DESIGNING AN EDUCATIONAL CERTIFICATION SYSTEM FOR EUROPEAN PRODUCTION ENGINEERS

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Abstract:
Granted by the EU Programme Leonardo da Vinci, a two-year pilot project, EPRODEC (European Production Engineering Certification) has been started. The aim of EPRODEC is to provide an appropriate "European Label" to the graduates of the accredited Production Engineering (PE) programme. The objective is to develop an accreditation system and organization that will implement the certification process for education and training within the field of Production Engineering all over Europe. Creating a unified accreditation system will make it easier to compare qualifications and skills. The paper presents some of the ideas behind EPRODEC and the first results.

Keywords: Production Engineer, Education, Cerification System, Curriculum, Accreditation, VET(Vocational Education and Training).

1. INTRODUCTION

European companies must be capable to manufacture products of superior quality at competitive costs to compete effectively in the global economy. Key to the quality of any product is an understanding of the manufacturing processes by which it is produced. Many different studies undertaken in recent years to define the most important areas of future industrial research have placed production understanding at or near the top of the list (see Brummett, 1985; Wells *et al*., 1995). In order to achieve products of superior quality it is consequently necessary to have adequately skilled, trained and educated production engineers that understands the manufacturing processes.

The changes taking place in industry as manufacturing shifts to new processes aimed at increased productivity are followed by new views of the educational system and of the training received by production engineers who will plan, implement, and operate the new advanced manufacturing systems. Given the variety of activities undertaken in manufacturing and the variety of products involved it is a considerable uncertainty about what a production engineer is in terms of education and training. A matter closely connected to this is how the knowledge can be certified.

Modern production engineers must be able to perform a wide variety of tasks with steadily increasing complexity. In this context, it is especially important to endow production engineers with cross-disciplinary knowledge since this is vital to changing technology and international competition. Production engineering curricula must therefore keep pace with the changes demanded by future trends in advanced manufacturing. A homogenous production engineering curricula that specifies the most important areas in this field and a European Certification System that can measure the skills and the educational knowledge level is therefore of great importance.

2. PROJECT DESCRIPTION

In order to develop and to specify a Curriculum and a European Certification System for Production Engineers, the pilot project EPRODEC (European Production Engineering Certification) was started in February 2007. The project which is granted by the EU Programme Leonardo da Vinci will continue for two years and the partnership consists of representatives from Universities, European Federations and Organisations. The aim of EPRODEC is to provide an appropriate "European Label" to the graduates of the accredited Production Engineering (PE) programme in conformity to the framework specified by the EUR−ACE Standards for

the Accreditation of Engineering programmes. The objective is to develop an accreditation system and organization that will implement the certification process for education and training within the field of Production Engineering all over Europe. Creating a unified accreditation system will ease up the mobility among production engineers since it makes it easier to compare qualifications and skills.

The long term goal is to improve skills and qualifications in basic PE up to B.Sc. level on purpose to promote the employment reliability and the trans-national mobility. This will be facilitated via a European Certification. For this goal the EPRODEC will establish a transparent training and certification system to improve students' professional qualification for a common European labour market. Organisational structure, quality assurance, methodology and rules for important areas such as E−learning, distance work, mentorship, collecting and recycling valuable information from retiring workers will be dealt with in the project. This will undoubtedly strengthen the quality in VET (Vocational Education and Training) systems and practices.

3. ACCREDITATION SYSTEM AND ORGANIZATION

The main goal of EPRODEC is to establish a unitary, transparent European training and certification system for Production Engineers based upon EUR−ACE Framework Standards for the Accreditation of Engineering Programmes. In the EPRODEC project the EUR−ACE framework standards will be applied for Production Engineering.

EUR-ACE is a EU−supported project coordinated by FEANI (see FEANI, 2007) with the aim of setting−up a European Accreditation system for the entire engineering sector. In the context, the EUR−ACE Project elaborated and published in December 2004 a first version of tentative EUR−ACE Standards and Procedures for the Accreditation of Engineering Programmes (see FEANI, 2005).

The major elements in the EPRODEC system are:

- An educational plan – "EPRODEC Curriculum".
- An educational package – " EPRODEC Educational resources".
- Procedures and practices for assurance and maintenance of academic standard – "the Quality Assurance Manual".
- A European organizational structure – "EPRODEC Accreditation Body".
- A validation instrument to attest acquired knowledge of both educators and trainees – "the European Production Engineer Certificate .

In Figure 1 the EPRODEC organization structure that will be created is outlined.

