult age. One simple way could also be to pay work placements very well, so that school fees can be paid.

Will there be work placements? When we talk of initial vocational education of a duration of more than a year, the answer to this question must be positive. Theoretical knowledge is appreciated among academicians, but when employability is concerned any practical experience will rank higher for the employer in the industry.

What should such courses look like? Students who have finished their general education will certainly show great interest in the subject area they have chosen because this will probably be the most motivating part of their education. Consequently, they will enjoy following the theoretical lessons which give them a sound basis of understanding what they will do practically at a later stage. At a certain time, which should not be too far from the starting point, the acquired theoretical knowledge must be applied practically. This can best be done initially in the educational institution itself. Countries with a tradition in vocational training of their young population will have no problem in finding the right schools for providing these means, such as laboratories or workshops. Other countries might have to resort to other methods such as hiring laboratories in industrial plants or expanding the time span of the integral work placement.

The work placement itself should be an integral part of the curriculum where the course is longer than one year. After about 9 months of education and training the students should have their first practical work experience. At this stage they might not have enough knowledge to do valuable work for the company who employs them, but the students will see whether their decision for a certain subject area was right and whether a certain direction within this subject area will really be their main area of interest.

After at least one month in a company the students will either decide to continue their specialisation during the course according to their interests or they will redirect their ideas of the chosen subject area and set different priorities. After another 6 - 12 months of formal theoretical and practical training another work placement will prepare the students for the final examinations. This final work placement will also give both the job seeker as well as the employer the possibility to observe each other and then, hopefully, to decide for each other in a „working marriage".

In general, it is expected that level-4 courses will increase tremendously in the next few years. All these courses demanding work placements will open all the opportunities for the employer and the employee to chose the right person for the right job and both parties will find more satisfaction in their common cooperation.

3.4. Level 5: Tertiary Education[137] with practical placement periods

3.4.1. ISCED description and general considerations

The ISCED 1997 classification describes level 5 as follows:

„This level consists of tertiary programmes having an educational content more advanced than those offered at levels 3 and 4. Entry to these programmes normally requires the successful completion of ISCED level 3A or 3B or a similar qualification at ISCED level 4A.....". For FACE, the subdivision of level 5 is interesting, since most programmes that are more practically oriented belong to level 5 B.

While „ISCED level 5A programmes are tertiary programmes that are largely theoretically based and are intended to provide sufficient qualifications for gaining entry into advanced research programmes and profession with high skills requirements.", „Qualifications in category 5B are typically shorter than those in 5A and focus on occupationally specific skills geared for entry into the labour market, although some theoretical foundations may be covered in the respective programme....The content of ISCED level 5B programmes is practically oriented/occupationally specific and is mainly designed for participants to acquire the practical skills, and know how needed for employment in a particular occupation or trade or class of occupations or trades - the successful completion of which usually provides the participants with a labour-market relevant qualification.

A programme should be considered as belonging to level 5B if it meets the following criteria:

- it is more practically oriented and occupationally specific than programmes at ISCED 5A, and does not provide direct access to advanced research programmes;
- it has a minimum of two years' full-time equivalent duration but generally is of 2 or 3 years. For systems in which qualifications are awarded by credit accumulation, a comparable amount of time and intensity would be required;
- the entry requirement may require the mastery of specific subject areas at ISCED 3B or 4A; and
- it provides access to an occupation".

With respect to the existence of level 5B programmes in chemical education, one can roughly subdivide European countries into 4 categories:

- countries with a longer or shorter tradition in practically oriented tertiary (chemical) education such as DE, UK, NL FIN; offered in Universities (in the UK some of them are „old Polytechnics" like Sheffield Hallam University), Polytechnics (FIN, EE), Fachhochschulen (DE), Hogeschoolen (NL) or IUP (Institut Universitaire Professionalisé)
- countries with some universities offering tertiary education with obligatory or optional placement parts, such as ES, P, I (Laurea Specialistica)
- a country in transition and reform processes having a legal framework for tertiary education with placements, but still lacking the fully developed co-operation with industry (PL, EE)
- countries with no officially recognised form of tertiary education containing work placement periods (e.g. CZ, SK, RO, BG) or with no such form in chemistry studies (but in Biotechnology, which is the case in A).

3.4.2. A Tour d'horizon of level 5 B in EU countries

In the countries belonging to this group, universities and industry have developed partnerships. Companies obviously see a benefit in hosting students who will soon be colleagues in the chemical community to help them experience real work life and, at the same time, integrate into the social, hierarchic and team structure of a company (see chapter 4., especially 4.1.).

German Fachhochschulen have developed from vocational training schools in the 60ies of the last century and are now indispensable partners of industry for R&D work (placement semesters and final year projects). Placement time is one semester or 5 months minimum. In the Bologna process, there seemed to be a risk of loosing this good practice - probably as a consequence of disregard of the specific needs and benefits of this form of education, and also due to wrong political concepts like the one that all first degrees within Bologna have to be 3 year courses. During a congress organised with the help of FACE[138], all industry representatives agreed that Fachhochschulen should keep their profile of practically oriented courses and by no means give it up and offer what ISCED would call type 5 A courses. Job chances of graduates from their courses, if they include placement experience and some key qualifications, are very good.

Some Fachhochschulen offer „dual courses" in which students are at the same time enrolled in a university and affiliated with a company, alternating between both[139].

Berufsakademien follow the same pattern, yet, there are none for Chemistry so far.

In the UK, the Royal Society of Chemistry has published its opinion on higher education in response to political considerations in 1996[140]. The sector has been facing decreasing numbers of enrolments in chemistry studies with subsequent closures of departments. At the same time, the classic sandwich courses of the Bachelor type have been enriched by the MChem programmes (see 2.3.5.) which are 4 year courses with one year of industrial placement. The RSC is in favour of this course type: „Professional education in chemistry is best delivered through enhanced first degree courses (MChem) offered by staff in environments in which chemistry is being pursued through research, high level consultancy and other appropriate scholarly activities. The institutions which offer such courses need to be resourced to match the requirements of industry for properly trained personnel." The fact that companies pay placement students a relatively high wages (compared to other countries) is evidence for benefits they see in the students' contribution to their work. Students

137 http://www.srhe.ac.uk/HERN/, see also http://www.synergesis.com/HERN/Frame1.html is the Higher Education Reform Network, active in helping to organise the Higher Education in Europe
138 http://www.hrk-bologna.de/bologna/de/1945_2087.php
139 Wissenschaftsrat (Hrsg.): Duale Studiengänge an Fachhochschulen: Empfehlungen zur Differenzierung des Tertiären Bereichs. Bielefeld 1997. ISBN 3-7639-0066-7
140 http://www.rsc.org/lap/polacts/dearing.htm

without such experience are often regarded as deficient when they start job life, needing what Michael Cooke in a discussion of FACE experts called „BPD - beginning professional development".

In the context of FACE, a recent study on the influence of globalisation on the sector of chemistry and chemical education in the UK merits attention[141]. One of the findings of this study is: Changes in the industry over the past 10 years have also had a major impact on education and training delivered by chemistry departments:

„For years, many Departments have offered industrial placement as part of their undergraduate chemistry courses and introduction of 4 year MChem courses with the option of a final year in industry has further increased contacts with industry. However, there is real concern that M&A activity has reduced the number of available placements and changed the requirements from industry. This is becoming a very competitive area with competition from other Departments and other disciplines for limited placements. Companies are also more reluctant to release staff for university training even though they are prepared to pay for it in the student's own time. Some Departments are adapting by developing flexible and distance learning packages tailored to the needs of specific industry sectors."

In the Netherlands, Hogeschoolen have traditions similar to those in Germany. Placement time is generally 10 months (final year project). In Finland, Polytechnics offer such courses, but the placement seems to face some organisational difficulties, such as confidentiality (a problem that Germany has solved - if needed, appropriate agreements are signed by student, university tutor and company). The IUP in France, existing since 1991, still have to fight for their reputation in competition with the classic Ecoles d'Ingénieurs. There are, however, universities with good placement practice, such as IPE[142] in Lyon or the Ecole Supérieure de Chimie de Chambéry[143].

As an example for the second category of countries, Spain has some good practice examples with obligatory (Universitat Rovira I Virgili, Tarragona) or optional (IQS) placement periods. Companies in Spain, including SME's and multinationals (see 4.1.) are in praise of their and of international placement students. Limiting factors for such study forms are the low esteem Spanish society seems to have for vocational training forms and legal restrictions as to total and daily work time of placement students.

A good example for a transition country with a highly sensitive group of academics and industry colleagues is Poland. The country has actively adopted the Bologna process and created Higher Vocational Schools and legal frameworks for placements. The Bologna expert for Poland, Marek Frankowicz, has been and is active in numerous projects, including FACE. He and his colleagues have set up a Polish version of the FACE homepage and held a congress in July 2004 with industry colleagues. Another congress on higher education in Europe will be held in July 2005[144]. Some good practice examples are reported in chapter 2.7. of this book.

Finally, among the countries having no legal framework for practically oriented tertiary studies are Czechia and Slovakia. In the course of the FACE project, representatives of the Czech Chemical Society being aware of this drawback for the sector in their country have begun to disseminate good practice and FACE results, in an attempt to change political attitudes.

Chapter 4 of this book will try to show with good practice examples why practically oriented studies and placements are valuable for the sector of chemistry. FACE experts share the opinion that all EU countries should study these findings and, if they have no framework for such courses, consider to introduce them.

3.4.3. Towards European convergence in Tertiary Chemical Education: ECTN, TUNING and the Eurobachelor

A very interesting and vast Europen survey on the impact of the Bologna declaration on Engineering Education in Europe was published by SEFI, the European Society for Engineering Education. It collects information about how relevant courses are being and will be changed in the reform process we face. Questions 9 and 10 cover the aspects of practice orientation and employability of studies and students[145].

The project Tuning Educational Structures in Europe[146] was intended as a two-year pilot project jointly coordinated by the University of Deusto in Bilbao, Spain and the University of Groningen in the Netherlands. The project was launched on 4 May 2001. One outcome relevant for the sector of chemistry was ECTN[147], another one the project of a Eurobachelor.

The European Chemistry Thematic Network, ECTN, is a forum for Universities to share knowledge of and make comparisons of their curricula in different subjects. Membership in ECTN is free, membership in the ECTN association affordable. Higher Education as well as VET institutions should consider to become members to have a chance of obtaining information and of helping to shape the common European Educational Space in the sector.

The Eurobachelor is a framework for a first cycle qualification in chemistry. While details can be found in the 10/204 version of the Eurobachelor[148], some basic features are quoted here:

„Although the Helsinki consensus was that a „bachelor-type" degree should correspond to 180-240 ECTS credits (3-4 years), there are indications that the 180 credit degree will become more common than the 240 credit degree, so that

141 http://www.rsc.org/pdf/general/m&aukreport.pdf
142 http://www.cpe.fr
143 http://www-esigec.univ-savoie.fr/page/format/geang.htm
144 http://www.chemia.uj.edu.pl/eurovariety/
145 http://www.ntb.ch/SEFI/Bologna/survey.pdf
146 http://www.cpe.fr/ectn/tuning%20background.htm
147 http://www.cpe.fr/ectn/
148 http://www.cpe.fr/ect//ceb/

this model is based on 180 ECTS credits. Those institutions which decide on 210 or 240 credits will obviously exceed the Eurobachelor criteria as defined here, but will hopefully use the Eurobachelor framework and define the remaining 30 or 60 credits according to principles which they will lay down (e.g. the Bachelor Thesis may well carry more credits or there may be an extended institution-supervised industrial placement)...

A primary aim of the Eurobachelor qualification is to provide a first cycle degree which will be recognised by other European institutions as being of a standard which will provide automatic right of access (though not right of admission, which is the prerogative of the receiving institution) to chemistry Master programmes...

It must be made clear at the outset that each institution providing Eurobachelor-type degree programmes in chemistry is completely free to decide on the content, nature and organisation of its courses or modules. Chemistry degree programmes offered by individual institutions will thus logically have their own particular characteristics. The depth in which individual aspects are treated will vary with the nature of specific chemistry programmes...

It is of pre-eminent importance that institutions offering Eurobachelor qualifications aim for high standards, so as to give their students good chances in the national or international job market as well as a good starting point to transfer to other academic programmes should they wish to do so."

The Eurobachelor, taking into account the Dublin descriptors[149], speaks of subject knowledge, abilities and skills as outcomes and requires a total of 180 credits.

This brief overview makes clear that all level 5 B programmes to be adapted within the Bologna process may well opt to include all necessary features to host the Eurobachelor in their curriculum! FACE experts advise all responsible colleagues to consider this possibility.

3.5. Level 6: Post-graduate Studies after a first degree

3.5.1. ISCED description and general considerations

ISCED description for this level is rather concise:

„This level is reserved for tertiary programmes which lead to the award of an advanced research qualification. The programmes are therefore devoted to advanced study and original research and are not based on course-work only....It typically requires the submission of a thesis or dissertation of publishable quality which is the product of original research and represents a significant contribution to knowledge."

3.5.2. Master degrees

Although the Master as a Second Degree in the Bologna Framework is primarily intended to introduce to research activities and possibly opening up the way to a Doctorate, there are Master degrees which have a practically oriented character in the taught part and/or contain a practical placement or Master thesis.

There are numerous joint Master Degrees offering studies at different European universities and awarding joint degrees of these institutions.

In connection with the Eurobachelor initiative, Terry Mitchell came up with an ECTN discussion paper[150] about a chemistry „Euromaster" which gives a good critical overview of Master programme types, discriminating between

- short programmes (in continuing education) not intended to form a prerequisite for PhD training
- standard programmes which provide access to PhD training
- Transitional programmes which provide access to PhD training and
- The „Real Euromaster", i.e. joint Master programmes

NB:

The MChem programmes in the UK are „extended" Bachelor (first degree) programmes of 4 years and not Master (second degree) programmes in the sense of the Bologna process.

3.5.3. A framework proposed for European and industrially based Master degrees

The following is the result of a meeting held in London in the rooms of the Royal Society of Chemistry Sept. 12th,1999. The meeting was part of the activities of the LEONARDO project IDEAS (see 1.5.2.).

Participants:

Dr. Tony Ashmore, Royal Society, Dr. Sepp Gruber, Royal Society,

Dr. William Geary, former Dirctor of Studies, Sheffield Hallam, Senior Expert in LEONARDO projects of UNIC

Prof. Dr. Leo Gros, Europa Fachhochschule Fresenius

Prof. Dr. Michael Cooke, Royal Holloway, Univ. of London

Prof. Dr. Tony Smith, CPE Lyon

Prof. Dr. Enric Julià, IQS, URL, Barcelona

Dr. Mercedes Manresa, IQS, URL, Barcelona

- A number of business schools offer degrees with compulsory language and international elements, as well as many Universities in their Chemistry courses (UK, Europa Fachhochschule Fresenius, CPE Lyon etc.). It seems that in the UK not many students take this option, while Fresenius and CPE have large percentages of participants.
- There is a diversity of first degrees in Europe and among the participating institutions, ranging from 4 (Fachhochschule Diploma) to 6 (Ingeniero Químico, IQS Diploma) years with or without compulsory international and language requirements.

149 http://www.jointquality.org/content/ierland/Complete_set_Dublin_Descriptors_2004_1.31.doc
150 http://www.cpe.fr/ect/arch/doc/2004/N02/ECTNNews04v05n02_EuroMaster.pdf

- Despite of this diversity, all participants agree that a common definition of a European Master is highly desirable for their institutions and students, especially with regard to the labour market.
- As far as the language is concerned, two foreign languages in addition to English would be a demand excluding most of the English native speakers among students.

All participants agree upon the following minimum criteria:

- 5 years total study time, among which there are at least
- 5-6 months (1 semester, 30 ECTS credit points) of professional employment/work experience abroad
- proficiency in 2 European languages, one of which is English (TOEFL, Cambridge certificate advanced level) and one other language that is not the student's mother tongue (GCSE or O level, minimum grade C; or equivalent)

This European Master could be a first degree if it was offered as such. With the Bologna process, it will normally be a second degree after a BSc. Then it could be a two-, three or four semester degree, depending on the duration of the Bachelor course and ensuring that the total study time of the candidate was 5 years to obtain the Master degree. It could be a mixed MSc comprising a practical part of 3-6 months (Master Thesis) and a taught part. If it is a one year course, it could be entirely practical with no taught part.

In normal Master courses, students have to pay study fees. Prof. Dr. Michael Cooke, Royal Holloway, London, proposes to „take university to industry", to offer an industrially based Master.

The MSc model of Prof. Cooke shows several advantages for industry and students:

- it solves instrumentation problems
- it solves current resource problems
- it solves I.T. access problems
- it answers staff development needs on employer's and employee's side
- it is attractive for European students - MSc. in 1 year

This model has the following disadvantages for the academic side:

- applied, not pure research
- not highly valued by academic research assessment (not good for academic career)
- produces no research money income (by which universities are measured/rated -
- „which is what you are judged by, the system perpetuates itself")

3.5.4. Doctoral Degrees

An interesting publication[151] dealing with PhD training to industrial and societal needs and describing a model of the University of Antwerpen. The article covers aspects of exposure of students to international experience and of university-industry partnerships.

There is an agreement among European universities about a degree called „European Doctorate"[152].

Prerequisites for this degree type are

- at least two months research work in a foreign country
- two evaluations of the thesis from two persons of different nationality, neither of them being of the candidate's nationality
- defence of thesis in an EU language different from the candidate's mother tongue

In the year 2000, the partnership UNIC found a placement for a student from IQS Barcelona, Inma Folch, in Mainz/D. She worked there for 4 months, in partial fulfillment of the requirements for the Dr. Europeo of her University Ramon Llull Barcelona. Additionally, she had to write her thesis in an English version and to defend in a foreign language (see 4.2.).

A desperate young scientist at Southampton University complained in 2001 about lack of international awareness or the doctorate in Spain[153]. As can be seen from the example above, there are other ways of handling the matter - in Spain.

3.6. Life-long learning and informal learning

FACE intended to study chemical education on all levels. Although life long learning and informal learning were not part of the core focus of FACE, they are briefly mentioned here.

