

INTEGRATING EDUCATION CONCEPTS – THE KOBLENZ REGION OFFERS A ONE-OF-A-KIND INFRASTRUCTURE TO LOCALIZE AND QUALIFY FUTURE SPECIALISTS IN ORDER TO ENSURE RELIABLE AND CONTINUOUS PROVISION OF BEST-SKILLED ENGINEERS TO THE REFRACTORY INDUSTRY.

Olaf Krause¹ and Peter Quirnbach²

¹Hochschule Koblenz, Höhr-Grenzhausen, Germany; ²University Koblenz-Landau, Germany

ABSTRACT

The refractory industry suffers a lack of young engineers in Germany. Within the past five years an integrating education concept has been developed to ensure a sustainable provision of young and best-skilled engineers to the refractory industry. The aim of this presentation is to demonstrate how the sophisticated network between education, science and refractory industry leads to efficient fulfilment of the industry's demands.

Because of a vertically open vocational education structure as provided by public legislation it is possible to promote young people even with initial limited educational achievements to finish with an academic degree. The cooperative education network, BFZK (educational and research centre ceramics), which closely cooperates with Koblenz University of Applied Science and the University Koblenz-Landau, allows best possible utilisation of this public education structure.

Since 2010 Koblenz University of Applied Science provides a bachelor of material science and was followed by the implementation of a master degree in cooperation with the University of Koblenz-Landau. The educational system follows two major tasks: Best possible and targeted education in order to provide graduates with tailor-made abilities for the ceramic industry. The second task is to promote science projects that are closely related to the demands of the industry.

INTRODUCTION

Based on excellent clay deposits in the Westerwald region Höhr-Grenzhausen looks back on a long tradition in ceramics. Beside the ceramic industry education and research in ceramics build a hotspot that is unique in Germany and Europe. All levels of education, vocational school for ceramics, state college for ceramics and Koblenz University of Applied Science are situated in Höhr-Grenzhausen. Apprentices and Students from all over Germany join in the educational system for Ceramics.

The Educational and Research Centre for Ceramics (BFZK) brackets education, research and economy in the broad field of ceramic materials. It guarantees the close and steady interchange with the ceramic industry that guarantees up-to-date contents and developments in teaching and research. Especially for the refractory Industry an Integrated Refractory Education System (IRES) was implemented in the entire educational system that allows trainees and students to enter into different levels according to their specific school graduation or to advance from their initial level to superior levels [1]. The educational system gets permeable for every young people committing themselves for a carrier in the ceramic Industry.

THE NETWORK: THE EDUCATIONAL AND RESEARCH CENTRE FOR CERAMICS - BFZK

Since its foundation in 1991, the Education and Research Centre in Höhr-Grenzhausen has developed very efficient in view of common and successful work of various research and educational institutions. The thereby achieved penetration in teaching and research in the field of ceramics is unique worldwide. Through continuous close contacts with the industry, the research of teaching and the museum facilities the ceramic materials should even stay what it had always been - a material of the future.

Here, the competence centre provides even more than just research and teaching. So, at Höhr-Grenzhausen one can go

through all facets of professional training, from the initial training in the ceramic field (an apprenticeship) to the doctor's degree in materials engineering. Similarly, the aforementioned institutes are closely working together with the industry, the trade, the art scene and with all other representatives of the ceramics sector. Thus, numerous national and international co-operations of manifold types have emerged in recent decades. Content references are available in silicate and high-tech ceramics and refractories, as well as in the technical and artistic applications with design and art issues.

Members of the Education and Research Centre are today eight institutions: the University of Applied Sciences at Koblenz with the Department of Materials Engineering, specializing in ceramics and glass, the Institute of Ceramic and Glass Arts, the State College of Ceramic Engineering and Ceramic Design, the Vocational School of Montabaur with the Department of Ceramics at Höhr-Grenzhausen, the Research Institute Glass and Ceramics, the Westerwald Ceramics Museum, the center for business start-up CeraTechCenter and the European Centre for Refractories ECREF. This integrated system enables the institutions to respond quickly to the needs of the industry with respect to the quality of education for the graduates.