The EPRODEC accreditation body (see Figure 1) and its central agency, the European Accreditation Office for Production Engineering within FEANI, will act for the management of the certification process, analysis and dissemination of information for the improvement of the quality of VET (Vocational Education and Training) in production engineering.

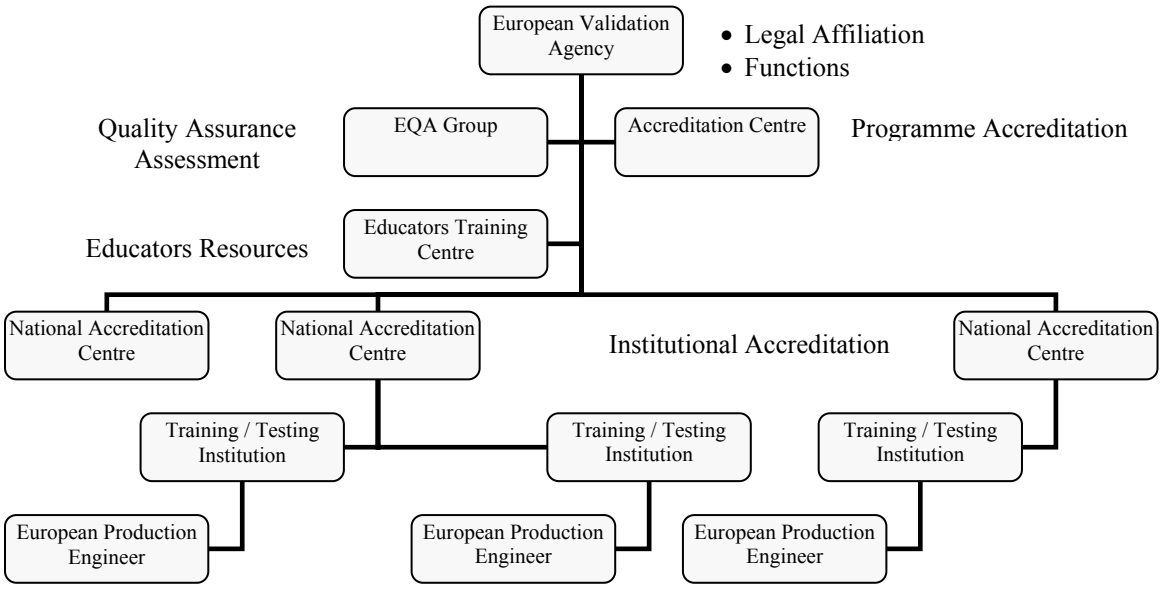

Fig. 1. EPRODEC Organization

The organization will actively strive to mobilise VET resources in production engineering throughout the European Union to provide high quality evaluation of production education and training, to supervise training programmes and to provide useful and clear information to Certification Institutions. The central agency will coordinate efficient and transparent procedures to allow timely access and to license competent institutions to promote and uphold the standards.

International collaborative activity poses particular problems and issues for the management and enhancement of the quality of teachers experience and the assurance and maintenance of academic standards. The Quality Assurance Manual (QAM) that will be developed addresses those issues and lays down procedures and practices, which will be kept under constant review, to guide the Certification Institutions and its staff in the certification process. The QAM will ensure that the learning opportunities for PE students, the totality of their experience and the standards of the qualifications they receive are of the highest quality within the resources available and independent of the institution issuing the certificates. The QAM will form the base of the European training centre.

The intention is to widen the already existing European network. The network will consist of Education Centres forming satellites around different Universities/Institutes.The network and its central agency, the European Certification Office for Production Engineering located within FEANI organization, will act as a catalyst for developing the certification process, analysing and disseminating information that improves the quality of VET in production engineering (see Figure 1). The network will mobilise VET resources in production engineering from throughout the European Union to provide high quality evaluation of production engineering, to advice on training programmes and to provide useful and clear information to Certification Institutions.

The curriculum framework for production engineering certification was developed in a previous LdV project, EPRODE. The structure is based on industrial input, such as questionnaires among industry employees and courses for Production Engineers. During the development process of the curriculum national differences and aspects has been considered. The Certification makes it possible to specify and maintain the realistic and European standards of professional competence for a common European education and training in Production Engineering. The Certificate is the final proof that the student has the ability and necessary qualifications working as a Production Engineer. It is a driver's license for the field of Production Engineering and the final stage of an iterative procedure. The certification system will not only be a grading system, but it is also an instrument for specifying and dealing with different activities during the education and training.
Within the EPRODEC a complete course package framework "the EPRODEC Educational Resources" will be developed, to lay at the foundation for accredited institutions.