At the Lisbon European Council in March 2000, government leaders set the EU a 10-year mission to become the most competitive and dynamic knowledge-based economy in the world, capable of sustained economic growth with more and better jobs and greater social cohesion. Lifelong learning is a core element of this strategy, central not only to competitiveness and employability but also to social inclusion, active citizenship and personal development[154].

Life-long learning encompasses learning for civic and social purposes as well as for the employment-related ones. It includes all forms of learning such as, formal learning (degrees), non-formal learning (vocational skills acquired within the workplace) and informal-learning. Life-long learning requires that learning outcomes from different settings and contexts can be linked together[155]. A general overview on life long learning in VET is found at the BIBB website[156].

As in many cases before, chemical industry and social partners in the sector are at the forefront of developments. In autumn 2004, they published a joint position paper referring to the Lisbon declaration on „Education, Vocational Training and Lifelong Learning in the European Chemical Industry."

151 F. Adams, E. Mathieu, Towards a closer integration of Ph.D. training to industrial and societal needs. Anal. Chim. Acta 393 (1999) 147-155.
152 See M. Manresa in: Leo Gros, Mercedes Manresa (editores) Estudios con Practicas en la Empresa : Porque los Necesitamos. Informaciones - Argumentos - Buena Pratica. Barcelona 2005
153 Cecilio Mar-Molinero, see http://www.viewpoint.soton.ac.uk/Viewpoint/432/
154 http://europa.eu.int/comm/education/policies/2010/lll_en.html
155 see also www.webcongress-maastricht2004.n
156 http://www.bibb.de/en/5867.htm

„They decided to create a joint working group which will as a first step make an in-depth analysis of the status quo regarding skills, qualification, vocational training and lifelong learning in the various chemical industries. As a second step there will be a best practice comparison and exchange of information between the different national systems. The collected experiences shall then form the basis for supporting further development in this area[157].“

Among the good practice examples, the Royal Society of Chemistry (UK)[158] and their other national counterparts like GDCh (D)[159], a FACE partner, offer a wide range of life long learning activities and specialised continuing professional development, CPD, courses. The RSC have developed a special scheme for academics to become chartered chemists. It requires regular, self-determined training activities, life-long, that have to be properly documented, or else the charter is lost[160].

The Weiterbildungsstiftung wbs, a joint initiative of the social partners in the sector and partner of FACE (D) offers training activities[161] and projects for further education. Chemical engineering education does therefore not stop after graduation. It is essential to keep up with constant change.

The German social partners published a study[162] on Industriemeister Chemie, a continuing professional development (CPD) course.

Other forms of learning as summarised in[163] are:

- Informal learning
- non-formal learning
- incidental learning
- implicit learning
- mentoring

A wealth of information on informal learning is found in the web[164]. E-learning will be of increasing iportance[165]. A study on „work-integrated learning“ evaluates possibilities and limits of informal learning[166].

For academics in the sector, the Chemical Societies offer the title of a European Chemist[167] which may be applied for by experienced chemists in the sector: „The award of EurChem will assist individual chemists who are moving from one employer to another in different member states, receiving equal treatment across the EC. Candidates for EurChem must:

- Be a member of a participating national chemical society (in the case of the RSC an applicant must be a Chartered Chemist).
- Have at least eight years of post-secondary school education including a category A minimum academic qualification.
- Have at least three years' approved post-graduation professional experience.
- Nominate two referees who must be members of the applicant's national chemical society (Chartered Chemists in the case of the RSC)“

The Dresden seminar (see 1.3.) on Chemistry studies in Europe recommends that „Chemists across the European Higher Education Area should support the scheme of European Chemist professional designation and the revision of the qualification tables to take account of the Bologna process. Collaboration between the Federation of European Chemical Societies FECS and ECTN is highly recommended in this matter[168].“

To become and remain a Chartered Chemist[169], experienced professionals have to follow a scheme of continuing education which they must properly document: „Achieving chartered status in any profession denotes to the wider community a high level of specialised subject knowledge and professional competence. The award of the CChem recognises the experienced practising chemist who has demonstrated an in-depth knowledge of chemistry, significant personal achievements based upon chemistry, professionalism in the workplace and a commitment to maintaining technical expertise through continuing professional development (CPD).“

3.7. Teacher education

Teacher education in Chemistry for secondary schools of the Gymnasium type in Germany is traditionally theoretically oriented. Teacher students have to choose two subjects and not one (like in France). In most cases, they have never had any practical experience in industry.

When German universities offer teacher training in continuing education courses, teachers say what they miss in their daily teaching is practical experience, especially with new analytical and production techniques.

In the German Federal State of Nordrhein-Westfalen, a new co-operative model of teacher education between a University and a Fachhochschule started in 2001[170]. Students who will be teaching in Vocational Training schools have a choice between two university based subject courses or one more general subject couse (e.g. chemistry, biology, physics or mathematics) and one vocationally oriented course (e.g. chemistry).

157 http://www.emcef.org/Committees/SD/Che/2004/PR-20040910.pdf
158 http://www.rsc.org/lap/educatio/rsedhome.htm
159 http://www.gdch.de/vas/fortbildung.htm
160 http://www.rsc.org/members/cchem.htm
161 http://www.wbs-wiesbaden.de/e_wbs_seite6.php3
162 Industriemeister Chemie. Dokumentation des Workshops „Industriemeister Chemie", IGBCE and BAVC, 2001 (for information abt.beruflichebildung@igbce.de)
163 http://managementconference.com/ProposalSystem/Presentations/P000679
164 http://www.trainingvillage.gr/etv/HomePages/Front_page_news/LLL03/LLLHauch.ppt;
http://www.ueapme.com/docs/press_releases/pr_2003/030204_%20training.pdf
http://www.academyavignon.net/protein/vademecum.html informal learning in SME's mechanics, wood and textile
165 http://applications.edreform.net/resource/332, an example see http://www.vs-c.de/projekt/
166 see QUEM-report Schriften zur beruflichen Weiterbildung: „Formen arbeitsintegrierten Lernens". Berlin 1998, ISSN 0944-4092
167 see http://www.gdch.de/taetigkeiten/ausbildung/eurchem.htm or http://www.rsc.org/members/eurchem.htm
168 http://www.gdch.de/taetigkeiten/ausbildung/recommendations.pdf , p. 4. For EurChem details see: http://www.chemsoc.org/networks/enc/ecrb.htm
169 http://www.rsc.org/members/cchem.htm
170 http://www.zsb.uni-muenster.de/material/m003.htm

FACE experts think that employability of graduates depends, among other things, on attitudes towards work life acquired during studies - and earlier! If school and vocational school teachers have own experience through industrial placements, that will have a profound effect on their teaching. It is therefore worth more than one model course in one EU-country to give them this chance. FACE has so far not looked into the situation of teacher training in other countries but will do so in the future.

3.8. ECTS in Vocational Education[171] and access from Vocational Training to Tertiary Education

A European conference organised by BIBB[172] on the European credit transfer system in Vocational Education and Training, ECVET discussed how the ECTS credit system can be used to document and to enable trans-national and trans-level transfer of skills, knowledge and competencies acquired in vocational education.

A literature review[173] gathers publications on the subject until 1997. A project of Universität Bremen[174] compared VET cultures in different European countries. Another study[175] compares Germany and the Netherlands.

A network in a neighbouring technical sector[176] is active in the field of Mechanical Engineering and may serve as a model. „The specific aim of this pilot project is to create a systematic procedure to ensure international transfer of vocational qualifications (in terms of competencies and skills) at secondary level in order to increase mobility in VET. Students/Apprentices should be able to use their qualifications - acquired in educational institutions or/and in companies - as a „common currency" throughout Europe. The vocational field of „Mechanical Engineering" was selected as a model for developing and testing this procedure."

All those activities clearly show that the political will of European countries is being realised in Vocational Education reform. Europa Fachhochschule Fresenius, DE, has an experience of more than 150 years in VET and, since 1971, a University of Applied Sciences under the same roof. It has excellent experience with the transfer credits (which in former years did not have this name, but existed) from level 3 and 4 vocational to tertiary education. Able students can, after an entry examination and based on minimum performance requirements, legally enter higher semesters of Fachhochschule (as stated in special rules for such a step, approved by government authorities). Probably for the first time, in co-operation with an Austrian VET institution, this also works trans-nationally (see 2.1.6.).

Given all these facts, FACE members will, in co-operation with other colleagues active in this field, continue to work on a „holistic view" of chemical education, including transfer of credits between levels (see 7.).

4. The context of practical work experience: Good practice reviewed [177] [178] [179]

4.1. The Employers' View: Costs and benefits of placements

4.1.1. Reasons, costs and benefits

Can the academic and school world alone „teach" skills and attitudes appropriate for the workplace? Often companies complain about graduates having little idea of what is happening in real work life. Prof. Dr. Michael Cooke of the University of London's Royal Holloway Inst. of Environmental Research put it like this (discussion during the IDEAS partnership meeting, Vienna, Feb. 24th, 1998):

In the UK companies often complain:

- that they have to fill knowledge and skill gaps of students
- that students are not able to tackle a given problem
- that students are not familiar with job life.

This suggests a need for „BPD" („Beginning Professional Development") instead of CPD (Continuing Professional Development) - a way to bridge the gap between studies and industry."

While many companies still plead[180] for specialists „sticking to their core task" and deny the importance of international experience for „normal" staff, the project NICE (see 1.5.2.) showed that there is a demand for chemistry graduates having foreign language competence and international and/or work experience.

171 http://www.na-bibb.de/uploads/leo/ecvet_eu-kommission_principles.pdf; for valorisation of results of research see: Agnes Dietzen and Michael Kuhn (eds): Building European Co-operative Research Tradition in Vocational Educational Training BIBB Berlin ISBN 3-7639-0834-X

172 http://www.na-bibb.de/home/vortraege_details.php?ID=24&site=Vortr%26auml%3Bge+%26+Pr%26auml%3Bsentationen - download of contributions possible

173 Weiterbildung und Hochschulzugang : eine annotierte Auswahlbibliographie deutscher, englischer und niederländischer Literatur / Dietmar Frommberger. - Oldenburg Bibliotheks- und Informationssystem der Univ., 1997. - 147 S. - (Beiträge zur Berufs- und Wirtschaftspädagogik ; 12). - Literaturverz. S. 134 - 147. ISBN 3-8142-0609-6. Online: http://docserver.bis.uni-oldenburg.de/publikationen/bisverlag/2000/frober97/inhalt.html

174 http://www.itb.uni-bremen.de/projekte/vet/home.htm

175 Formation of disparate structures in European vocational education: a comparison between The Netherlands and Germany. In: Hanf, G. / Greinert, W.-D. (eds.): History of VET in Europe in a Comparative Perspective. Thessaloniki (CEDEFOP) 2004 (im Druck) (zusammen mit Reinisch, H., Jena)

176 http://www.vocationalqualification.net/vq/

177 In 1997 a survey of the topic was published: Spanning the Chasm: Corporate and Academic Cooperation to Improve Work-Force Preparation. Source see http://www.bhef.com/publications/spanning_corporate.cfm

178 A transnational EU project (1999) http://www.1do3.com/uk/page.php?x=19,719,4603, tncwe, contains helpful information for students and companies on work placements, in several European languages. Another helpful source is the project MESIPA(Methodology to Evaluating Student Industrial Placements Abroad), related to engineering studies, see http://www.cefi.org/STAGES/GUIDE_M.HTM. It includes placements abroad. CEFI is the French „Centre de ressources et de prospective sur les Grandes écoles d'ingénieurs et de gestion, et sur les emplois d'encadrement", see http://www.cefi.org/

179 One of the best sources we know is http://www.physsci.ltsn.ac.uk/Publications/PracticeGuide/guide1.pdf This comprehensive and well written guide for academics, students and companies is a true outline of good practice in work placements. A LEONARDO project offers a virtual training site for placement candidates, see http://www2.shu.ac.uk/hosted/virtx/vx2/home/about.cfm

180 Leo Gros, White paper "Needs of Industry in Chemical Education", Product of the pilot project NICE LEONARDO I, D/97/2/00156/PI/II.1.1.c/FPC of EFF

Asked to give a presentation to colleagues from industry of what he thought they expected from his students, the co-editor of this report showed them the following picture which - humorously exaggerating - shows a cross-breed having all possible capacities and strengths in one: „the pig giving wool and milk and laying eggs“.

Figure 8: Sus lanata oviponens (Design: Hans Gros)

While universities try, in vain to „produce“ these fantastic beings, they can still offer types of courses that bring students nearer to the „ideal“ profile the labour market wants. What are features of such study programmes?

A German chemical industry colleague, responsible for Technical Vocational Training in BASF company, Ludwigshafen, D, Dr. Norbert Meyer, puts it like this: „We do not care so much about what a candidate has done. We are interested in what he or she can do! Can he/she discuss in English, explain a technical problem correctly and to someone who is not a specialist in the field? We ask academics to please go beyond curricular hours and contents and let us know: What is the graduate able to do - which competences does he/she have?“ Another colleague, former Human Resources Manager with HENKEL, Düsseldorf, D, Christoph Thienemann, used an interview (1998) with the author of this chapter to give the following legacy:

- We still need intensification of close cooperation university-industry
  („we cannot afford the luxury to teach far from the reality of working environments“)
- European/international markets need internationally trained young people. „We can no more accept that universities speak of international training - they have to do it!“
- Do what you say -
  have proof of foreign experience in your C.V.!
  „Universities and students that speak globally and act locally, drop out when it comes to the acid test“
- We need young people who speak the language of and have an understanding/feeling for the culture of the business partner!
  „If you eat sauerkraut in Mallorca, you are nothing but a local player!“
- What was if your diploma not only showed what you have learned, but also what you are capable of and willing to do?

A survey on the relevance of „international competences“ for employability published in 2003 by HIS, Germany[181] (see esp. tables 6.14 and 6.15a) comes, among others, to the following conclusions:

- 55% of the companies employing engineers (scientists) want proficiency in the English language14% want at least two foreign languages spoken by graduates. 44% of the graduates interviewed said they needed special foreign language proficiency in their job
- More than 25% of all job offers in this sector include statements about work abroad, 20% speak of the need to travel internationally; 20% of the graduates working in the sector say they have to travel abroad
- Despite the fact that foreign experience is asked for short study times are an important positive criterion for employment

If it is true that work placements in industry or institutions that will employ young chemists and international experience and language proficiency enhance employability and make students fit for work life after graduation, then there is no other way: industry and academic/school world must co-operate to organise such placements, to offer language courses and to open ways for international work placements.

One of the most important messages students will take home from such a placement is what university graduates often lack: a feeling for cost/benefit questions! The author and many industry colleagues are therefore convinced that placements themselves must not be excepted from cost-benefit analysis. If placements brings no benefit for companies, they will not offer them. And if a placement has no positive cost-benefit balance, then most probably the student has not had a chance to or was not able to do useful work - which in turn means that the placement, seen from his or her and the academic side, was not successful, and was not what it was meant to be.

The following interviews and statements of industry colleagues are meant to encourage those who doubt, and to invite those who hesitate: If you need students, tell the universities and schools. If not, think about the reasons - and read your colleagues' experiences. Since most big and multinational companies have established procedures for placements, the examples shown here are devoted to SME's. Many of them would not have started with placements without academic input and help programmes, but all of them benefit - and say it.

181 see http://www.his.de/Abt2/Auslandsstudium/Mobilitaet/KAP6.HTM . This chapter is part of a comprehensive survey on "Vorbereitung auf Europa durch Mobilität und Internationalisierung des Studiums", see http://www.his.de/Abt2/Auslandsstudium/Mobilitaet/INDEX.HTM

4.1.2. „Social duty, investment, clear benefits“: work placements in an analytical laboratory at Chemetall Frankfurt (D)[182]

My name is Heide Brito. I am a chemist and Head of the Analytical Department of Chemetall Frankfurt. My staff consists of 18 people. I have a university degree. Of my staff, 7 are Fachhochschule graduates, 8 are Technical Assistants or Technicians and 2 Laborant. Our daily work is to solve technical process and product related problems of our internal and external customers, mainly using modern analytical techniques.

Why do I think Alternating Education is valuable?

Why do I invite placement students to work in my department?

We have apprentices, placement semester students, students doing their final year project with us and students working during their holidays. Among them are many students from FACE partner institutions, like Europa Fachhochschule Fresenius, HBLVA Vienna, Hogeschool van Utrecht, Institut Químic de Sarrià Barcelona (I have visited all four).

First let me say that I like to give young people who are interested in our work a chance to learn and to widen the scope of their skills and knowledge.

Let me give you some key arguments that support industrial work experience:

- Students help us to do our daily work, but especially work on small projects which we cannot do with our full time staff. People sometimes think this replaces regular jobs. It is, however, my experience that it helps us to develop new techniques and applications which we can then sell to our customers. This makes jobs in my department safer.
- Companies have a social duty to take part in the training of their own future staff. We strongly support the German University of Applied Sciences approach. This alternating scheme cannot work if companies do not take part actively.
- During placement periods, we get to know young people very closely during e.g. one half year. This helps us enormously when it comes to recruiting. Many former placement students now work with us. One third of the staff in my department are alumni of one University of Applied Sciences (EFF).
- Whenever possible, I would prefer to hire people who have some practical experience (ideally a vocational training, e.g. as a lab assistant, plus University of Applied Research studies) For applied research and development, I prefer these graduates to classical university students. They have learned to evaluate results in a practically oriented way (they would e.g. rather study the pattern of IR spectra instead of calculating resonance band energies).
- Our placement students create value - they bring more profit than they cost (we pay 550 Euros per month). Moreover, we invest considerable time in their training.
- Students bring in new ideas. This is especially true for EDP. One student from Austria independently developed an Excel database of analytical results which we now use daily. The database links numerous analytical results with practical questions and properties of substances and mixtures of our customers.

What do I expect from your placement students - and what do we invest into their training?