The uniqueness of this network is the close connection of practical research (FGK, ECREF and University of Applied Sciences Koblenz), foundation activities (CTC), teaching at University (Bachelor and Master of Engineering "Ceramic Science" degree), the State college (State-certified ceramics engineer, State-certified ceramic Designer) and at the vocational school as well as the steady interchange amongst all of them.

In doing so BFZK aims for two main goals. One particular interest is to make the various fields of applications of this fascinating material group Ceramics available to the public and to unveil its (already existing but hardly seen) tremendous influence on the quality of all our lives.

In addition, the close and steady interchange with the industry guarantees up-to-date contents and developments in teaching and research.

The industry, ranging from primary materials to finished end production, utilizes the affiliate network of the BFZK for its own further development. To benefit from research and teaching experience and to access innovative research achievements clearly is a win-win-situation.

At the same time, the BFZK is an important point of contact for globally working graduates in terms of professional cooperation and exchange of knowledge. Joint projects, conferences, symposia, seminars and advanced trainings are conducted regularly.

COOPERATION BETWEEN EDUCATION BRANCHES IN HÖHR-GRENZHAUSEN

The vocational school for ceramics, the state college for ceramics and Koblenz University of Applied Science have identified the local aggregation of continuing education systems as a unique opportunity to provide tailor made future employees for the ceramic industry at any demanded educational level. For the refractory industry the compilation of this integrated education system (IRES) is furthestmost developed.

Constitution and function of IRES

In the recent 9 years an individual, quaternary education system IRES (Integrated Refractory Education System) has been

developed for the refractories industry, benefiting from the capacities of the member institutions of the Education & Research Center for Ceramics. This system was compiled in consultation with the industry and reflects all the requirements of commercial, technical and academic education sectors. As shown in fig. 1, this system enables trainees and students either to enter into different levels according to their specific school graduation or to advance from their initial level to superior levels. Prerequisite for the latter is their continuous development.

Vocational school for ceramics

Besides traditional handicraft activities in ceramics, further different jobs are to be found in the ceramics industry. Among other professions, young people are today trained as industrial ceramists either specializing in plant engineering or in process engineering. Vocational school education in Germany is always a dual educational system that combines education with on-the-job training. Hence graduates are practically experienced and possess a firm theoretical basis.

The industrial ceramists for plant engineering are employed in the manufacture of ceramic products by automatic shaping processes. They are further responsible for operating and monitoring, as well as the maintenance and adjustment of machines. In addition to a thorough knowledge of ceramic raw materials and production processes, the trainees are also educated in metal engineering as well as in the measuring and control technology. The academic part of this three-year professional education is subdivided into 12 learning fields. The first six learning fields provide basic knowledge of ceramics, while the subsequent six learning fields focus on achieving specialization in the specific profession. After about 18 months, the trainees will take an intermediate exam consisting of a practical part (solution of a special task with relevant documentation in the enterprise they are working for) and a technical discussion. The final exam consists of a theoretical part and a practical task with a technical discussion. Upon passing the exam successfully, a certificate as a skilled industrial ceramist will be handed out to the student.

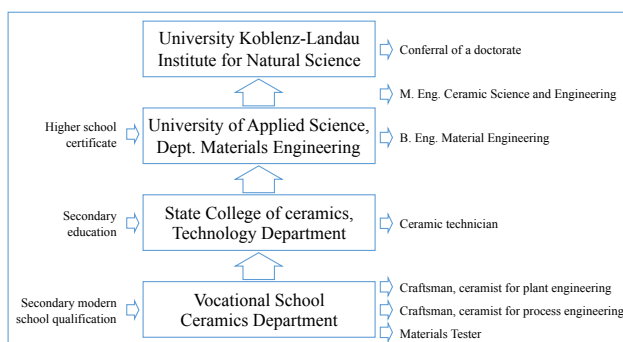


Fig. 1: The Integrated Refractory Education System (IRES) as implemented in Höhr-Grenzhausen [1].