Since the vocational training will take place at many different European locations it is essential to develop an instrument, a Certificate that guarantees the quality. Quality assurance is thus an important feature of EPRODEC. As education and training in PE will be carried out at many different locations their quality has to be maintained at a high level. Creating a quality assured Certificate this will ease the possibility to make use of special competence only available at specific places. Consequently this addresses both educational access and continuing vocational training. Through the final project goal, PE knowledge will be better appreciated than today.

4. CURRICULUM

In essence, the function of a unitary PE curriculum can be summed up as a clear and concise statement of what matters in PE education. This translates the EPRODEC educational mission into concrete terms for key areas of learning and thus focuses teaching on shared goals.

The EPRODEC curriculum focuses on modular programme of study, and outlines the intended knowledge, understanding, skills and attributes of a student completing that particular module. EPRODEC curriculum consists of 12 modules, each of them rated at 15 ECTS (see Figure 2).

Module I, 15ECTS	Module II, 15ECTS	Module III, 15ECTS	Module IV, 15ECTS
Materials Engineering	Machining Technology	Integrated Product and Process Design	Quality Engineering
Module V, 15ECTS	**Module VI, 15ECTS**	**Module VII, 15ECTS**	**Module VIII, 15ECTS**
Information Technology and CNC	Manufacturing Systems	Forming Technology Sheet Metal Forming	Joining Technology Welding
Module IX, 15ECTS	**Module X, 15ECTS**	**Module XI, 15ECTS**	**Module XII, 15ECTS**
Production Management	Joining Technology Mechanical & Chemical	Manufacturing Technology	Forming Technology Bulk Forming

Fig 2. EPRODEC Curriculum Structure

EPRODEC modules contain courses that cover major areas in production engineering and management. The production engineering "core" modules provides a common language and fundamental base for all production engineers (see Table 1 in Appendix). Technological disciplines are designed to be unique and specialized. To date, EPRODEC encompasses three specializations: Manufacturing, Forming and Joining (see Table 1in Appendix).

The role of information technology in manufacturing can be seen in the increasing use of computers to underpin product design and fabrication processes and to support related business processes such as sales and distribution. Information technology is integrated in the EPRODEC modules to ensure a suitable foundation for advanced manufacturing technologies. Consortia of educational institutions and industry has been formed to improve and to develop new PE programme.

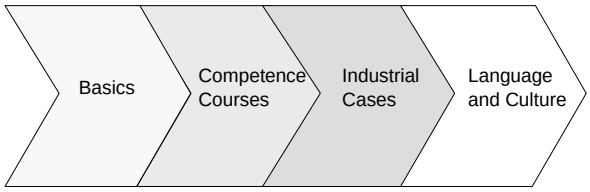

Fig 3. EPRODEC Module Structure

EPRODEC modular structure is based upon a unitary combination of theoretical or basic knowledge necessary to understand competence courses, practical activities perform in laboratory or industrial companies, language and culture courses to enlarge the European dimension (see Figure 3). Emphasis has also been placed on the communication skills of reading, writing, listening, and speaking in both technical and non-technical courses.

The degree of standardization of the European production engineering program will be reflected by curricula, educational material, resources, quality assurance system and the process for continual programme review. However, high flexibility is ensured to adapt to national industry demands and to shape student identities in the light of structural features of different national industry profiles.

5. QUALITY ASSURANCE

Given a European dimension to the production engineering education implies not only to guaranty a common level of knowledge and skills for the graduates but also to assure a high quality level of the trainers (see Aylett *et al.*, 1996).
The primary purpose of European accreditation in PE is to ensure quality control and quality assurance, commonly with reference to a certification system in the areas of education and training. The role of quality assurance and accreditation of European production engineering institutions is reflected in the continuous quality improvements. Translated into assessment programmes, EPRODEC educational system is used for education monitoring and the evaluation of accredited institutions. These serve to ascertain and assess learning outcomes, and this feedback function contributes to the output-driven management of the PE education.

If European production engineering education is to achieve its own identity as a unique European discipline in the future, it must assume the responsibility for developing not only of a common body of knowledge but also of a highly qualified faculty staff. Objectives, educational process, resources and quality assurance system must be periodically re-examined and renewed.

6. CONCLUSIONS

This paper underlines the importance of creating a unitary education programme for Production Engineers and a European Accreditation Organization that can certify both Production Engineers and their Certification Institutions. A transparent training and certification system for Production Engineers will ensure both quality and high standard for education and training. This will substantially ease mobility among European production engineers and will also be a basis for higher standards in many European companies, especially SME. Today, the mobility among production engineers is very low, partly because the education and training level differs considerably among EU countries, being almost beyond comparison.