- Our „investment“ starts when I go to universities and present my department and possible projects to students.
- We give the students a sound training of skills and knowledge in all analytical procedures which they work on. This training is practically oriented and relevant for their future job, since it is part of our daily work. They learn in the context of real tasks. My staff supervises the placement semester students. With the final year project students I have a weekly meeting to supervise their work.
- We expect students to join in with our daily work and to comply with the rules for safe, exact and neat analytical practice. They must produce meaningful profitable results that we can sell to our customers, compensating for the time that we invest to train them. They must be able to work in a team and be diligent and punctual.
- A placement semester student must have sound basic knowledge, especially in Analytical Chemistry. (This is why we readily take in students from our partner university Europa Fachhochschule Fresenius.) They must be trained to work methodically. A final year project student should have more profound knowledge and be able to do scientific work with a certain independence, including the writing up of reports and literature search - including books and original papers, not only the internet!
- Students will not bring new knowledge as far as instruments are concerned, because we have a high standard for our equipment. However, they bring in fresh ideas and cultural experience. My people get a chance to meet foreign students. That enhances their interest in foreign languages. Three of them are now learning Spanish - we had several Spanish placement students with us.
- Students receive an individual assessment for their personal record, plus a standardised evaluation form that Europa Fachhochschule Fresenius based on a form of Hogeschool van Utrecht.

182 Dr. Heide Brito has actively taken part in all the LEONARDO DA VINCI projects of the partnership of Europa Fachhochschule Fresenius. Her dedicated and outstanding contributions to industry-academic co-operation are gratefully acknowledged. Interview of 01.09.2003

4.1.3. „Projects driven with momentum and to time scale“: EFF-students at Olympus Diagnostica Ireland[183]

What do we need?

The Diagnostica business largely is a very competitive segment in the healthcare sector. Over the last few years the business volume increased by a few percent only. The requirement for cost savings in the healthcare sectors is common to all industrial countries. As one consequence the laboratory sector is going through a consolidation process, which resulted in a significant reduction of sites. This process is still going on. The new laboratories are significantly bigger and have more buying power. This makes the business from a price perspective highly competitive.

Another development out of this is a change in customer expectations. Customers nowadays are no longer interested in buying instruments and analysers from Diagnostica providers. They are expecting problem solutions from the industry. In consequence Olympus Diagnostica offers system concepts, instruments and reagents. These concepts also include handling of primary tubes, sample distribution to different analysers, archiving of samples after the testing is done (archiving for re-testing, if required), managing reagent and consumable supply, managing quality control requirements and instrument maintenance, as well as patient specific data reporting.

As far as our key business segment is concerned, we have to supply a complete package of all reagents used in a laboratory. The reagents have to be of high quality and low price. All our reagents, calibrators and controls must meet all medical requirements.

In parallel over the last few years there was significant progress made in the standardisation for test results. Traceability of tests became a requirement. Reference methods we agreed for many of the analytes. The CE marking became mandatory for all reagents. So the Diagnostica business is now much more regulated.

So a lot of strategic attention was put into the extension of our reagent panel, continuous quality improvement, as well as cost reduction programmes.

Why are we interested in students and graduates?

We get students and graduates in project teams involved, where we investigate product improvements or new product concepts. These are the areas where we are in contact with external customers and experts, talking about new medical requirements of technical progress in analytical approaches.

Through the student placement we get into collaboration with universities. We see this as an important step in developing networks between industry and the scientific world. It can lead to technology transfer with value additions from the academic and commercial partner. Such collaboration and the looking beyond the walls approach is seen as a chance for grant allocation from EU sources (like the Marie Curie program for post-doctoral researchers).

The temporary employment of students and graduates offers job opportunities for the company and the students. We have some employees, which started as placement students in Olympus Diagnostica.

Good Level of Analytical Skills and Hard Work: German Placement Students

The German placement students appear well-placed to contribute to certain project aspects due to their inherent skills which might be listed as follows:

- Good deductive reasoning
- Good levels of mathematical understanding and analytical skills
- High level of computer literacy
- Ability to follow direction and report in a well-defined structured manner (verbally and in writing)
- Culturally, the nature of the Fresenius students appears to encourage an enquiring/ investigative spirit commensurate with scientific research aspirations
- Hard-working!

Their good work ethic ensures that a project will be driven with momentum and to timescale.

What are the types of projects students and graduates got involved in over the last few years? Mostly the students or graduates were we put into our project teams are feasibility studies for:

- Reagent re-formulation under quality or cost aspects
- Comparison between different reagents, like benchmarking
- Development of new Olympus products, like an analyser wash solution or an improved immunoglobulin G reagent.

The long-term relationship between EFF and Olympus Diagnostica and hosting one or two students every year, allows us in scheduling the student resource into our strategic projects plans. As we meet on a regular basis, we have established a discussions about new technologies or R&D grant applications. Such discussions also support the networking between EFF/Olympus Diagnostica and other universities.

4.1.4. „For an SME, the relative impact of placement students is high ...“: SBS Specialist Bioanalytical Services, Egham/UK

My name is John Halket. My company, SBS, is a very small SME, consisting just of myself and another half time person. Additionally, I have contract personnel, e.g. one person 2 days a week in King’s College, London, and one post doctoral fellow on demand. The turnover of my business varies a lot, and I can never be sure of next year’s projects. So I keep expenses low, have literally no overhead. I must be and I am very flexible. I can make my own decisions, do not have to sit in board meetings, but, on the other hand, I am fully responsible for success and failure.

183 Interview/statement of Nov. 2004. Special thanks goes to Dr. Gerhard Gunzer, Dr. Frank Kretschmar, Dr. Ludwig Pfützner and Dr. Matt McCusker for reliable and fruitful co-operation over more than 11 years, to Padraig McNulty who started it, and to Ludwig Fresenius who brought us in contact with him.

Why do I think sandwich placements are valuable for students?

A placement means real life experience in a real company, and combined with the academic education it is an excellent preparation for the work life.

When I was a student myself, I used to work in companies informally during the summer. A semester or year of placement is more structured.

Why do I invite foreign placement students to come and work with me?

I was a placement student in Spain in a Bilbao paper factory through IAESTE back in 1968. This affected me a lot. I had never been abroad before. I learnt some Spanish and experienced a different culture. I see those students like myself, especially the ones who have never been to the UK. I try not to speak German to them, only the very first days in case of a problem that needs clarification.

What is my company's benefit?

I give the students a basic chromatography and mass spectrometry training and some safety training. Then I assign them tasks, usually half routine, half research project work. They have hands-on-experience with my highly sophisticated equipment while I benefit from their work. Some just do the routine properly, others have tremendous initiative and give input themselves. I have had very few weak students only. For an SME like mine, the relative impact of good placement students is high, and there are projects which I could not do without them. I still have contact to some of my former students. They all have found excellent jobs, and in some cases their thorough and practical introduction to a modern analytical technique that needs some experience to yield reliable results proved to be one key factor for their employability. So there is a clear benefit for both sides, and EU grant money they get along with a modest salary I can give them is well invested.

Have I also had national placement students?

I have never been offered any. I have PhD students, though, one working for a company in a specific project. It is a pity that Analytical Chemistry is not well recognised in the UK, it is looked down at as being a „Messknecht", as you would put it in German. Currently some UK Chemistry Departments are being closed, even the one in King's College which has just celebrated it's the 50th anniversary of DNA discovery (Franklin & Wilkins). Students do not want to study chemistry, the social reputation of this field is not very good.

Although there are excellent courses in Universities and some excellent graduates, the British chemistry labour market benefits a lot from continental chemistry graduates these days (German, French, Spanish).

4.1.5. „Fill the gap between University and company life"[184]: Needs and policy of BASF España

My name is Jorge Figueras Morera. I am Director Productions of BASF Espanñola, Tarragona, E.

We have some 1070 employees of which 860 work in production. Some 15 academics work in production, 20 in engineering and projects. 20 ingenieros tecnicos and 20 tecnicos work in production.

We have a turnover of some 930 Million Euros per year. We produce polymers (e.g. Polystyrene, Expandend Polystyrene, Dispersions, Copolymers, Polyester resins), additives (e.g. plasticizers) and crop protection agents.

We do have national graduates with practical experience during their studies: Technicians have obligatory practical periods. University graduates do not have obligatory practical times, but sometimes work during holidays. The Tarragona based University Rovira I Virgili has a practical placement period. Each year we have 5-6 students for periods of 4-5 months coming from that university. I definitely welcome such graduates.

As far as language proficiency in our daily work is concerned, we need people knowing English (level: first certificate). We welcome German - although it is not a pre-requisite.

We have had several LEONARDO DA VINCI placement students, among them were four from Europa Fachhochschule Fresenius.

What do we expect from placement students? They must have basic knowledge and grasp their task rapidly. They do project work that cannot be done by full time employees along with their daily work.

What do we expect from graduates? They must have a minimum of skills and knowledge. We expect them to be able to follow an aim or objective tenaciously. There are people with a lot of theoretical knowledge. When you confront them with a real life problem, this is a completely new situation for them. Others seem to never have studied in a university - they come with little knowledge. We are interested in an „intermediate" type of person.

Most graduates come with high excessive confidence. In the university, many professors and students use the informal „tu" when talking to each other. In an industrial environment, this is unusual.

We have to teach them our company policy. They have to interact with the production people who do not have an academic background. We have to make clear that decisions in a company are made in a hierarchy of responsibilities and that often not everyone knows the implications of decisions - freshly graduated people who join us have difficulties to accept that.

We welcome foreign experience of graduates. Such people are more flexible, accept other mentalities more easily.

What would I suggest as an innovation in your country's educational system?

184 Interview of 19.12.2002, amended by statements of Arturo Gutierrez, BASF, on Oct. 15th, 2004 during a FACE meeting in Barcelona. We thank BASF for their open minded academic relationships over years.

I would welcome if students worked in a company at the beginning of their studies, just to show them what they are heading for! I know that this is against our own rule of taking in students only when they have some 120 credits (2 years of study). I would also welcome more emphasis on courses with integrated practical and/or foreign experience.

Additional notes taken during a presentation of BASF and their placement policy in 2004:

While in Spain there is no grown culture for placements, Germany does have such a culture. We, being the Spanish branch of a multinational company, adapted this policy. We accepted this model under the leadership of a former CEO of our production site in Tarragona, Dr. Klaus Steigerwald. He was of German origin. One day, he got a phone call from a German BASF colleague who had been a member of the DECHEMA Working Party on Chemistry Studies in Universities of Applied Sciences. He had been keeping telling his university colleagues how important foreign experience was for us. One of them, Prof. Leo Gros of Europa Fachhochschule Fresenius in Idstein, had taken his word for it and had tried to get a placement in Spain - in vain. This initiative prompted our people to consider placements for foreign students, and since then we have had several of them.

The people we need have to bring in initiative and be solution and team oriented. They must bring innovation and enhance change and improvement. They have to be result oriented and to adapt to the practice oriented view of cost and benefit of projects. Motto: there may be very complicated solutions - keep it short and simple!

Therefore, universities should fill the gap between academic and company life. They should foster the students' understanding of security and safety aspects, of languages, of process control EDP and of the basics of fluid dynamics.

4.1.6. „The LEONARDO money is well invested... „ : For CATENSA, placement Students are an asset[185]

My name is Enrique Villagrasa. My company, CATENSA has some 170 employees in production, 5 academic and 15 non-academic technical staff, 8 administration people and a turnover of 100 Million Euros per year. We have three other sites - Montcada (80 employees), Massanet (F, 120 employees) and UK (90 employees). We produce felt and polymer composites, esp. for the automotive industry.

We have no national graduates with practical experience during their studies. There is no tradition for Alternating Studies in my country. Most people arrive in our company without any previous real industrial experience. I would definitely welcome graduates with work experience.

Language proficiency plays an important role in our daily work. A company cannot survive in a local market. We have to speak the languages of our customers if ever possible. Learning languages means entering new grounds and other concepts of life and work as well.

We have had two LEONARDO DA VINCI placement students so far. One German did a one year First Work Experience period with us. After that year we employed him. Now, after five years, he is the head of our R&D unit. He keeps the contact to foreign customers all over Europe. He speaks - besides his mother tongue - Spanish, French and English. He plays an important role in CATENSA now[186].

The second spent a practical placement semester with us. He worked on R&D projects and brought lots of fresh ideas into the company. He soon got involved with customer relations as well.

Both students were an asset to our work. The LEONARDO money is well invested - if all taxpayer money was so well invested, I would welcome that. The EU should put even more money into this pot.

What do I expect from placement students? They should grasp their tasks in a minimum of time and then become productive. They bring in new points of view, new approaches to old problems, new perspectives - those who have spent years in our company have different views. Students bring in systematic approaches to R&D problems. Their knowledge allows them to grasp a problem quickly and carry out applied research.

What do I expect from graduates? I expect students to join in with our daily work and to be team players. Each company has its own characteristics, and we want freshly employed colleagues to adapt to ours. We want them to have foreign experience - such people are difficult to find in the Spanish job market. We want them to have basic knowledge and skills. They have to get acquainted with the company itself, its products. We have to teach them that all R&D activities are motivated by needs of our customers.

4.1.7. „Student work time is regrettably limited...“: With Oliver Rodes, students are well trained[187] to analyse waters

We are an SME being specialised in water analyses and Spanish market leader for mineral water analysis. We have 35 people working with us. Our contacts with Europa Fachhochschule Fresenius go back to a meeting of my father with the late Prof. Wilhelm Fresenius in Wiesbaden in 1988.

We regularly take in Catalan students for placements. They come from the University of Barcelona and from Rovira I Virgili University Tarragona. Student work time is regrettably limited to 500 total hours, split off into 4 daily hours during some 125 days. We would like to have them for full days - they would be able to learn more and work more continuously. Students obtain an allowance of 150 Euros per month. In microbiology, we would prefer students from vocational training institutions like Joan Pellegrí. Their training

185 Interview with Enrique Villagrasa Pie, Consejero y Director Financiero, Grupo Industrial CATENSA, S.A., Barcelona, 20.12.02, whom we thank for the excellent co-operation in placements

186 see 4.2.2.

187 Interview with Jorge Oliver Rodes on Oct. 14th, 2004. Our special thanks goes to Dr. Benito Oliver Rodes, an unforgettable meeting with whom in Wiesbaden, Germany, in 1988 stood at the beginning of all the "catalan connections" of EFF.

is much more practice oriented than that of university students. However, their placement period is only one month, again 4 daily hours. In that short time, nothing meaningful can be learnt.

We carefully look after the students and train them well, since we have to comply with quality assurance rules. Working with accredited methods, we have ENAC quality audits.

We gladly take in students from abroad like the ones from Europa Fachhochschule Fresenius. We integrate them into the daily routine and, on top, give them a project to work on.

4.1.8. „Their work contributes to the lab's economic success..": Students help make wine with scientific know how at Torres S.A., Vilafranca del Penedés (E)[188]

We work in the analytical and biotechnology departments of Torres S.A., a leading wine producer of Spain situated in Vilafranca south of Barcelona, Spain.

We regularly have Spanish placement students. The benefits we have from placement students are manifold. We introduce them to all types of work we do and then expect the students to bring in their experience and come up with fresh ideas off the track of our daily routine. They also help train our staff in foreign languages (in their language or English). Their work contributes to the lab's economic success.

When we employ people, we prefer the ones with practical experience. All our employees have done placements during their studies. This experience gave us a chance to get to know them, and we always have a choice to make when we need to hire someone.

We were very satisfied with the placement students we got from Europa Fachhochschule Fresenius Idstein and Vienna.

4.1.9. „...that there was a future to win in these countries." - Student placement at Galvanoplast Fischer, Liberec (CZ)[189]

I studied Chemical Engineering at Cottbus University. Placements were not compulsory during my studies, but I decided to go to the Czech Republic for a placement time. My choice of a placement in a country of the east of Europe was based on the idea that there was a future to win in these countries. I learnt Czech at the university. After my examination, I started to work for VDO in Prag. Then I joined Galvanoplast Fischer.

When we take in students, they start to learn about galvanic processes and their control. They get to know the company structure and ways of communication, company hierarchy and procedures. Then they join in the daily lab and/or production work and start to bring in their own ideas.

There is no tradition for industrial placements in this country. When I am looking for new colleagues, I prefer experienced people. However, we take in graduates directly after their examination in business studies. They need some time to adapt to our company and their tasks. When I worked with VDO, we would publish job offers at Prague Technical University or Brno University and take in appropriate graduates. They needed half a year before they were fully integrated.

What is definitely positive in this country is the excellent basic training in universities and a relatively high percentage of engineers in relation to the total population.

Liberec university has a good co-operation with Breslau and Zittau universities - they form a regional triangle with trans-national study programmes.

This year we took in two students of Europa Fachhochschule Fresenius for 5 months each.

4.1.10. Schlumberger - a model for company policy and participation in EU projects

Schlumberger, a multinational company with a site in Brussels, is a FACE partner. The company describes its „Best Practices for Hiring Interns"[190] as follows:

Why take interns?

- Make Schlumberger known - Use as a tool in Pre-recruitment
- Reinforce communication with professors and staff & Evaluate technical level of universities, department and laboratories

General guidelines

- Appoint/assign person in charge of internships for the region/business group
- Spread internship offers to touch a large group of universities and departments
- 30% women interns
- Take risk!

Attract

- Plan openings and job descriptions well in advance - Communicate early to students
- Use student visits and alumni to 'market' internships
- Ensure timely response to all applications - don't let them pile up before selecting and replying
- Salary aligned according to market. Same salary across business groups in one country.

Integrate

- Practical details organised before arrival (office space, computer, telephone, contract, e-mail...)
- First day: welcome student, visit site, meet department staff, review the assignment, Invite for lunch
- First week: student meet with a representative of the personnel department
- Supervisor has a contact with the intern everyday (does not have to be work related)
- Written guide for the intern and a guide for intern supervisors- per area, and customise with site guide.

188 Interview at Torres laboratory on Oct. 14th, 2004, with Braulio Esteve Zarzoso and Joan Marco, whom we thank for introducing students to the fascinating world of wine analysis and biotechnology

189 Interview with Peter Endlich, Dipl. Ing., Galvanoplast Fischer, Liberec CZ, on Nov. 18th, 2004. Thanks goes to him and Peter and Erwin Fischer, Fischer Galvanik Germany, for having opened a door to a "new EU country" for placement students.

190 Source: Recruiting Co-ordination Europe, Schlumberger, Paris. We thank Guy Goyeau for expert advice on placement policies and practice.