In complement to the industrial ceramist for plant engineering, the industrial ceramist for process engineering is responsible for product-specific topics. Thus, the trainees also obtain basic knowledge during the first six learning fields, whereas the second part of this formation aims at the manufacture of ceramic products, the production of bodies, glazes and working molds, as well as the shaping and firing of ceramic bodies, since these areas will be their fields of responsibility in production. The industrial ceramist for process engineering is further responsible in the field of product refinement and processing ensuring compliance with and control of the product quality throughout the whole production area.

The third profession refers to the refractories industry, where the materials tester (chemistry) for glass, the ceramics industry and inorganic materials are employed. Their tasks are

the investigation of raw and auxiliary materials and finished products, the sampling and analysis as well as the execution of test series with the associated documentation. Special assignment will find these trainees in the refractories industry at the inspection of incoming raw materials, as well as for the support of the production process. This formation also takes three years and finishes with an exam as a skilled industrial ceramist. The teaching content does not only focus on the ceramic expertise, but also on the fields of chemistry and physics.

State college of ceramics

The State College of Ceramics located at Höhr-Grenzhausen provides a unique educational system. To avoid the shortage of ceramic-specific experts to react on changes in professional education contents and the required professional integration, a modular training system was coined almost 20 years ago. It meets the latest requirements of a modern system of initial and advanced professional training. Self-contained seminars (modules) related to individual topics can be attended in block form.

The system enables in-job training to attend individual selected modules as a personal advanced training, to acquire specific knowledge that is required for a particular company or to graduate as a ceramic technician. This facilitates employees to improve flexibility, on the one hand, and enables to penetrate industrial and academic knowledge on the other hand.

The modules represent self-contained advanced training contents. They do no longer provide subject-specific, but application- or project-specific knowledge of a certain material. If all modules are successively attended during two years, the trainee will obtain the certificate of a ceramic technician. During this two-year period, the trainee must work on a final project independently. If the modules are attended over an extended period (at least two modules per year), the title as a ceramic technician can also be obtained in part-time in the sense of an in-service training. Likewise, it is also possible to attend individual modules for a personal advanced training. Within the module combinations, there are numerous options, enabling the trainee to tailor his training according to his specific needs.

Admittance can get everybody who has either accomplished a ceramic apprenticeship or who can prove multi-year practice in the ceramics industry. Other admission qualification can be approved upon request. Full-time learning over two years (2400 hours of instruction) or part-time learning over up to eight years is offered (1920 hours of instruction).

Skilled ceramic technicians work as an employee in ceramic plants starting with raw material suppliers, through production companies towards suppliers of equipment, glazes, chemical additives, etc. In small-sized companies the technician is often employed as a production or operations manager, in large-sized companies he usually works as a supervisor of a shift or laboratory or as a division manager.

Education at Koblenz University of App. Sci.

The Department of Materials Engineering, Glass and Ceramics looks back on an already 135 years tradition in education of ceramics. As a department of the University of Applied Science the institute is named as said since 1999. In 2010 the conversion from diploma degree program to bachelor of material science has been successfully carried out and was followed by the implementation of a master degree in cooperation with the University of Koblenz-Landau in 2012.

Entrance requirements

German students registering for the Bachelor of Engineering degree course need to reach "Fachhochschulreife" or equivalent. In terms of British qualifications, this level of attainment would normally be obtained after one year of 'A' level study in England and Wales or at Scottish Higher level.

Applicants from England and Wales would therefore need to have 'A' level qualifications with the recommendation that Mathematics and German have been studied at this level.

Current admissions requirements of the University require that prospective students provide evidence of their language skills in German (either DSH-2; or TestDaF with TDN 4 in all parts; or Goethe-Institute Certificate C2 (ZOP)).