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APPENDIX

Table 1 Modules Description

Module	Topics description	Learning Objectives	Areas of Skills acquired
Core Modules			
Materials Engineering	Engineering materials, Mechanics of materials, Engineering Mechanics, Manufacturing processes	Recognize that the utilization of materials is interdisciplinary in nature. Understand material properties and how to test. Make the student familiar with the fundamental knowledge about material, applications and traditional manufacturing processes.	Theory, technology, language
Quality Engineering	Statistics, Design of experiment, Quality assurance and control.	Statistical methods for quality control and improvement. Understand how quality planning and quality management are performed,	Theory, technology, management
Integrated Product and Process Design	Geometric dimensioning & tolerancing, Design paradigms. Product Information management, Product data models	Understand cross-disciplinary principles that addresses the production engineering and the design area. Train the student in systems design under economical and technological constraints.	Theory, technology, management
Information Technology and CNC	Virtual factory, reconfigurable factory, Computing in manufacturing, Manufacturing information system, CAD/CAM, Process planning. CNC programming	Apply modeling and simulation principles and tools. To be able to understand how CAD/CAM and CNC technique can be used in production. To apply geometric modeling. Understand advanced manufacturing technology infrastructure. Definition and signification of group technology.	Theory, technology, management.
Production management	Operations research, Global competitiveness, Life cycle management, Supply chains, Human resources	Understand and apply basic models. Relate production processes phases and marketing product stages in a dynamic environment. Design P/OM operating systems.	Theory, technology, management

Table 1 (continued)

Module	Topics description	Learning Objectives	Areas of Skills acquired
Specialization in Manufacturing			
Manufacturing Technology	Rapid prototyping, Manufacturing processes, Powder technology, Surface technology, Abrasive machining, micromanufacturing. Manufacturing costs	Define and characterize different fabrication techniques. Select machine and processes. Calculate manufacturing process capability.	Technology, economy
Machining Technology	Machining theory, Mechanics of cutting, Economical cutting, Tool selections, machine-tool vibration, Process monitoring and control, capability analysis, engineering metrology.	Fundamental knowledge about different machining methods. Understand their applications, limitations and the deformation mechanisms behind them. Economic analysis concerning cutting. Knowledge about material and tool materials, their use and behavior under different conditions. Stability and process control.	Technology, economy
Manufacturing Systems	Production Planning, Principles of automatic control, Kinematics, dynamics and drives, Machine tools and industrial robots, Automatic control of machine tools and robots, Production control	Understand principles of production control in a manufacturing system.	Technology, management

Table 1 (continued)

Module	Topics description	Learning Objectives	Areas of Skills acquired
Specialization in Forming			
Manufacturing Technology	Thermodynamics and heat transfer Manufacturing processes, metal casting processes and formability. Surface technology, friction, wear and lubrication.	Define and characterize different fabrication techniques. Select machine and processes. Calculate manufacturing process capability.	Technology, economy
Sheet Metal Forming	Sheet metal forming, Theory of plasticity, Bending, Stretching, Drawing, equipment and economics, drawing defects and residual stress.	Understand the basics of the theory of plasticity. Understand the difference between bending, stretching and drawing. Describe the deformation mechanisms for each method and identify main factors. Context in which each method is used. Calculate force and energy required.	Technology, economy
Bulk forming, Extrusion technology Hot extrusion, cold extrusion.	Bulk forming, Extrusion technology Hot extrusion, cold extrusion.	Describe and understand the difference between cold and hot rolling. Characterize extrusion as a process and in which context it can be used. Describe how the microstructure is affected during the deformation process. Die design.	Technology, economy

Module	Topics description	Learning Objectives	Areas of Skills acquired
Specialization in Joining			
Manufacturing Technology	Thermodynamics and heat transfer Manufacturing processes, Surface technology, quality assurance, inspection and testing.	Define and characterize different fabrication techniques. Select machine and processes. Calculate manufacturing process capability. Train the student in inspection and testing.	Technology, economy
Welding technology	Materials engineering, Metallurgy, Welding processes, Mechanical assembly, Fusion – Welding processes, Diffusion bonding.	Describe and characterize different assembly techniques. To Train the student in MIG, MAG, MMA and TIG. Understand why welding defects occur and what can be done to avoid them. Calculate the carbon equivalent, energy relationships and working temperatures.	Technology, economy