During the internship

- Regular but informal follow-up on progress and integration
- Invite to department meetings and general site events - make the intern feel as a member of the team
- Invite professor/staff member from the university to visit mid-term
- In co-operation with the personnel department:
- - Discuss future projects with the intern early (provided the intern is performing well)
- - Inform of possible openings as well as the career development and training possibilities (including web based tools such as the career centre)
- - Make sure they know of our interest in hiring

Evaluation

- Establish and fill out a formal evaluation sheet for each intern
- Discuss the evaluation with the intern during a formal interview. Ask him/her to fill out comments
- If profile is suitable for SLB, but no job opening in the unit, communicate CV + evaluation form to the recruiting coordination for the region or to a personnel manager/recruiter you know has a job opening.
- For poor performers, make sure to give a professional, coherent feedback on performance that is understood.
- Feed-back to professors/staff

Follow up

- Organise a meeting with all trainees in the country/unit/segment to share experience, pass on important info on SLB, openings, application process and to create a memorable event
- Interns going back to university for one or more years: Stay in touch with good performers (send Season Greetings, Annual Reports), display interest, invite to the SLB stand during the campus fair at their university. Let them be your Ambassadors.

Hire

- Track conversion ratio of interns to regular employees. Analyse results (per BG and RC consolidates)
- Be their informal mentor during the integration process

Proposed Action Plan

- Establish/update guides for intern and supervisor as well as recommendations for customisation
- Establish/update and implement an evaluation form

Include in objectives:

- 30% women interns
- for 35% of interns: develop or renew contact with professor/staff (visit)
- 25% of interns hired
- Former interns on Schlumberger stand at all campus fairs

Schlumberger took part in SERA[191], a project that worked on a method of location and evaluation of competence developed and implemented during a training abroad.

4.2. The Students' View: Enhancing competencies, employability and career chances[192]

4.2.1. Industrial placements - work experience for life and life experience for work

This chapter comes up with a collection of 14 exemplary statements/interviews reflecting students' and alumni's experience with placements (especially abroad) and their opinion on the influence of this experience on their own personality and on employability and career. They give convincing evidence for the benefits placements have for students.

If this is convincing for the reader, and if it is true that companies want placements and see benefits for themselves, then students should readily adopt this practice, and universities should do their utmost to offer programs.

A survey published by HIS in 2003 comes to the conclusion: „The coming need for internationally oriented engineering/ science graduates seems to loom on the horizon already, while it has not yet sufficiently penetrated the minds of students[193]." This sad finding does definitely not hold true for the students who speak out about their foreign placements in the following case studies.

4.2.2. „Perfectly prepared..." - European academic and work careers with LEONARDO

„...able to adapt and work with different cultures and mentalities..."

Marcus Stiegler, during his 2nd year of studies at Europa Fachhochschule Fresenius (D), told his supervisor he had great interest in spending some time in Spain. He had started to learn some Spanish. It proved to be difficult to find a placement. Even in a multinational company, obstacles were high. When the supervisor was told by a colleague of BASF Deutschland, Dr. Norbert Meyer, that his company wanted international experience, he told him of the problems he had had to place a student in Spain. A month later, the then Director of BASF Tarragona, Dr. Klaus Steigerwald came to meet the supervisor, and they agreed upon placement conditions. Steigerwald, of German nationality and with international experience in setting up a new production plant in Mexico, was fully aware of the benefits of placements and saw the need that industry has to take part in the training of their own future staff. This example is typical of how many placements become possible: strong student interest, academic support by a dedicated and patient supervisor, personal will on both sides to overcome obstacles.

Marcus did his practical semester abroad with BASF Espanola, Tarragona, Spain, working in their quality control lab after a language course in Spain (and several other students of EFF did so later). Being interested in a placement in

191 http://www.sera-europe.org/sera/

192 The authors gratefully acknowledge the support of alumni who were willing to describe their placement experiences and career, and the help of Dr. Mercedes Manresa, IQS Barcelona who helped to gather the Spanish contributions. Leo Gros thanks the former placement students for taking the risk and chance to go abroad. With their dedicated work they made further placements possible, convincing the companies of the benefits of placements.

193 See http://www.his.de/Abt2/Auslandsstudium/Mobilitaet/KAP6.HTM

a South American Spanish speaking country, he asked his supervisor for help in this matter. A year later, he went to Chile (Concepción) for his final year project thesis work, doing research on polymeric liquid crystals with a former fellow student of the supervisor.

After the examination, Marcus wanted to find a first job in Spain. Now the Network UNIC (University Network with Industry in Chemistry) of EFF and 50 European partners was useful, and luck was on Marcus' side: The head of the „Bolsa de Trabajo" at the EFF partner University Institut Químic de Sarrià in Barcelona forwarded a fax of a Spanish SME to EFF. They were looking for a student speaking German for their quality control lab. LEONARDO DA VINCI paid Marcus one year of first work experience grant at CATENSA, Santa Perpetua, Cataluña, a supplier for automotive interior parts with production sites in Spain, France and the UK. After one year the company offered him a permanent job. Several years later, Marcus he is now head of R&D in this company, doing business in the UK, Germany, France, Spain and most of the other European countries and speaking German, Spanish, French and English with his colleagues and customers, having been perfectly prepared by his educational training - as he states - not only in a linguistic point of view but especially in being able to adapt and work with different cultures and mentalities. The company says they are glad to have him and since have taken in more placement students.

Although this is an outstanding example, there are many more, clearly showing the benefits on all sides that work placements, and above all European work placements have.

„ ...I could apply my theoretical knowledge in practice..."

My name is Axel Kappeler. I am 34 years old and project leader at Arthur D. Little, management consultancy. I graduated at EFF Fresenius in 1996.

After the first years of study at Technical University Darmstadt and at the University Konstanz, I decided to continue my studies at EFF Fresenius in 1994. Why did I decide to do so? The practically oriented education at this institution fascinated me because it combined chemistry and process engineering with environmental management and business administration and it offered the opportunity to study abroad.

I could directly change from my old university because all my courses, which I have already taken, were recognized and I only had to catch up with three subjects, which were part of the curriculum in the first semesters at EFF Fresenius.

In the 5th semester, I did my work placement in a Research Centre located at University of Louvain-la-Neuve, situated in the French speaking part of Belgium. There I worked on a very practically oriented polymer research project which turned out to be a perfect preparation for my diploma work.

After the work placement I added one semester abroad, to be more exact, I went to study at the EFF-partner California State University in Long Beach (California). I received a grant for this paid by the Deutscher Akademischer Austauschdienst (DAAD), the German Academic Exchange Service, in the frame of the Program IAS. In the USA, I could improve my English to a high degree, which allowed me to find a job more easily, but I also learned to work in a team to realise project aims. Additionally, I could apply my theoretical knowledge in practice by working on a project, a security study for a refinery and an audit for minimizing waste in a galvanisation company.

My diploma work, finally, was carried out in the centre for Application Technology at the chemical company Degussa in Hanau. The subject of this diploma work centred on polymer chemistry, a knowledge which I acquired in my first internship in the 5th semester. This contact was also provided by EFF Fresenius.

As my main area of study in the second part of my education at EFF Fresenius I specialised in environmental chemistry, which helped me for my project work as well as for my future job.

What am I doing now? I have worked as a consultant in the department of of environmental and risk management for Arthur D. Little, one of the most highly renowned management consultancies, at Cambridge, England. The wide variety of my activities, first as a group member, soon as a project leader, comprises security analyses for refineries or railway enterprises, security audits for the environment or work for chemical companies, the development of risk management systems for private and public companies or studies for the British Ministry of Economics investigating the competitiveness of different branches. I have stayed in England, Germany, Austria, Italy, France, Scandinavia or the Middle East while working on these projects.

EFF Fresenius has outstandingly helped me in manifold ways:

- Recognition of my courses done at different universities without causing problems and demanding too much bureaucracy
- Help in finding a work placement in a French speaking foreign country
- Integrated semester abroad with a grant from the DAAD
- Project work as an integrated part of the studies abroad
- Recognition of my credits obtained in the U.S. without causing problems and demanding too much bureaucracy
- Practically oriented education in my core studies of environmental chemistry as well as in the courses of environmental and business management
- Finding a diploma work in the practically oriented research done in chemical industry
- Finding a contact to my present employer Arthur D. Little

Germany - UK: First Work Experience, a PhD and a Hidden Return Ticket

My name is Hilke Donohue. Between 1992 and 1996 I studied chemistry at EFF Fresenius and graduated in 1996. I spent my obligatory work placement semester together with a second student at a metal processing, medium sized company in Columbus/Ohio, USA. After my studies the international contacts of EFF Fresenius and a grant from the mobility project UNIC in LEONARDO made another work placement possible in the UK. For my master and later my doctoral

diploma I went to Sheffield Hallam University in Sheffield, England, a partner university of Fresenius. I finished my thesis in 1999 and was then employed for Trikon Technologies in Newport, South Wales. Trikon produces equipment for the semi-conductor industry. I have worked in the area of process integration since 2001. 2004 my English husband and I moved to Dresden (D) and both continue to work in the field of semi-conductors. My company is Dupont Photomask.

My university supervisor told me how the partner universities had got in contact in 1994: A Fresenius student gave him a slip of paper with the name of a British citizen who had worked for an international company in Germany and was now going to Sheffield Hallam (SHU) as a professor. He contacted him immediately. Soon a British student applied for a placement in Germany. His supervisor came to meet him - part of the tutoring programme of SHU. That was the beginning of a very fruitful and lasting co-operation[194]. When Prof. Dieter Münz was looking for a post-grad student, I was informed and applied. This is how networks open up new ways for students.

„....I am starting a spin off company....“ - A Research Career with a practical outcome

My name is Kai Hoettges. After my O-level examination in Germany, I initially qualified as CTA (Vocational Training, Chemisch Technischer Assistent), at the Fresenius Academy. During that time, I took part in additional courses of General Education. This and my good results in the CTA examination opened me a way into the third semester of the Chemical Engineering degree studies (Dip. Ing. Chem (Fachhochschule)) at Europa Fachhochschule Fresenius. This is an example of transferability of secondary VET school credits to tertiary level.

During my studies I spent my placement semester in Sheffield, UK (with a LEONARDO grant) and did research for my diploma thesis at Royal Holloway University of London, UK. In both cases I developed large volume injection methods for gas chromatography under the supervision of Prof. Michael Cooke. Contacts gained during this time allowed me to secure a place for my PhD studies at the University of Surrey, where I studied lab-on-a-chip devices. The project let to a patent application for a miniaturised liquid-liquid separator. After my PhD I worked as a postdoctoral researcher on several projects (including a four month Marie Currie fellowship in Bologna), investigating the applications of dielectrophoresis to enhance the detection of bacteria, to separate carbon nanotubes and to characterise cells. This work led to further three patent applications. Currently I am starting a spin off company to commercialise the results of my research in high throughput cell characterisation. I live in the UK with my Italian wife.

4.2.3. „With the European countries growing closer together, I believe it is essential to be able to speak other European languages“ - PhD studies in a European context

With trans-national (Austria-Germany-The Netherlands) and trans-level (Kolleg-Fachhochschule-University) mobility to a PhD

My name is Heidelinde Dietrich. In 1999, I finished my Post-secondary, non-tertiary vocational training at the Kolleg für Chemie, HBLVA Rosensteingasse Vienna, Austria. In the framework of a partnership of this school with Europa Fachhochschule Fresenius Idstein, Germany, I had a chance to qualify (entrance examination) for the third year of Fachhochschule studies.

The first half of this third year (regular 5th semester of studies) is a compulsory placement semester (5 months minimum) in industry. With the help of a Leonardo da Vinci grant, I could spend this semester at TNO Voeding in Zeist, The Netherland. I liked the work and the country and came back for a final year project (Diplomarbeit). In both cases, I worked in the Department for Chemical and Biochemical Sensors. I developed a coating for biosensors based on S-layer proteins. Such sensors can measure noxious mycotoxins in food. I could work in a team and learn to apply many biochemical techniques. I had a chance to work with BIACORER Upgrade, a device for determining interactions between proteins on one hand and proteins or other molecules on the other hand. My time with TNO proved to be very productive and I learnt a lot.

The experiences I had made were one reason why I was offered a job as a Research Analyst at Delft Technical University. I develop enzyme tests using fluorescence techniques in the sub- nanoliter-range. I also measure enzyme kinetics with special a microscopic device.

I am currently working for my PhD thesis and just now preparing two presentations for an international congress in California.

I want to add that the two placement periods in the Netherlands stimulated my interest in a foreign country - and gave me a chance to learn another foreign language, Dutch.

„..... focus on the field of forensic investigations“

My name is Sylvia Steffen. I studied chemistry during eight semesters at the University of Applied Sciences „Europa Fachhochschule Fresenius“ (EFF) from 1997 until 2001. In the 5th semester students are expected to complete a so-called practical semester in a company or in industry in order to implement their knowledge in the field of applied practical work. Most students benefit from the wide international network the EFF has built up - it is intended to respond to almost any wishes the student has concerning the field and place of work. The students usually spend either this placement semester or the time during their diploma work abroad. There are enough possibilities for financial support such as the

194 The excellent co-operation and lasting friendship of Dr. William (Bill) Geary - author of chapter 2.3., Prof. Jack Yarwood, Prof. Michael Cooke (co-editor of this book), Prof. Dieter Münz and many others is gratefully acknowledged.

LEONARDO programme which offers money for travelling and living costs.

During my studies I had the great chance to spend my placement semester in Sheffield/UK at the Materials Research Institut (MRI) within the Sheffield Hallam University (SHU). For six months I worked in the research group of Prof. Jack Yarwood doing Raman microscopic investigations on gunshot residue particles. This work was a co-operation between the Bundeskriminalamt (BKA) in Wiesbaden/Germany, the MRI in Sheffield and the EFF in Idstein/Germany. It was then and after two more work placements at the BKA directly when I decided to focus on the field of forensic investigations.

In my diploma thesis, done at Bundeskriminalamt, I also concentrated on the analysis of gunshot residues.

After my studies I decided to do a PhD at the Technical University of Freiberg where they offer the possibility of so-called „co-operative doctoral studies" to students from Universities of Applied Sciences. This means that those students can immediately start with their PhD work while attending some additional courses (including written examinations) which the faculty council has to decide about. So did I, additionally attending the courses Structure Determination II (Analytical Chemistry), Quantum Mechanics (Physical Chemistry) and Chemometrics.

Furthermore these postgraduate studies for a PhD are still accompanied by one professor from their Fachhochschule, in my case Prof. Dr. Leo Gros.

At the moment I am still working to become a PhD in Analytical Chemistry within the research group of Prof. Dr. Matthias Otto, Institute of Analytical Chemistry at the TU Bergakademie Freiberg. My task is the development of chemometric methods for the evaluation of particle analyses to differentiate between gunshot residues from different ammunition. This project is also funded by the European Union (project no.: JAI/2003/AGIS/033) and will last until the end of September 2005.

I personally think that the studies at the EFF with their focus on international co-operations are very helpful to young academics who need to attend international conferences and want to socialize in industry. This is why I am glad to have recently been able to help a young secondary vocational school student to find a placement in Kraków, PL, at an institute I co-operate with.

„...possibility to study abroad for up to three semesters, which I took full advantage of..."

My name is Christiane Riedinger. The first time I heard about the Fresenius European University of Applied Sciences in Idstein was during a field trip with my chemistry A-level course back in 1998. I had always planned to study Chemistry, but the opportunity of taking language classes in addition to the main subject drew my attention to the University in Idstein. With the European countries growing closer together, I believe it is essential to be able to speak other European languages, especially on a professional level. The University Fresenius takes that into account by including compulsory English classes for Chemists into the degree they offer.

Another point that attracted me to Idstein was the possibility of obtaining a minor degree in Economics in the last four semesters of studies. I believe it is very important to have generally applicable skills, in addition to the excellent professional skills offered by Fresenius.

The final point that led to my decision was the possibility to study abroad for up to three semesters, which I took full advantage of. I spent my practical semester in France, at the Ecole Européenne de Chimie, Matériaux et Polymères de Strasbourg (F), working on new analytical devices using immobilised bacteria to detect heavy metals in inshore waters. The following semester I spent at the Fresenius partner University of Long Beach, CA as an exchange student. During this time, I developed a strong interest in Structural Biology. This led me to apply to Dr. Kristina Downing's laboratory at the University of Oxford for my diploma thesis, during which I worked on the structure of proteins involved in human diseases.

In 2004, I was awarded a four-year studentship in Structural Biology by the Wellcome Trust to carry out my DPhil thesis at the University of Oxford. I am now working with Prof. Jane Endicott in the Laboratory of Molecular Biophysics. I am studying the structure and biochemical properties of novel tumour suppressors, as well as the design and characterisation of small molecules to inhibit the interaction of tumour suppressors and their antagonists during carcinogenesis.

The European orientation of the degree in Chemistry at the Fresenius University of Applied Sciences has certainly encouraged me to pursue my career abroad and I am very happy with the outcome of my undergraduate degree.

„...practical work experience abroad of 3 to 6 months duration should be available for all students ..."

My name is Nuria Tricas. I am currently doing my PhD at Institut Químic de Sarrià, Barcelona, including two research periods in Holland and Germany.

I did my placement with a LEONARDO grant. My host company was Procter & Gamble, Egham, co-operating with Royal Holloway University, Egham, UK. A partner of my home university in many European projects, Prof. Michael Cooke, acted as my supervisor in Egham. The project was about the identification and quantification of amines in the mouth of persons who had been treated with a mouthwash solution.

My broad university training which had also developed my ability to work independently helped me to lead a project in an hitherto unknown field. What I have missed during my studies was the chance to improve my knowledge of the English language: if you enter with a First Certificate, there is no advanced course for you. More different levels of language proficiency should be offered during a university carreer, and if that is not possible, other languages should be offered like French or German.

My most important experience during the placement time was that I got to know a different culture during and after work time. Language and work habits are equally important. Although work experience in a company is good to get in contact with work life, going abroad is even more intense an experience, since you are in a completely unknown place where you have to adapt quickly.

I cannot say for sure that this placement enhanced my

employability, but I am sure that it opens up doors for other foreign experiences. At the end of my studies I spent 3 months of my final year project in the U.S., and I am currently doing a part of my doctoral thesis in Germany. I must say that those first three months in the UK gave me sufficient confidence that I was able to meet similar challenges.