Bachelor of Engineering						
Sem 1	Sem 2	Sem 3	Sem 4	Sem 5	Sem 6	Sem 7
Basic natural science						Bachelor thesis
Basics in ceramics		Ceramic in-depth study				
Process technology						
Business and administration						

Fig. 2: The curriculum of the Bachelor of Material engineering.

Bachelor of Material Engineering

Within 3.5 years the students gain 210 ECTS (European Credit Transfer System) credit points and finish their degree program as bachelor of material science that enables to take up a master course of studies at any university in Europe that offers a similar apprenticeship. The curriculum as shown in fig. 2 can be divided in five sections starting with the basic knowledge in natural science and ceramics that is followed by a deep-in study that provide special lectures in silicate ceramics, ceramics for civil engineering, functional and structural ceramics, refractories and glazes. The students gain further expertise in general process technology and business and administration. In the 7th semester they complete their studies the bachelor thesis that is typically executed in cooperation with industrial partners.

Master of engineering - Ceramic Science and Engineering		
Sem 1	Sem 2	Sem 3
Materials physics	Materials for Aeronautics	Master thesis
Materials chemistry / Korrosion	Thermochemistry	
Glass materials	Energy process engineering	
Structural and functional ceramics	Further elective modules	
Silicate ceramics		
Bio ceramics		

Fig. 3: The curriculum of the Master of engineering.

Master of Engineering – Ceramic Science and Engineering

The bachelor degree programme is followed by a consecutive Master that is executed in cooperation with the University Koblenz-Landau. The students gain further expertise in material physics, materials chemistry, thermochemistry. The courses are provided by the University of Koblenz-Landau. Further in-depth studies in ceramics as listed in fig. 3 are given at Koblenz University of Applied Science. After the 2nd semester the students elaborate their master thesis that is again executed in cooperation with the Industry. In total the graduation as Master of Engineering – Ceramic Science and Engineering takes five years as it is common practice beyond the Bologna Process within the European Union. Students who join in the Master after three year's bachelor education have to

account for supplementary modules in order to gain further 30 credit points that are necessary to finish the master.

Co-operative education concept for a Bachelor of Material Engineering degree

A praxis integrated curriculum is currently in preparation. It combines on the job training with the curriculum as already summarized above. Instead of seven semesters the curriculum will be extended to eight semesters. That will be necessary to provide a co-operative education concept that enables students to accomplish a course of studies that is equal to the bachelor as described above.

The target group for this co-operative education concept is identified beyond materials testers, craftsman (ceramist for process engineering and ceramist for plant engineering) as well as beyond ceramic technician who work in the ceramic industry and fulfill the entrance requirements reported above. This target group persists as employees in the enterprises and accomplish their course of studies in terms of apprenticeship training. It is planned that in the 3rd and 5th semester the education is performed in co-operating enterprise, where defined scientific projects are elaborated.

From the sight of the industrial partners this educational concept is very beneficial for at least four reasons:

- It is capable of being integrated in the internal qualification structure,
- Offers the opportunity to promote talented workers in a period of life in which they cannot resign their positions,
- the co-operation can obligate talented workers to the company and
- the concept has a high potential to attenuate the oppressive skills shortage that is especially a problem for enterprises that are in out-of-way regions.

Preliminary discussions with representatives of the ceramic industry were clearly encouraging for us to push this project forward.

Sem 1	Sem 2	Sem 3	Sem 4	Sem 5	Sem 6	Sem 7	Sem 8
on the job training preparation		On the job training		on the job training follow-up		Bachelor thesis	

Fig. 4: The currently discussed curriculum of the praxis integrated Bachelor of Engineering.

LITERATURE

[1] Quirnbach, P. and Krause O. Integrating Education Concepts: the Koblenz region offers a one-of-a-kind infrastructure to identify and qualify specialists in order to ensure reliable and continuous provision of best-skilled employees to the Refractory industry Goski, Dana; Smith, Jeffrey D. (Hrsg). Proceedings of the Unified International Technical Conference on Refractories: UNITECR 2013. Hoboken, NJ: Wiley 2014 S. 413 - 416