Since most of the daily project work in such a placement period is done by one person alone in a lab, language seems less of a problem. However, planning, organisation and presentation of the results is impossible without speaking the language. For problem solving during the project, you must make yourself understood. Although it is desirable that you speak the language of the country you go to, you should have a sound understanding of English - and interest in the language of the host country.

If I was to give possible host companies an advice, I would suggest that they should give the student freedom to decide upon and plan their own work, even if this means the project must be more modest. Team work is important as well as everyone's capacity to make his or her own decisions, come up with solutions and face their own problems. If a placement limited itself to mere routine work, the experience would not meet the demands of student and university. From the economic point of view, the company should just take care of some the expenses like accomodation or travel expenses. I think placement is part of the studies where a true salary is not required.

If I was asked which innovation I propose for my country's educational system, I would demand that a practical work experience abroad of 3 to 6 months duration should be available for all students. Even if, as I said, this does not guarantee employment, it makes the work habits of the person mature.

„...the most important advantage was to improve my English..."

My name is Sergi Colominas Fuster. I did my placement in the Materials Research Institute (MRI) situated in the buildings of Sheffield Hallam University. They do R&D contract work in the application of novel technologies in the sector of chemistry and for companies in many other fields.

I have had a very good university training in my home university IQS, Barcelona: I am familiar with the use of instrumentation as well as with problem solving. What I was missing was a good knowledge of foreign languages. In my opinion it would be very important to motivate the students to learn more than one foreign language, that means English plus a second language.

As far as the placement itself is concerned, the most important advantage I took out of it was to improve my English. From the professional point of view, I had a chance to get to know new techniques and instrumentation, new points of view concerning problems to solve, and to integrate myself in an existing team.

I am now doing my doctorate studies at IQS. I am convinced that in the labour market such a placement receives special attention.

It was essential for my work to speak and understand English, since most of the colleagues only knew their own mother tongue. Without a sound understanding of this language, I would have been unable to do my daily work.

From a host company, I would expect that my tasks would help me to broaden my chemical and methodological knowledge. I would like to (and I could) learn less current analytical techniques which are not used in routine laboratories.

If I was asked which innovation I propose for my country's educational system, I would ask for a better instruction in foreign languages, not only offering English, but also other languages like French and German.

If I was to give possible host companies an advice, I would suggest that they offer more information on tasks they offer the students; especially those which can broaden the students' knowledge or which include the use of equipment that is not available during university studies. They should also give better information on accomodation available.

4.2.4. „Key qualifications for your future job life....." - employment in the home country, but with European experience in mind

„....I would prefer improved possibilities for such experience abroad..."

My name is Imma Folch. After having finished my PhD (which was a Doctorado Europeo, see chapter 3.5.4), I now work with PROTEIN in Girona (Spain) as a Head of the Laboratory.

I did my practical placement in a Max Planck Institut für Polymerforschung in Mainz, Germany. My studies at the Institut Químic de Sarrià had given me good capacities to develop a project, to search and evaluate all available information, to draw conclusions and to develop new projects. I had learnt very little about synthesis and analysis of polymers (the new curriculum of IQS now offers such lectures).

My work in this research institute was similar to university research and very much different from work in a private company as far as type of work, time pressure and results are concerned. Along with the scientific work, I had ample opportunity to experience life in a foreign country - much different from a tourist trip: On the one hand, you perceive your host country - the character of people, social habits (shopping hours, work time, meal times), their concepts of life in all its aspects (transport, city life, pastimes, religion), the country's history, and the type of population (ethnic groups). On the other hand, you tell people about your home country: you compare it with things that seem surprising to you, and you answer questions concerning things which poeple think of us.

Moreover, using a foreign language daily helps to improve it. Since we communicated in English, both sides had a benefit. Daily activities like buying things, travelling and negotiating made me familiar with a minimum of conversation in the country's language; in three months time, having arrived with absolutely no knowledge of German, I succeeded in making myself understood in these simple daily matters.

I do not think that this research placement abroad improved my job chances directly, however, it was very positive for my overall capacity to help myself in a foreign environment and in adverse situations.

As far as language requirements for such a time abroad is concerned, there should be a basic knowledge that gives you a chance to avoid misunderstandings and helps you not to be isolated. I did not have any problem, because the dominant language in this reserch institute was English. During the first days, I felt terribly isolated outside this scientific environment. The different origin of the German language compared to the languages I knew did not even permit to deduce what signs, ads, newspaper headlines meant. However, you work most of the time and then you are accompanied by someone. Soon you learn to help yourself with the basics.

If a company offers placements, I expect a clear idea of what they expect from me. They should give me the material and the training I need. I would want regular contacts with my sending university and chances to learn or improve the host country's language.

If I was asked which innovation I propose for my country's educational system, I would prefer improved possibilities for such experience abroad, with different time schedules, so that all students have a chance to find an attractive and feasible placement. The contact between different cultures should become more frequent.

„...I would ask for compulsory and paid work experience periods as an integral part of academic studies..."

My name is Carlos David Graboleda. I did my placement at Surtec Deutschland GmbH in Zwingenberg, Germany. It is a chemical engineering company working in surface treatment. They have management, marketing and sales, production, research and development, environment and analytical lab departments.

Experience, professional work and quality of my instructors were excellent. I got to know different working and organisation methods, apart from the personal and cultural enrichment that living abroad gives you. I think that this foreign work experience improves my job chances, because of the experience I gained, the work relationships I got and the fact that such a placement qualitatively improves your CV.

From a personal and from a professional point of view, language is an important issue. You can make yourself understood more easily and avoid misunderstandings. You feel more comfortable if you can communicate properly, and this is necessary for a good performance in your work.

From a host company I expect a positive attitude towards the student in placement. This means that you treat the student as just another colleague in the company and thus give him the best chances to develop professionally.

If I was asked which innovation I propose for my country's educational system, I would ask for compulsory and paid work experience periods as an integral part of academic studies. I think this is useful both for company and student. This holds especially true for the sector of chemistry.

I am currently preparing to work for my host company in South America.

„...these experiences later were one key factor for a multinational company to offer me a job... „

My name is Eduard Conejos. I obtained a Leonardo da Vinci grant of Europa Fachhochschule Fresenius for incoming students for a 5 month placement with Institut Fresenius. My project was to set up analytical methods for the determination of traces of impurities in secondary and primary cycle water. I was able to work independently, but needed help of suppliers of analytical equipment. So I had, for example, to visit METROHM company in Switzerland.

The experience was without any doubt fruitful for me, including the contacts with professors of the neighbouring Fresenius university as well as with different companies.

I want to stress that all the work was done using a foreign European language, German.

All these experiences later were one key factor for a multinational company to offer me a job. In the interviews with BAYER, my five month placement in Germany was regarded as highly positive. Later, the usual personal and telephonic contact with clients, suppliers and BAYER Germany reminded me of this foreign placement period.

„....I could develop my own personality further..."

My name is Gerlinde Brodnik. After having finished my examination at HBLVA Rosensteingasse Wien, I continued my studies at EFF Idstein, Germany. Transfer of the credits I obtained in the Kolleg (post-secondary, but non-tertiary vocational education in Austria (see chapter 2.1.4.) and an entry examination allowed me to enter the third year of Fachhochschule studies of EFF in Idstein. This year begins with an obligatory placement. For the degree with „European Studies" in Chemistry, the placement must be abroad. I joined Olympus Ireland for half a year. These are some of my impressions:

Ireland - a fascinating country for me! It was always the big dream for me to get to know the Green Island. And I could make this dream real during my studies at EFF Fresenius. Many questions first came to my mind: Will I find friends? How will I cope with the new culture? How will I cope with the „foreign" language?

Three houses rise on the horizon, one of them is a pub. Men and women sit at their tables and clap to the rhythm of Irish folk music. The people smile, invite us to join them and in the next moment a pint of Guinness stands in front of us. Who looks for friends, will find them. Hospitality, friendliness and cosiness are characteristics associated with the Irish nation. And these characteristics became very familiar to me. The Irish mentality still influences my life. I simply look more calmly at problems and have become more open to people.....

The road is narrow and bumpy. I stop. This is the spot where the High Cross should be? The road sign points towards a meadow with cows. Between the cows stands a cross - culture far away from mass tourism. Where can we still find a building which was constructed of stone, without mortar and

which survived for 1300 years? Old walls with a history, with ancient tales to tell and background information - I enjoy discovering culture in a new way. Back in Vienna I began again to read about the history of my own home town and I like to show visitors around Vienna and point out the unusual details to them.

„How is it going?“ These are the words which start every conversation in Ireland. When speaking about everyday problems more and more different words of the language once so greatly feared become part of the conversation. Learning English? Yes, but playfully! Colleagues at work and new friends support me patiently and pretend not to hear some of the mistakes I still make. They speak correctly so that I can learn the language properly. In my job English is a very important part, without knowing this language my working conditions would be much harder and I would have less fun when speaking to foreigners. And one more detail I learned in Ireland: I now speak correct German with all people who do not know my language. Only in this way will they learn the language.

For me this placement in a foreign country was a great step towards independence. To survive in a „foreign“ language and make friends was a new experience which I would not like to miss. Nowadays experience abroad has become a requirement for finding a job, but at the same time I could broaden my horizon so that I could develop my own personality further.

Use the opportunity for a work placement abroad and you will collect thousands of new experiences.

I am currently working as a specialist for clinical analysis equipment with Bayer Austria.

„...key qualifications for your future life in a job....“

My name is Jörg Heisiep. I studied Chemical Engineering at EFF Fresenius in Idstein. I did my practical work placement between 1st Sept 2000 and 31st January 2001 in the UK.

Since 1988 I studied at EFF Fresenius to become chemical technical assistant. Because of my good results I was given a chance - after an entry examination - to enter year two of the Chemical Engineering course at the same institution. A work placement abroad is one of the additional activities for acquiring the additional distinction „European Studies“ on the diploma. Because English is so important for our area of studies, I chose an English speaking country. As I am especially interested in analytical chemistry, I decided to go to Bioanalytical Services Ltd, a small enterprise which offers services in bio-analytical chemistry (see chapter 4.1.4.).

Pesticides are biocides the identification of which has a great importance in bio-analytical chemistry. My task was it to widen the possibilities of the spectra in an HPLC-MS/MS Pesticide data base and to check its usability in the laboratory routine. To find a high correspondence of the spectra in the data base, a great amount of parameters must be considered. The tiniest changes can affect the quality of the spectra negatively and consequently this was one of the most important aspects of my research. In the beginning hundreds of relevant pesticides were analysed and ordered accordingly with the help of the software of the data base.

For checking these results, I used tap and river water with standards of pesticides. For the sample preparation I used common methods. The samples were analysed by SPE-cartridges and were separated by column chromatography.

The highly complex task required an initiating phase with a lot of initiative on my part and special support from the person looking after myself. We discussed the various questions of the project in meaningful periods. A second person introduced me to the routine works of the company. The company also helped me with finding accommodation and with job relevant questions.

I had acquired the scientific background during my studies and it turned out that I already had the necessary practical and theoretical requirements to understand my task in the company. The person responsible for me at EFF Fresenius supported me additionally with extra knowledge. He also came to see me in Egham to inform himself about my scientific progress.

Naturally, it is difficult to understand foreign structures and habits, but this is the ingredient which makes a stay abroad interesting, makes you sensitive and broadens your horizon. A work placement abroad should be obligatory. Besides the scientific work, a talent to get yourself organized, to succeed in a team and to cooperate with your team mates plus tolerance is of importance. These are the key qualifications for your future life in a job.

I did my thesis work at Merck, Darmstadt (D). One reason why they gave me the task was that my time in the UK had prepared me for the special and complex analytical technique I had to use. This thesis work was again one key to employment in the same company. I work in the central service lab for analyses and mainly do GC-MS, HPLC-MS and HPLC-NMR, including high throughput analysis. Together with my studies in the university, my work placement was an excellent start for what I do now.

4.3. The academic view: Organisation, tutoring, credits - and the benefits for the institutions

In this chapter, Ray Wallace, renown expert for placements and Head of the ECTN working group on this subject, humorously describes findings of statistical relationships between placements and academic success. His university is very conscious of placement programmes. Three FACE partner universities (EFF - D, IQS - E, BUTE - HU) describe their experiences with placements, especially foreign placements. A good practice guide for placement management and assessment is found in the web[195].

195 see Lit. 179

4.3.1. A sandwich year can seriously damage your chances of obtaining a poor degree![196]

(Raymond G Wallace)

Much has been written about the benefits of the sandwich degree experience for equipping students with those skills which are highly sought after by employers[197]. Much less has been said about whether the sandwich period enables students to fare better than they otherwise would have done in their studies, on return to the university, had they not had such experience. Although this question can never be answered absolutely, I believe that there is an underlying assumption, often based on anecdotal evidence, that these students may well achieve better academic results. Firmer evidence is harder to gather, and indeed data on this subject appear to be lacking in the literature. Although it has to be acknowledged that 'a good performance' can be influenced by many factors, the rigours and discipline of a work placement can do much to focus the mind, sharpen the organisational skills and improve the work ethos of the individual for the return to the university. Where there are cohorts of students exposed to one academic pathway rather than another, it should be possible to discern meaningful differences in academic performance, given sufficient numbers.

Comments and discussions over the years led me recently to examine data from my own Department regarding the degree outcomes of different cohorts of students during the academic years 1997/1998 to 2000/2001. In particular I compared data for students who had followed a BSc chemistry sandwich degree pathway with students who had studied on our full-time course, with and without industrial training, and with national results for all subjects and all modes of study.

If these departmental chemistry data are put together for the four years and compared with national data[198] for all subjects and all modes of study, the following observations can be made:

- NTU chemistry students following a chemistry sandwich degree have a significantly greater chance of obtaining a first class honours degree than their full-time counterparts and indeed than students of any subject discipline or mode nationally
- The same local observation is true for an upper second class honours classification, although the 'advantage' is marginal compared to all subjects and modes nationally
- Our full-time students are more likely to obtain a lower second or third class classification and this is higher than the national average

This trend is apparent for all four years looked at, and although sample sizes are small these data suggest the value of looking at national data to see whether similar trends are discernable in other institutions. Such data is, of course, in the public domain but not readily accessible. Statistics on degree outcomes are collected by HESA (Higher Education Statistical Agency) and certain data could, until recently, be made available through the Society for Research into Higher Education[199] for student academic study.

The wider perspective

Late in 2001, data concerning degree outcomes for (a) chemistry degree courses (sandwich, full-time & part-time modes (b) all [combined data] courses (sandwich, full-time & part-time modes) for the academic years 1994/5 to 1997/8 were obtained from SRHE for a final year student project. These were the most recent years for which data sets were available.

Initial evaluation of the data for all chemistry courses as a whole nationwide suggested that there were differences in the performance in each degree category for students on sandwich, full- and part-time courses, although these differences appeared to be small. Such simple analysis can, however, hide significant differences by including inappropriate data. For instance taking total numbers of chemistry students, sweeps in departments only offering a full-time study mode (the majority) and this leads to unbalanced cohort size comparisons. (In the years studied 85% of chemistry students followed the full-time mode, compared to 15% on sandwich courses). Additionally and importantly, it does not allow comparison between students following essentially the same academic course, differing only by an intervening year of industrial experience, in the same institution. The latter situation should provide a much more revealing insight as to whether the sandwich year may be having an effect on subsequent academic performance.

From the data provided, twelve universities fulfilled the criteria of running both sandwich and full-time courses and having statistics for four years. They were Aston, Bath, Bradford, Cardiff, Kingston, Liverpool John Moores, Loughborough, Nottingham Trent, Paisley, Salford, Sunderland and Surrey. When the number of firsts, upper seconds, lower seconds, thirds and pass degrees were tabulated for each type of degree and each institution, what became apparent immediately was that in all cases except one (Bradford), students who followed a sandwich degree pathway were more likely to gain a first or upper second class honours degree, than those who studied by the full-time route. This ranged from, Cardiff 76% (SW), 49% (FT) to Paisley 31% (SW), 12% (FT) of students respectively. The gap between the two modes of study was never less than 19%, in 'percentage points advantage', in numbers of students gaining a 'good' honours degree over those awarded the lower classifications. In once case (Sunderland) it was as much as 52%!

If we combine the data from all eleven institutions, we have roughly equal numbers of students studying by sandwich (1015) and full-time (1049) modes. Examination of the data reveals that a sandwich student is, on average, three times

196 Paper presented at the ASET European Conference: 3-5 September 2002: Cambridge, UK - Integrating Work & Learning in Europe. The author is indebted to Ms Elisabeth Glansfield for the initial evaluation of data sets referred to in the later part of this paper and to the Society for Research into Higher Education for the supply of statistical data.

197 Work Experience: Expanding opportunities for undergraduates, Lee Harvey, Vicki Geall and Sue Moon, Centre for Research into Quality, 1998, ISBN 1-85920 113 X, and references cited therein.

198 http://www.hesa.ac.uk

199 http://www.srhe.ac.uk

more likely to gain a first class honours degree as compared to his/her full-time counterpart (SW 17% firsts, FT 6%) in institutions where both pathways are on offer and that approximately twice as many sandwich students are likely to gain a 'good honours' degree as full-time students (SW 56%, FT 30%).

Conclusions

In this chapter I have deliberately avoided detailed statistical evaluation of data, since the purpose of my investigation was simply to discover if there was a readily discernable difference in final degree performance of sandwich, compared to full-time students, following the same academic course. I believe that such a difference is clearly demonstrated. However a note of caution has to be sounded before concluding that a sandwich degree provides more, better academically qualified, graduates than a traditional degree. It will be readily apparent that a number of other factors may well influence student performance. Certain questions need to be asked. Probably the most obvious - are the more able students being preselected by the employer interview process? This must be true to a certain degree but in my experience, placements are secured by a wide ability range of students. Do the entry point scores of the two groups of students differ markedly? Are the students seeking industrial placements more motivated anyway? Are they different in temperament, approach to life and study etc? Is a year in industry simply alleviating financial problems, allowing the student to concentrate on studies in the final year, without the need for paid employment at that time? Doubtless there are other questions we could pose. These alternative and additional factors need to be the subject of further study. One thing is clear however - there is strong evidence to support the fact that sandwich students do indeed, on average, do better when it comes to final degree results, whatever the reason. Other studies have shown that they find employment more easily[200]. If only for these two reasons, and there are many more besides, it is imperative that the sandwich route to a degree should continue to be encouraged and supported.

4.3.2. Eight years of experience in European practically oriented Studies: Europa Fachhochschule Fresenius

In 1996, Europa Fachhochschule Fresenius introduced its international/european study programme in Chemistry. We started from the finding that there are „European Business Schools", asking ourselves whether chemistry courses have to take place „in national test tubes" well isolated from other countries. We decided that this was not the case.

For the first time in Germany we offered Fachhochschule studies in chemistry, examination regulations including that a student may obtain his/her Diplom-Ingenieur-degree with the addition „European Studies in....." (here follows the option they took).

Prerequisites are specified:

- at least one semester of practical work abroad
- English standard test (e.g. TOEFL, Cambridge certificate)
- basic knowledge of a second language
- participation in a seminar covering aspects of European R&D, given by students who are back from their practical semester abroad

This is an option about one third of all students take, which means, they fulfill all four criteria.

In the basic part of the study (1st - 4th semester) the students are able to gain a founded knowledge of chemistry and natural sciences. Before students enter the main part of their study they have to spend one semester in research, development, marketing related to chemistry. This is the preferred option for going abroad.

In the advanced part of the course (6th to 7th semester) the students may select two out of six options of specialisation which are offered in addition to the core subjects

The study is completed by a final thesis in the 8th semester which normally has to be done in a company.

Industry has received this concept very well - which is not astonishing if one knows that the University's advisory board took part in the development of the course.

We found that the „package of features" we developed fostered Alternating European Studies:

- An institutional policy clearly expressed in the institution's name Europa Fachhochschule Fresenius, being a core mission of the university
- A clear framework of regulations, recognised by the relevant government bodies of the Federal State of Hessen (who took part in the development from the first day on!)
- Guaranteed ways of recognition of periods spent abroad
- A network of 50 companies and universities helping to find the proper placement company and country for each individual (University Network with Industry in Chemistry, UNIC)
- Sponsoring by EU LEONARDO DA VINCI grants doing away with most of the financial obstacles
- Tutoring of work experience abroad by staff of EFF visiting the students abroad at least once during the 5 months - travel expenses being in part own funds in placement projects. In rarer cases, colleagues of partner universities in the foreign country do the tutoring.
- Motivation by teaching staff and by fellow students coming back home and being enthusiastic about their experience

All this motivates students to go abroad: From 1993 to 2004, the average percentage of students doing so increased from 15 to 70-80% of a year's graduates. These figures are unique in Germany, the average (including study semesters abroad) being some 14%. From 1996 to 2204, 239 students obtained LEONARDO grants (57% of them being women).

Students are also encouraged o learn languages (offered from semester 1 onwards, Technical English being compulsory, Business English, French, Spanish and Dutch being options) the value of which for their professional career is obvious:

200 http://www.prospects.ac.uk

Over the past years, employability of the EFF students was very good, especially for those having taken advantage of language and foreign experience offers.

Between 1996 and 2004, students continued their career heading for an MSc and/or PhD in the UK, Ireland or the U.S. 12% got a first employment abroad.

The experiences of some students having been exposed to foreign work placement are presented as case studies in chapter 4.2.

4.3.3. Practical work placement in companies: Good practice in a Spanish private University

(Mercedes Manresa)

The Context of Industry Needs and University Training

For companies, the widening beyond the borders between countries has obliged the Spanish companies to access world markets, increase competitivity, adopt new technologies at an ever increasing rate.

All this requires considerable change in the organisation and development of the companies. They have to re-position actively and give a rapid answer to the new situations that continuously arise and to be innovative moving forward with the challenges they face.

In such a situation, education plays a key role and has to answer the needs which arise in this context. One of its most important and immediate aims is employability. Therefore, students must obtain the necessary qualification to be able to work on a certain level of responsibility and independence.

To reach this aim, a framework and regulations for work experience periods during studies have been established (see chapter 2.5.2.).

Practical Laboratory Work at IQS

One of the characteristics of IQS, founded in 1916, is that almost 50% of the course hours are practical work, so that students are able to carry out many of the procedures that will later be part of their work in the company.

On the other hand, IQS has always kept a close relationship with companies co-operating in research projects, solving practical problems, offering technical service etc. Thus, students work on real life projects in the IQS.

Because of all this, companies offer work placements for students, especially during the summer period.

Aims of Industrial Placements

For the students, work experience in companies means

- First contact with real work life
- Integration into a company
- Self-training and -apprenticeship

The success of the work experience will depend on the work habits students have to develop and to strengthen during their placement:

- Responsibility for their work
- Quality of the work
- Team spirit
- Methodical and orderly work
- Reliability and punctuality
- Ability to communicate
- Interest to learn
- Initiative and readiness to take decisions

Organisation of Industrial Placements at IQS

For students heading for their first degree, the summer period is when they are free to go for a placement. This is why IQS addresses companies reminding them that students will be available during their holiday period. On the other hand, students of IQS interested in a placement are asked to sign in. During the rest of the course time, companies address IQS directly, and their offer is published on a whiteboard. Students can select three companies that seem most attractive to them, and IQS sends the students' CV's to the companies. Companies ask students to come in for an interview, select the candidate and inform IQS. IQS then sends the work experience contract to be signed by company, student and university, accompanied by an insurance certificate. When the date of the work placement has come, the student integrates himself into the company and follows their requirements. A tutor in the IQS and one in the company are assigned to each student; they orient the student and follow his or her progress. At the end of the placement time, the company writes a report in which the habits, competences and progress of the student are described.

For students with a first degree who want to specialise or deepen their knowledge in a certain field, post-graduate courses are offered (Master courses with at least 400 course hours).

One of the differences between IQS and other universities is that in some its Master programmes[201] work placements are possible. Among them there are two with obligatory placement: The Master in Food Chemistry and Engineering[202] and the Master in Prevention and Risk Management[203].

In the first case, students who are not already working in industry have to spend a minimum of three months in a company of the food sector which is procured by the IQS. The work done during this placement may serve as a basis for the final year project which is also a prerequisite for the degree.

The legal national government framework for the Prevention and Risk Management Program requires a practical project of 150 hours complementary to the theoretical part and the presentation of a report. For IQS students, this project must be done in a company, which can be the one in which the alumnus is working or the one procured by IQS.

201 see http://www.iqs.es/frames/cast/general.htm
202 see http://www.iqs.masters/alimentaria/alimentaria.htm
203 see http://www.iqs.masters/prevencio/prevencio.htm

Benefits of Placements

For the students, placements offer

- The possibility to have access to a job contract. Placements are becoming the best assessment procedure. Around 40% of the students having done placements are employed by the same company.
- An asset and enrichment of their C.V. When they apply for jobs, companies have a very positive opinion of placements
- Education and competences in fields that the course curriculum itself does not reflect: decision making, initiative, communication, correction of errors, acceptance of hierarchical decision structures
- The possibility to write up the final year project (thesis) on the basis of the work done during the placement

For the IQS, placements help to

- Maintain a close and continuous relationship with the companies. Many of the ties to companies are fostered by alumni of the IQS, most of them members of the Asociación de Químicos e Ingenieros of the IQS, which creates a corporate environment
- Keep track of the companies' needs
- Maintain a personal relationship with the student, an aspect which is only found in private universities with their special character

A possible negative impact of the practical placements can be that companies hire students instead of normal fully paid labour force. This may be the case, especially during summer holidays, although company representatives argue that the work students do would otherwise not be done, and that the students' results contribute to the companies' competitiveness.

Related Forms of Placements

- Foreign placements: The need to know languages and other cultures prompt many students to seek placements abroad, most of them in English speaking countries, followed by those with German mother tongue. The difficulty here is to find companies who accept to take them in and to pay the cost for the students. Most of the students therefore apply for LEONARDO grants. On the other hand, it is no less difficult to find Spanish companies who take in foreign students for a placement. This is not a common practice in Spain. However, the network UNIC (University Network with Industry in Chemistry), founded by the IQS partner university EFF (D) has opened ways to place some 34 Spanish students in Germany and other European countries and about 24 EFF and other network members' students in Spain (1996-2004).
- Placement programs for unemployed persons: The Catalan Government has mounted a project for unemployed professionals[204]. These people have access to training courses, many of which contain obligatory placement periods in companies to obtain the diploma or title they lead to.

Foreign placements necessary for the European Doctorate are mostly research placements in appropriate institutes or university departments (see chapter 3.5.4.).

4.3.4. International study programmes and placements: Hungarian good practice at BUTE

(Peter Moson)[205]

Introduction

This chapter presents the development in the last 15 years and the future plans of Budapest University of Technology and Economics (BUTE, founded in 1782, www.bme.hu), the most important Hungarian technical higher educational institution. The basic objective is to inform our existing and potential partners, to share the experience, to initiate further co-operation.

The example of BUTE is more or less typical for the whole region of Central- and Eastern European countries. Detailed information about the Hungarian educational system in English can be found on the homepage of the Ministry of Education (www.om.hu). A comparative presentation of several European countries with useful links is developed by the FACE (Forum for Advancing Chemical Education) Leonardo project.

In the mid 80-ties BUTE used to be a „classical" technical university with 6 faculties (architecture, chemical, civil, electrical, mechanical, transportation engineering), 5 year (bac+5) study programs in Hungarian.

Nowadays the picture of Budapest University of Technology and Economics is much more diversified. BUTE defines itself as a multilingual higher educational and research institution. The basic changes (caused by adaptation of EU, USA practice, international, regional trends, development of ICT etc.) are:

- two new faculties (natural sciences, economic and social sciences) have been created.
- New training programs related to engineering (e.g. biomedical, design, engineer-manager, environmental, informatics, mechatronics), related to other fields (economics, mathematics, physics etc.) have been introduced.
- The number of students was doubled by 2000, at this moment it is ca. 15.000. The number of staff is slightly decreased. There is about 1.000 teaching and research personal.
- There are more „outputs" of the system, e.g.: bac+2 years (120 credit points - accredited higher level professional education), bac+3 (180 credit points, college), bac+5 (300 credit points, diploma engineer considered equivalent to M.Sc.), bac+8 (480 credit points, Ph. D.).
- BUTE has academic training in 5 languages: Hungarian, English, French, German, Russian. Their detailed description (together with the programs offered) can be found on the homepage (www.tanok.bme.hu).

204 http://www10.gencat.net/gencat/AppJava/cat/estudiar/altres/index.jsp

205 Peter MOSON, Leonardo institutional coordinator; Budapest University of Technology and Economics (BUTE). Paper presented at the 15th Annual Conference of the European Association for International Education (EAIE), Vienna, 12. 09. 2003.

- The students' (and professors') foreign mobility (both academic and practical placements) has been increased importantly. In the early 90-es it was supported by special regional programs (e.g. PHARE, TEMPUS). Later Hungary (and BUTE) joined the international programs (mainly European, e.g. Socrates/Erasmus, Leonardo da Vinci).
- BUTE considers the strengthening of economy - university relations as an important, permanent task. It is carried out by different, partly organised, methods (e.g. enterprise representatives at the university councils, conventions).

Some of the new elements listed above were discussed at earlier ICEE conferences[206] as well. This chapter will concentrate on the basic structure, activities related to the incoming and outgoing international exchange. The slogan related to this field is „Study abroad is no longer a luxury, but a necessity". The international education concerns mainly 4 languages:

- ENGLISH (started in 1984). BUTE has a 4-year International Secondary Grammar School, a 1-year Pre-Engineering School, B. Sc. (4-year, 240 credit points), M. Sc. (2 year, 120 credits), Ph. D. (3 year, 180 credits) programs. The full programs are paid (the tuition fee is from 1500 EURO to 5000 EURO/semester depending on the training), but it is free for part time studies of exchange students (mainly from EU and USA). Most of the participants are foreign citizens, the total number of learners enrolled is ca. 750.
- FRENCH, GERMAN (founded in 1991,1992). These are 4 semester training courses (bac+2, 120 credit points). The ca. 300 (100+200) participants are mainly Hungarian citizens. There is no tuition fee.
- RUSSIAN (from 1989). M. Sc., Ph. D. level training in robotics for about 30 students from Russia (and some other countries of the former Soviet Union).

The aim of this chapter is to present international exchange programs with BUTE participation (this activity is related especially to the foreign language education), and discuss them from the viewpoint of the topics of ICEER2004 WORKSHOP: INTERNATIONAL EXCHANGE PROGRAMS.

The contribution starts with the analysis of general elements important in all exchange programs (language, funding), it is followed by case studies (training in English, academic exchange, practical placements). A chapter is devoted to the future (plans, probable trends).

Language

The Hungarian language is spoken only by ca. 15 million people all over the world, and it is different from practically all other languages (there is some grammatical similarity Finnish, Estonian etc., but a Hungarian cannot understand any foreign language without long studies). These facts determine the relation to the language issue both for outgoing and incoming students.

Outgoing students: As outside Hungary there is only a very limited higher education in Hungarian, some knowledge of at least one foreign language is evidently the minimum for any international exchange program. To obtain a diploma of BUTE is compulsory to pass medium level state exams in foreign languages (at least 1 for M. Sc. equivalent training, 2 for Ph. D.). Actually at this moment about 90% of students entering to the university have some language competence (ca. 50% English - it is continuously increasing, ca. 30% German). BUTE offers language courses in the first semesters to its students. The French, German Divisions have been created (among other objectives) to improve the language competence and to prepare students for foreign exchange programs.

Incoming students: As the foreign students typically do not speak Hungarian, they join one of the foreign divisions. However they are encouraged and supported to learn Hungarian (it is compulsory in secondary school, optional in higher education). Before arrival cultural, language competence can be obtained via the Internet[207].

Funding

The funding is crucial both for training in foreign languages in Hungary (which is the base of the reception of incoming students) and for the number of outgoing students.

The Hungarian economy after a 6-7 year long period of decline (which can be explained by the privatisation, re-organisation of enterprises, etc.) has started to grow slightly. The GDP is less than the EU average. The total income of families is smaller than in the EU countries.

As a consequence higher education is under financed (despite the fact that the government tries to do its „best", e.g. the average salary of professors was increased in 2002 by 50%, but it is much lower than in the EU), there are permanent financial problems. There is a normative financial system depending on the number of students determined by the state. The budget is the same if the training is in Hungarian, or in a foreign language. However BUTE understands the importance of foreign language education. The education in English is self-financing, the French, German divisions and exchange activities are supported by BUTE own funds (this support in 2003 was approximately 80.000, 80.000, 70.000 EURO correspondingly).

Related to the outgoing students one can remark that BUTE joined large European programs (e.g. Socrates/Erasmus, Leonardo), entered into international organisations (e.g. AUF - Agence Universitaire de la Francophonie), signed more than 100 contracts with foreign universities (some European

206 SOL CH., MOSON, P.: Strengthening the Links between Enterprises and Universities. Alternative Training of Engineers. In Proceedings of International Conference on Engineering Education (ICEE) Technical University of Ostrava. August 10 - 12, 1999, Czech Technical University in Prague, August 13-14, 1999 (See: http://www.fs.vsb.cz/akce/1999/icee99/Proceedings/index.htm)
SOL CH., MOSON, P.: Alternative Training of Engineers. Extension. In Proceedings of International Conference on Engineering Education (ICEE 2000).
MAURY CL., MOSON, P.: Evaluation of Students Industrial Placements Abroad. In Proceedings of ICEE 2001 Conference. August 6-10, 2001. Oslo / Bergen, Norway. (ISBN-1-588-74-091-9). See CD, http://fie.engrng.pitt.edu/icee or http://ineer.org .
MOSON, P.: International Education at Budapest University of Technology and Economics. International Conference on Engineering Education (ICEE 2002, Manchester Aug. 18-22, 2002). (see: http://www.ineer.org).
MOSON, P.: Student Exchange Programs (academic, practical placements) in Europe. In International Conference on Engineering Education Proceedings (ICEE 2003, Valencia, July 21-25, 2003). CD ISBN: 84-600-9918-0 .

207 see e.g. www.studyinhungary.hu

co-operation will be presented later, here we mention only that in the last 5 years 159 USA exchange students from 7 institutions spent at least 1 semester at BUTE). The number of scholarships is limited by the possibilities of these programs, the university typically can not support directly outgoing mobility.

Engineering training in English

Most of the incoming students (more than 90%) attend the courses in English. BUTE created a special unit the called International Education Centre (IEC) for the organisation of engineering training in foreign languages. This unit carries out the following main activities:

- Organisation of the training (B.Sc., M. Sc., Ph. D. courses in practically all engineering disciplines, see www.tanok.bme.hu). It should be underlined that IEC „only" organises the training (recruitment of professors, timetables of courses, educational facilities/rooms, support materials etc.), it has no teaching and research staff. The education is carried out by the professors of BUTE in part time work for some supplementary salary.
- Management and PR activities. The educational market is increasing world-wide, there is an important competition. There are some stable elements (e.g. a Bulletin printed each year - it can be found on the Internet as well, partners in foreign countries), and permanent renewal (exhibitions, PR campaigns).
- Recruitment, follow up of the students (full, part time training in Hungary). Besides the academic administrative tasks it means continuous work with the Hungarian Foreign Ministry, Embassies abroad (visa requirements), and foreign embassies in Hungary. A personal tutorial (for case of academic and housing, visa etc. problems) is offered to the students.

In the last decade the number of students participating in BUTE education in English is stabilised around 500-600. The data from the academic year 2003/04 are: 608 students ((B.Sc. - 287, M. Sc. - 98, Ph. D. - 16, others - 207), 461 in full (paid) training, 147 part time (exchange) students. The origin of the students is in continuous modification. In year 2003/04 the 5 mostly represented countries are Iran (115), Cyprus (105), Libya (57), USA (52), Nigeria (37). The same data for 2000/01 were: Greece (80), Israel (56), Cyprus (53), Libya (53), USA (35). Concerning the faculties most of the students are enrolled in Electrical Engineering/Informatics (174), Architecture (148), Mechanical engineering (84), Civil engineering (74). As related to the sector of FACE, there is a study program on Environment/Infrastructure.

This training has existed for 20 years. It can be considered as a success story. It contributed importantly to the development of the university (in many aspects from the language skills of professors to finances). The main risk potential obstacle is the instability of the number of students enrolled in the courses with tuition fee. It depends on several unpredictable events (wars, economic crisis, terrorist attacks etc.), on events which consequences one can not see clearly (e.g. nowadays, related to the fact, that Hungary joins the EU), on other problems (e.g. there was an important interest from Chinese students to enter but it has not been realised because of visa problems).

Academic exchange (Socrates/Erasmus)

The ERASMUS program (created in 1987) is the largest student exchange activity of the European Union. BUTE (Hungary and other 6 Central and Eastern European countries) joined the program in 1998. A small unit headed by the BUTE Socrates institutional co-ordinator (I. IJJAS) has been created to carry out the tasks (preparation of bilateral agreements, publicity, selection of candidates, evaluation etc.) Last year related to the 5th anniversary of BUTE participation in the program a book[208] was published (it can be found on the internet, www.tudig.bme.hu/erasmus). This summary is based on this document. The program contains several activities, this chapter is restricted to students and professor mobility based on bilateral agreements of eligible institutions.

The main conditions (abbreviated, simplified) of BUTE students' participation:

- Hungarian citizens can go only to EU countries. Non Hungarian citizens can not study in their home country. A student can take part only once at the program.
- Minimal length of scholarship is 3 months or a full training period, maximum length is one academic year.
- The main objective is to study abroad. Practical placements, research etc. can be supported only under special conditions.
- The studies in the framework of the Erasmus program must be accepted at the home institution based on a 3-lateral Learning Agreement prepared and signed before the start of the training.

Some data about BUTE participation. In 1998-2003 there were 500 outgoing (with average 6.4 months abroad) and 305 incoming students. The university has 137 institutional contracts, the first 3 countries are France (36), Germany (31), Finland (15). The outgoing students went to 12 countries, Germany (130), France (122), Finland (65) occupy the first 3 places. The most involved faculties are: Architecture (226), Mechanical engineering (84), Civil engineering (74). More than 100 incoming students came from France, about 50 from Finland, Italy and Spain.

138 professors of BUTE spent short visits (one week, 8 hours teaching load) in EU countries.

The Erasmus exchanges have been integrated into the international activities of BUTE. The risks, obstacles are both financial and organisational. The scholarships are low (taking into account the relatively low salary level in Hungary mentioned above) 250 EURO/month for students, 400 EURO/visit for professors (in 2003). Another was that the decision about the support was given after the start of contractual period.

208 ÍJJAS,I. (editor): Budapest University of Technology and Economics. Participation in the Socrates / Erasmus program. 2003. 68p. ISBN 963 421 780 X. (See: www.tudig.bme.hu/ersmus).

However BUTE introduced the credit system (ECTS) about 10 years ago, the departments are not flexible enough, each Learning agreement requires a long discussion. There are some attempts to improve the situation and determine the equivalence of full, or large parts of programs on bilateral, multilateral level.

Internships (Leonardo Grants)

The LEONARDO DA VINCI program (created in 1994) is the largest student practical placement activity of the European Union. BUTE joined the program in 1999. A small (virtual) unit headed by the BUTE Leonardo institutional co-ordinator (P. MOSON) has been created to carry out the tasks (co-ordination of activities related to the program, preparation of project proposals, publicity, selection of candidates, evaluation etc.). The projects managed by this unit have a homepage (http://tutor.nok.bme.hu). The program contains several activities (mobility, pilot projects, networks), this chapter is restricted to the mobility of students and young graduates. It is based on annual projects proposed by BUTE in the name of multinational consortia (members are enterprises, higher educational and other institutions of EU countries).

The main conditions (abbreviated, simplified) of BUTE students' participation:

- The students can go only to the EU and some other countries participating in the Leonardo program.
- Minimal length of scholarship is 14 weeks, maximum length is one year.
- The main objective is to work abroad at an enterprise regulated by a tri-lateral agreement (enterprise, university, student)
- The projects contain a cultural and a language preparation of participants, a double tutorship during the placement, evaluation.

Some data about BUTE participation in the Leonardo II. program phase (2000-2006). 11 project applications were presented (partly together with other engineering schools), 7 were accepted, 1 rejected, 3 are in the evaluation decision period. The aim of these projects is to support outgoing mobility. There are 3 types of internships for BUTE students: „blue collar" summer work (56 students of the French Division to France), „technician - engineer" placement for students having ca. 200-250 credit points (65 students, earlier mainly in informatics to Germany, later in all disciplines to different EU countries), young graduates (a new project is presented for 15 participants).

The Leonardo da Vinci internships are popular. Here the financial support is relatively high (115 EURO/week in the first 13 weeks, one return ticket, insurance). The main task is to find the enterprise with needs corresponding to the knowledge, competence of student. Lately BUTE counts more for the individual activity of beneficiaries, professors, and on specialised European Networks, e.g. LEO-NET (Leonardo Network for Academic Mobility, www.leo-net.org), or FACE presented before. The risks, obstacles are related to the project based functioning of the program, which means that there is no guarantee for sustainability, and application, reports etc. require much efforts from the management. Some (smaller) problems are related to the length of internship, which in case of summer placements lead to schedule differences, modification of the deadlines of academic year.

Future

Hungary signed the Bologna Declaration in 1999 to join the European Educational Area, a National Bologna Committee was created in 2002. The main consequence of these facts will be the introduction of 2-cycle (B. Sc., M. Sc.) engineering training in 2005 (for some experimental courses), in 2006 (for all higher education). According to the current (not final) version the technical higher education will be divided in 7 groups and these groups in subgroups (16 altogether). The total number of credits for the full (B. Sc. And M. Sc.) training will be uniformly 330 credits, the repartition between the B. Sc. and M. Sc. levels depends on the type (e.g. architecture, civil engineering 240+90 credit points; chemical, electrical, mechanical engineering 210+120 credit points).

The consequence of the Bologna process is not clear for BUTE international education and exchange programs. If the current plans are realised then the programs of BUTE English and Russian Divisions can be easily integrated into the new system. The case of French and German Divisions is more complicated. For some professions (e.g. agriculture, economics) the practical placements are indicated in the plans. It is not the case for the technical ones. What is important that university would like to maintain the international exchange activities, and the best way probably can be found in co-operation with our partners.

Another modification concerns the introduction of a new university management system. The details are not finalised, but it will be similar to the chancellor system of Anglo-Saxon countries.

Final remarks

This chapter concentrated on the main elements of international exchange programs at BUTE (engineering education in English, largest related EU programs). Most of the programs are successful, sustainable (they have survived the end of the project phase). Of course there were problems, failure as well. Here we mention only the accredited higher level professional training (bac+2 years, 120 credit points, partly transferable in case of further higher educational studies). This successful training in France (IUT - Institut Universitaire Technologique) was adapted at BUTE in the mid 90-es in 3 professions (electrical, chemical, transport). This adaptation was premature, the related national law was accepted later. The programs have not been accredited, there was no stable financial background. So this training was closed in 1997. Nowadays BUTE participates in several bac+2 programs, but on new basis. The education is realised by vocational secondary schools in the Hungarian countryside under the supervision of the corresponding BUTE faculty.

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The author on behalf of Budapest University of Technology and Economics thanks the European Union (especially Socrates/Erasmus, Leonardo da Vinci programs), all other national and international partners for their support to the BUTE international engineering exchange activities. These programs and their presentation at the ICEER2004 confe-

rence would not be possible without the strong engagement of BUTE (especially of rector Ákos DETREK_I, vice-rector on international relations and research György HORVAI, director of International Education Centre Gyula CSOPAKI).

4.3.5. Networking with FACE

(Ana Cristina Figueira)

I came in contact with the FACE project during a meeting of the working group on Industrial Placements of the European Chemistry Thematic Network (ECTN) in Toulouse in April 2004. At that time, I was far from imagining that the experiences of the coming months would be so rewarding.

I was asked to contribute information about the situation of chemistry studies and work placements in Portugal.

In fact, at national level, the work that I have been doing for FACE allowed me to get in again with colleagues from my studying days at Faculty and later, with alumni who are now lecturing Chemistry either in Polytechnics, Secondary Schools, or Vocational Schools. FACE work has also given me the opportunity to find more and to systematise knowledge on the different learning options/systems available for Portuguese students at the different ISCED levels, some of which, having been a Polytechnic/University lecturer for the last 19 years, I was not even aware of.

Looking at a European level, FACE has also provided me with an awareness of the different teaching systems that exist in Europe at the different ISCED levels. Considering the moment in time we are at, namely the Bologna Process, this was definitely an extremely important experience.

We should, however, not forget that FACE is concerned with chemical education that includes practical experience in companies. When we started looking for work placements for our Food Technology students at the then 'Faro Polytechnic Institute' in 1988, this was unheard of in Portugal. A lot of work has been done since, and presently curricular work placements, particularly at Polytechnic level, are not only accepted, but have been implemented in a number of institutions. Work placements are now being regarded as an added value, both by students and prospective employers. At the University of the Algarve, these work placements have been taking place not only at national, but also at international level. Our students have been placed for industrial training in Africa (e.g. Cabo Verde) and in several different European countries (these last, mainly through EU-funded programmes, such as Socrates/Erasmus and Leonardo da Vinci). Regarding the latter, once again FACE has provided the opportunity for the prospective signature of new Socrates Bilateral Agreements (e.g. with Europa Fachhochschule Fresenius - we've already received a contact from one of their students who'd like to do his placement in the Algarve), as well as a network (based on UNIC, see 1.5.) for contacts with other European Institutions, for student and staff exchanges. The participation in a Leonardo da Vinci funded project for student mobility on the Chemistry Area, promoted by the Higher Vocational School Tarnow (Poland) has also come up from FACE's Barcelona meeting in October 2004, where some further developments also emerged, based on the idea of a Leonardo da Vinci Project on 'Food Safety'.

Moreover, FACE members have proved important both as collaborators and/or as advisors on valuable contacts or possible funding sources for projects that I am involved in, or planning to get started: another aspect of networking.

These are some of the reasons why I am glad to have taken part in FACE.

4.3.6. The Role of the Chemical Societies in chemical education

Whether European Chemical Societies should appear in the chapter on the Universities' point of view may well be debated : They represent a membership of chemists in numerous professional environments. As good practice examples, the Gesellschaft Deutscher Chemiker[209] and the Royal Society of Chemistry, London[210], are presented here.

GDCh have regularly collected information from the universities to present yearly statistics on Chemistry studies in Germany[211] and actively shape and take part in the discussions about educational matters, e.g. by publishing position papers on current issues concerning Chemistry studies[212].

RSC do the same[213] and even have an industrial placement site on their homepage[214] at which companies can offer work placements and download documents. GDCh have a „market place" for placements as well[215].

Now a European organisation is being formed, and there should be a way to make education, especially practice oriented forms of chemical education, a matter of concern for this professional body.

209 The FACE team thanks Dr. Kurt Begitt, GDCh Frankfurt, for his constant, excellent advice and support, and the RSC for their expert input over the past 8 years in several previous EU projects
210 http://www.rsc.org/
211 http://www.gdch.de/ks/publikationen/statistik.htm
212 http://www.gdch.de/oearbeit/pospap.htm
213 http://www.rsc.org/lap/educatio/rsedhome.htm
214 http://www.rsc.org/members/industrialplacements.htm
215 http://www.gdch.de/ks/stellen/praktikantenboerse.htm

5. Practice oriented chemical education: evaluation of strengths, weaknesses, opportunities and threats - a European „SWOT[216]- tour d'horizon"

5.1. The example of a diversified set of qualifications in Germany and Austria: Quo vadis?

Austria has a good tradition with its HTL - a technically oriented secondary school. Currently it attracts pupils more than the general education equivalent.

A weakness is that HTL pupils are relatively over-qualified when graduating (they are not expected to have already learnt what they can do, at their young age). HTL is threatened being somehow out of the current European main stream in VET - although the countries of the former Austro-Hungarian empire have a similar model (which, however, is endangered by money and image problems.

Students are barely 15 years old when they start, are introduced early to skills and therefore have an easy access to science and practical work (would anyone suggest that a musician learns to play an instrument late? Why should it be different with chemistry?). The HTL is an opportunity to offer a short way to a diploma which includes university admittance (Matura, A-level) and vocational training (Higher National Qualification level) at a time, with a high number of science course hours.

The Austrian Kolleg, being based on a Matura (A-level) degree starts at a later time in life. The Kolleg pretty much resembles the former German Chemotechniker, with the important difference that the latter was accessible for young people after ten (and not 13) years of school. The Kolleg may suffer an image problem to be the second choice only. This is not justified by response of the labour market, but perceived by many people that are not well informed). The number of incoming students is currently decreasing; competition of public and private FH with apparently attractive, esp. courses related with „bio-" are great.

On the other hand, Kolleg has hard working students who can reach a clearly defined vocational education in a limited time. They usually have better language and foreign language proficiency than HTL students. Attractive options (Biotechnology, Environment) and the fact that the Kolleg of HBLVA Rosensteingasse is well renowned in industry are assets as well as the possible access to 5th semester studies of a German Fachhochschule (situated in Vienna). Kolleg has the advantage of taking in drop outs from university and thus helps to diminish the number of impasse careers. At the moment it seems that HBLVA Kolleg remains the only institution at this level. This special form of a two year practically oriented training merits to be considered as an option not only in Austria and the countries historically linked to it!

Chemistry and related courses at the German Fachhochschule with its specific practice oriented profile and work placement periods seemed to be an endangered species for a while. With Bachelor and Master courses being introduced, the profiles of different types of university are becoming blurred - if the universities so wish - because the legal framework does not necessarily demand a differentiation between degrees of classical universities and Fachhochschulen.

In the framework of the Bologna process, but in contradiction to its flexibility, one German federal state tried to force universities to stick to 3 instead of 4 years and thus lose the practical semester. DECHEMA and GDCh backed the position of industry - strongly confirmed during the Conference initiated by FACE and GDCh on Nov. 25th, 2004 and demanded that the profile of Fachhochschulen be preserved. Employability of Fachhochschule graduates is good and a strong argument for their existence. In general, FH courses in chemistry with attractive optional subjects, a good (European) placement system has good chances in the future.

The future of German apprenticeship models like Laborant will depend on the economic and structural situation in the companies. With the current reform trying to define the expected learning outcomes and competences of the apprentices, industry seeks to

Some German CTA and BTA (Chemical and Biological Technical Assistant) vocational schools offering this two-year course at this time suffer from a lack of pupils. The basic knowledge and skills of incoming pupils are sometimes low. Placement periods that have been recently introduced at first seemed too short to really attract industry to invite students. Yet, EFF has started a LEONARDO project for foreign placements of these pupils, and first positive results are to be seen, when both sides do not expect more than can be achieved in a short time. Not astonishingly, most companies that could be convinced of giving it a try were those which had already had positive experience with half-year periods of students. It seems that companies tend to (and esp. SMEs are forced to) decrease their own training efforts in basic VET (Duales System), which gives more chances to school-based first VET training. If schools are well equipped and give a sound practical training, chances of the school-leavers are good at present.

The model of co-operative training shops (like FACE member SBG Dresden) is an attractive alternative to conventional company based VET under the present and expected conditions of the labour market in the sector.

5.2. Threats and opportunities in conflict: Placements in Spain

Spain has a legal framework for practical placements, but industry is not fully content with it: Companies see deficits in time restrictions and insurance matters.

Messages from Spanish industry are: Limited placement time (four hundred hours/three months) does not permit long term projects-six months to one year would be ideal. The shorter the placement, the less fruitful for both sides - the companies and the students! Students want placement and holidays at

216 Strenghts, weaknesses, opportunities and threats for practice oriented chemical education were discussed at the FACE regional meeting in Kraków in July 2004. This idea of Marek Frankowicz and his colleagues served as a model for similar analyses in different countries. The findings of these FACE expert discussions are the basis for chapter 5.

the same time - they should make a choice. If the assurance problem is not solved on a general, ideally European basis, companies might refrain from taking in students. If trade unions continue to see students in placement as a cheap labour force threatening jobs, instead of realizing that they are a good chance of integration of young people into the labour market - this will cause problems for companies.

Spanish companies see positive aspects of placements:

International student exchange becomes possible through placements. The company gets to know possible future employees - in 40% of the cases, students get a contract after the end of their studies in the company they spent their placement in. Foreign students can help companies to carry out specific tasks which demand language proficiency.

Companies see the chance to achieve a clear cut homogeneous legal framework all over Europe for student placement. Then networks of multinational companies can be efficiently used without too many obstacles - so that e.g. an Irish university can address the Irish branch of a multinational company to find placement in their Spanish location.

Although a legal framework for placements exists, many Spanish universities and university professors are not aware of or not willing to allow placements. Time will be needed to penetrate the idea and practice of work placements more deeply into the academic world.

5.3. Awareness and action - but economic constraints: Poland and Estonia

In Poland lots of activities are going on to shape legal frameworks, to discuss new ways and to co-operate more strongly between university and companies.

Hindrances in this process are bad experiences with placements in former times when they were obligatory but well hated and not highly respected - some say an alibi matter. Lack of finances and economic problems of a Polish industry in the wind of change are additional problems. The old, purely academic traditions thus has it easier to prevail.

There still is a lack in good „systemic“ contents in the co-operation, but there are good practice examples showing that the co-operation can work.

The emerging sector of Higher Vocational Education and improved job chances with the help of career offices are positive factors. Students show high interest in placements, and the European labour market perspectives as well as grants from the EU encourage them further.

The situation in Estonia is similar: There is a general awareness of the benefits of placements. Yet, in many cases the weak educational commitment of companies is due to structural and economic problems. These problems lead to a lack of continuity in university company relationships. The geographic mobility of students is still too low.

These weaknesses can develop into real threats for the relatively young placement tradition if low salary and low placement task quality keep students from considering sandwich studies as a good option.

If the sector succeeds in organising longer practical periods with better payment, then the situation may change.

5.4. Need for changes in policy: Czech Republic

Czech FACE partners regret that the social system in general does not encourage hard work and performance in many students yet. Czech legislation completely disregards placement matters or sandwich study programmes. If placements are done, they are too short. The VET sector is highly underfinanced (most of the money going into the general education sector), teachers are not well paid, equipment is old, and government administrative staff not trained well enough to understand needs of VET. In a country with 10 million inhabitants, 8 VETschools (Higher Secondary Schools) for chemistry are too many (Austria has one such school in Vienna, plus a small private one in Graz) to be efficient, strong and well equipped. General European standards for VET would therefore help to develop Czech VET further.

VET students in Higher Vocational Schools are mostly too young for international placements. On the other hand, the fact that they come in at an early stage gives them a chance to slowly and thoroughly develop skills and understanding in science, still having a relatively high level in general education.

FACE has increased the awareness of colleagues in this country that action is needed and that dissemination of FACE results is a chance to foster the discussion about policy changes:

If VET was also offered on the tertiary level, chances for placements might become better. The colleagues see a chance for experienced people from other EU countries to invest in VET in the new EU countries.

6. Conclusion: Messages - recommendations - policy implications - actions to be taken

Chemistry is the central science for the understanding of matter and life. It has to do with molecules and atoms, with crystals and complex supra-molecular structures. Their properties depend on their structure. The structure-activity relationships we know, try to understand or investigate are the key to innovation, to new products, to clinical analysis, to forensic problems, to diagnostic and therapeutic, to medical and pharmaceutical application. Chemistry is a central „motor" of innovation in many branches of industry, inventing new materials and producing sustainable products. We need and we will need people who imagine what others do not imagine, who see what others do not see, who understand what others do not understand: structures and underlying principles, phase transitions and reactions. Each colleague in the „Chemical Community „ knows that such understanding grows through experience in doing things and doing them again, in „eating and digesting" lots of single facts. We then know how to find our way in the enormous diversity of this micro-world - and how it „appears" in and influences our visible macro-world. Wherever decisions have to be made and action has to be taken in matters of the shaping of this macro-world, expertise of chemists is required. No economist, no politician, no psychologist can make responsible decisions without the input of those who have learnt to study the laws of nature.

To win the minds and hearts of young people for this understanding and the work that can be done with it is a noble task for every chemist. To „teach them well" and to find out what „well" means in a given context of time, place and needs is a common task for the whole chemical community that no one else can fulfil. It is a great experience to co-operate - across borders, across language barriers, across cultural differences, bringing in own traditions. If everything goes well, individuals interact, not just organisations. Their will, dedication, determination and experience, their firmness and modest but self-conscious reasoning and - in many cases - their friendship help to define and achieve demanding goals. This needs visions and it also creates and feeds new visions. Having visions in minds and hearts, the detailed, tedious work in committees, conferences, curricular reform groups, with its „slings and arrows" becomes less boring and frustrating - and it will be necessary to continue for a long while. It is not only necessary - it is and will be rewarding.

Which are the most important messages FACE has gathered from and wants to send to the stakeholders in the sector?

6.1. Messages from the Stakeholders

The employers say:

In FACE and in many other related projects and initiatives, many companies and industry colleagues have contributed to our knowledge. We need well-trained young people. We want them to speak languages and understand cultures. Many of them should have practical work experience so that they can integrate themselves in the culture and teams of our companies smoothly and understand what it means to work for benefits with limited costs. Education must be thorough in matters of science and work skills and give students and pupils a chance to develop their personality including the key qualifications we need.

Give special attention to the needs of SME's and allow for education profiles that contain relevant tailor-made units.

Give education programmes clear profiles defined by learning outcomes and focus in contents. Let differences between types of programme and approach exist. On the other hand, allow for and enable transparency and transferability of credits for knowledge, skills and competences to encourage gifted young people to go for the next step on the ladder of chemical education - we can not afford to lose one single talent that becomes frustrated.

EU and national politicians: Every cent invested in mobility and educational co-operation and innovation is a cent for the Lisbon goals.

The students say:

Wake up our curiosity, do not drown our initiatives. Teach us to ask questions instead of teaching ready made answers only. Give us a good understanding of the basics and teach us relevant skills. Give us chances to transfer them from one country and level to another. Help us find ways to get to know the workplace during our studies - companies and teaching institutions co-operate. Give us a chance to experience the implications of work life before it „really" begins - employability and labour market are, for us, not „mere words" but our future. Help us find ways to cross borders and to experience other countries and learn languages. The mobility programmes of the EU have had and will have so many positive effects!

If you plan and carry out reforms, think of why and for whom you make them. Let us take part in the discussions.

The educators say:

Give education public attention. Show us that you know that it plays a decisive role if we want to reach the demanding goals set in Lisbon. Politicians: Respect our experience and expertise by asking us when you plan and carry out reforms. We need freedom to shape our curricula in co-operation with industry and social partners. Sometimes we even need money - we will carefully use it, and invest it well. Companies: open or keep open your factories and labs for our students to help them become colleagues and integrate more easily. EU politicians please continue with EU programmes that foster initiatives and innovation - and mobility.

6.2. Schools and Universities: Cherish or install placements, enhance horizontal and vertical mobility, enable life long learning!

Recommendations:

- Teach the basic knowledge and skills well. Also train laboratory work skills thoroughly, not forgetting the most simple techniques and basics like weighing, pipetting etc.). Teach transferable knowledge. Foster curiosity. Do that at all levels of education.

- Carefully evaluate existing models of chemical training and education in all member countries as to whether they can contribute to a diversified, transparent, flexible, needs oriented system (A „House of Chemical Education“) for life long learning.
- When designing curricula, see learning and education programmes in chemistry as parts of a European (horizontal, border-crossing) and life long learning (vertical, level-crossing) network
- Minimise the student drop out rate in all your courses Policy implications and action to be taken.
- Define learning outcomes, use common descriptors (like Dublin, **ISCED....**) for all different types of education and describe courses in terms of modules, credits and competences. Give special attention to VET and ensure that its credits are transferable to Higher Education for gifted students.
- Find appropriate ways for entry and exit in all your courses which offer chances for transition to higher or lower levels, depending on student performance.
- If your country and/or your institution has a tradition in including work experience in curricula, cherish and improve it. If not, study good practice examples and decide whether you can follow them.
- If you already have European mobility projects, continue and improve them. If not, start such initiatives.
- Take part in conferences and meetings to learn and contribute a maximum from and with your and other educators' experience. Speak out and agree upon concrete measures to be taken in your local and national context, always having the European context in mind.

6.3. Companies and Social Partners: Actively take part in chemical education and ensure more continuous employment perspectives!

Recommendations:

- Continue and enhance the good practice of co-operation of social partners and the dialogue and co-operation with educators in the sector. Meet them and tell the public and decision makers in politics what the sector needs and why.
- If you offer placements and see their benefits, continue to offer them and tell other colleagues in companies about the benefits.
- Try to organise a more coherent and consistent employment policy to avoid that young people do not see perspectives in our sector because you think you have to or have to take short time decisions ruling out long term aspects.

Policy implications and action to be taken

- Actively take part in conferences and meetings discussing educational reforms. Find ways to do so even if time and money are scarce - take part in EU projects and join with educators and politicians to do the job.
- If you can offer VET in your company, do so. If not or not alone, think of taking part in or creating partnerships with other companies, social partners' associations and schools to form networks (multi-firm training shops) to offer VET courses sharing costs and benefits.
- Continue the good initiative you started in Helsinki in September 2004, including educators in your discussion wherever you think it might help, and come up with a coherent set of measures and actions to be taken by all stakeholders in the sector and by national and European politics.

6.4. Students: Take your chances - go for placements - be mobile - qualify!

Recommendations:

- Do not finish school without having taken the chance to learn something about science. Even if this is not „your field“, science and its results, and the actions of scientists, have an enormous influence on your life. Do not ignore this field of knowledge.
- Be curious in the best sense of the word - the latin root „cura“ means care: Carefully study matter and life and let yourself inspire by its beauty and the need to acquire and use knowledge in a responsible way.
- Be aware that all teachers are learners at the same time. Force them to find new answers to your questions. Use your brains to ask meaningful questions and expect meaningful answers - or new questions.

Policy implications and action to be taken

- Be informed about education and careers in Chemistry and related fields. Use the web, go to Open Days in universities, schools and companies. Ask teachers, students, employers questions and critically think about the answers they give you.
- Do your best, and if you can do better, ask for ways to continue one step further, but mind you: If you cannot do it with a smile, don't do it. There is work to do on all levels of qualification.
- Learn languages and go abroad. Take the initiative and ask your teachers and professors to offer such chances. If they do not - maybe their competitors do.

6.5. Decision Makers: Shape Legal Frameworks - accept diversity of educational profiles - continue European Educational Programmes

Recommendations:

- Listen to all stakeholders in the sector. Do not listen to those who look back in anger or in melancholy. Do not listen to those who only have ready made answers. Discuss with those who use experience to go forward and who have at least one new question for every answer given.
- Respect the special needs of the sector of chemistry which are in part due to the special nature of nature and its laws - and of technology. Consider the needs of SMES-they highly contribute to your countries' economic success.
- Explain political position papers well to ensure that your dreams and goals become the dreams and goals of the stakeholders in the sector.
- Do all you can to minimise both drop out rates of weak and obstacles to advance for qualified students.
- Support the creation of courses integrating work life in industry and university studies.

Policy implications and action to be taken:

- Accept and foster diversity instead of uniformity. Let proven national and regional traditions win the future and help them to become part of a transparent system in which all regulations enable life long learning for individuals. Especially consider the following forms of learning:
  - VET courses offered by companies („Dual system" learning) integrating company and school/university as places for learning and training
  - Multi-firm training shops/co-operation networks to give SME's better chances of offering VET despite of their shortcomings with regard to a comprehensive curriculum
  - Institutions of general education with a focus on science and chemistry (why are children encouraged to put an additional focus on music or sports at an early stage, but not on science, on chemistry?) - a model being the Austrian HTLs or Polish Higher Vocational Schools
  - VET courses offered in schools for students with different entry levels, offering transfer into the next level if the student is able and willing to continue
  - Post-secondary but non-tertiary education like the two-year Kolleg (A)
  - The work integrated form of studies at Berufsakademien (D)
  - Universities of Applied Sciences like Fachhochschulen (D), Hogeschools (NL), Polytechnics (FIN), IUP (F) etc., generally offering 3-10 month placement periods
  - Universities with a more research oriented focus, especially those with international study programmes and joint degrees
  - Master and doctoral programmes with European and/or industry related contexts
- Preserve or shape legal frameworks that allow and even foster practical work experience for as many learners as possible. Let not impediments like lack of insurance, prohibitive bureaucracy and paperwork nor time and schedule restrictions imposed by you hinder initiatives of students, companies and universities.
- Provide flexible systems of learning that allow entry, exit and transition - with transfer of credits - to minimise drop out rates and to maximise chances of advancing to higher levels, depending on the individual capacities of each student or pupil.
- Continue with the Bologna and related processes, have a „holistic" trans-level view of education, but do not forget to patiently look into the details that play a decisive role.
- Definitely continue EU programmes for education, especially mobility programmes. One of FACE's industrial co-operators put it like that: „LEONARDO money is well invested".

7. Our vision: „A European House of Chemical Education"

7.1. „You see things and say: why? I dream things and say: why not?"[217]

Imagine a House of Learning for Chemical Education. In the first floor, vocational training institutions including the so called „dual" education shared by employers and schools have their labs and lecture halls. Pupils and students on this floor regularly spend times at their future workplace to gain practical experience on the job. On the second floor, we find schools offering non-tertiary, post-secondary education forms like the Kolleg or HTL in Austria. The third floor houses tertiary education institutions like Universities, Fachhoch-schulen, Hogeschoolen (NL), IUP (F) etc. They offer course programmes with compulsory, 5-12 month internships in industry. This house is built during past and future years integrating many different educational traditions all over Europe. Corridors and stairwells are there to link different floors (levels) and rooms.

The vision which we not only dream of but which we have to realise is entry and exit at each floor and mobility between all rooms and floors of this house for individuals, only depending on their respective abilities, strengths and weaknesses. Transparency of pathways into, through and out of this House of Chemical Education ensures free movement including re-entry after a period in the job for all those who want to make a career in chemistry. This is not only a vision, but also a challenge!

Is a uniform, simply shaped „house off the peg", doing away with all national traditions and unique solutions, the ideal solution to this challenge? Definitely not. It is a dangerous and disastrous illusion. Dangerous because it would suffocate tried and tested traditions, and disastrous because it would disregard strength that lies in diversity. It is this diversity which gives individuals the freedom of choice. It is this freedom of choice which is the basis of success in training and jobs.

Diversity, and the competition it entails, require transparency. We must therefore use and improve instruments that help to make different approaches to enter, leave and pass the house of chemistry transparent, and thus comparable within a lifelong learning process. Europe has developed these instruments: teaching or learning modules describe contents and learning outcomes, credits make workload comparable, and both make diplomas and degrees transparent. Performance is described by grading systems. The „Diploma Supplement" transports the comprehensive information about an individual student, and the Europass nicely adds to this, documenting the European record of an individual learner.

217 G.B. Shaw, John Bull's Other Ireland (on a poster in Dublin airport)

7.2. Some shortcomings of current educational policies

The House and the possibilities it shows is a model for the European Educational space that can help understand achievements and shortcomings of European educational policies.

Which are important shortcomings that need to be considered on our way from Bologna to Bergen and beyond?

- Mobility in Europe so far included horizontal mobility between countries. In rare cases, „vertical" mobility between levels was considered, and even less „diagonal" mobility between different levels of education in different countries.
- Transparency as planned by politicians in the past seemed to limit itself to Bachelor and Master university degrees. The transparency it means to achieve is a virtual one, given the manifold approaches to these degrees. If not carefully handled, the Bologna process only claims to bring about clarity, while in fact risking to increase confusion and leaving to human resources people the task to assess individuals because degrees are not really but only formally comparable.
- All those educational forms which include optional or compulsory practical experience suffer from the fact that they were not duly considered (although not formally ruled out) in the Bologna process. National policies like the German one threatened to kill the great tradition of e.g. Fachhochschule degrees by forcing universities to only offer a 3 year-bachelor in which a half-year placement period does not fit. This happened while the British colleagues created the four-year Bachelor with an MChem degree including one year of industrial placement! At the same time, EU policies demand employability as an outcome of the reformed courses, while industry clearly shows reluctance in giving away a proven „educational product" such as the Fachhochschule „Diplom" guaranteeing good employability for holders of degrees in technical fields such as chemistry.

7.3. Long term aim: A European chemical education pathfinder system

Given the proven benefit for industry, students and given the positive impact on employability, we think that the House of Chemical Education needs to be extended and optimised under three basic pre-requisites:

- Preservation of good practice in all member countries, with ways opened to transfer good practice examples into countries which decide to have them
- Enhancement of individual freedom and development through both trans-national and „trans-level" mobility in a sequence of life-long learning periods
- A fair chance for „alternating" learning models that include practical periods in the workplace, assigning credits to assessed practical periods at all levels of education

With many European partners, FACE wanted and still wants to contribute to a process leading to a European system of education for the sector of chemistry which is based on the Bologna declaration; which is based on good practice in all European countries and on existing work (ECTN, Tuning) and models („Eurobachelor"); which includes all ISCED levels from 3 to 6 (e.g. NVQ as well as tertiary education); which is characterised by only two formal elements: modules and degrees and which is described by only two sets of figures: credits (ECTS) and assessment grades. This would mean that the use of ECTS has to be extended to vocational training. Attempts are being made in this direction.

At the end of such a process, country specific features may and will still exist. There will be multiple ways of obtaining a degree, from a continuous „classical" education in one „block" to forms of life long learning and continuing education. Each degree will be defined by minimum requirements in terms of modules to be obtained. Modules obtained once shall not be „lost" (although, after longer periods of job life, „catching up - modules" may be necessary). The way/sequence in which modules are obtained should leave lots of personal freedom and flexibility for learners and employers.

Specific features will be formats with integrated, clearly defined, tutored and assessed periods of practical experience in the work place. Another feature might be a basic (e.g. Bachelor) scientific and practical training followed by e.g. a Masters for future teachers (with pedagogical and didactic modules).

Possible degrees to be defined could be European „formats" of Dual training like vocational qualification, 3 years; Technical Assistant Training 2 years; Technical Schools like the HTL (A); Bachelor, 3-4 years; Master following a bachelor's degree, 2-1 years (total of 5 years) or, more radically said, formats which deliver degrees after 2, 3, 4, 5 and more years.

What is now described in years will ultimately be described in modules with credits (ECTS) and not only take into account years elapsed (which can be utterly misleading) but also workload per module and learning objectives.

At the end of the day, different national traditions may merge into a European set of highly differentiated multipurpose Chemistry qualifications.

Such a balanced set of qualifications might one day serve as a model for other sectors, including the feature of practical experience (why should philosophy students want to miss such a chance?).

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LEONARDO DA VINCI ist das Aktionsprogramm der Europäischen Union für die berufliche Bildung. Der Europäische Rat hat die zweite Phase des Programms am 26. April 1999 verabschiedet. LEONARDO II hat eine Laufzeit von sieben Jahren (2000 – 2006) und ist mit einem Gesamtbudget von 1,15 Mrd. € ausgestattet.

LEONARDO DA VINCI unterstützt und ergänzt die Berufsbildungspolitik der Mitgliedstaaten. Durch transnationale Zusammenarbeit sollen die Qualität erhöht sowie Innovationen und die europäische Dimension in den Berufsbildungssystemen und -praktiken gefördert und damit ein Beitrag zur Leistungsfähigkeit in den Mitgliedstaaten erbracht werden.

Das Bundesministerium für Bildung und Forschung (BMBF) als politisch verantwortliches Ressort hat die Nationale Agentur Bildung für Europa beim Bundesinstitut für Berufsbildung (NA beim BIBB) mit der Durchführung des Programms LEONARDO DA VINCI in Deutschland beauftragt.

Die von der Nationalen Agentur beim BIBB herausgegebene Editionsreihe „impuls“ dient dazu, Ergebnisse von LEONARDO-DA-VINCI-Projekten zu präsentieren, Innovationen und Entwicklungen in der Berufsbildung aufzuzeigen und zu verbreiten sowie einen umfassenden Meinungs- und Erfahrungsaustausch zu initiieren.

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