THE VIRTUAL TRAINING CENTRE (VTC) FOR CNC (COMPUTER NUMERICAL CONTROL)

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Abstract

The objective of this paper is to present the innovative training centre for CNC: http://www.vtcforcnc.com. The Virtual Training Centre (VTC) was set up on the Internet for Computer Numerical Control (CNC) training based on virtual aids. A virtual space (a CNC training portal) on the Internet which allows the constant sharing of e-learning-based CNC teaching material was created so as to foster the further development of e-learning based CNC educational contents. The VTC for CNC is an interactive platform, a meeting point for policy-makers, social-partners, practitioners, researchers and all those with an interest in CNC field of vocational education and training. Experts in the field are able to share and exchange knowledge and experience with associates within and outside the European Union.

Keywords: Virtual Training, CNC, Virtual Environment

1. Introduction

Recently virtual training has been regarded as an innovation notably for vocational training. There have appeared numerous virtual learning environments and various approaches and tools to this end. The focus of “virtual learning” is in fact is on computer technology and education. In this context, a large number of vocational training centres and technical universities are giving priority to Computer Numerical Control (CNC) Training, especially in the last decades. New developments on CNC machines are providing a continuous need for updated CNC training curriculum. Training on CNC should follow similar developments and in particular in their programming capabilities, automation they offer and their technical capabilities. In addition, CNC programming is becoming more and more automated through the use of CAD/CAM systems. This requires from the programmers to acquire CAD operation capabilities, on top of their CNC operation and programming knowledge. The major objective in the field of CNC training is to improve the qualifications and competences of the trainees, which is directly
related to a well-designed and effective curriculum to be carried out on CNCs. The facilities for CNC training vary a lot and this has had direct impact on the experience that the trainee is acquiring during his/her apprentice.

This paper presents the design, the development of an International Virtual Curriculum for CNC training, via an Internet based e-learning centre. This Virtual Curriculum in CNC training is the main result of an International Leonardo da Vinci Project with three participating European Countries. The developed training material is implemented in a Virtual Training Centre (VTC), which includes a virtual space (a CNC training portal) on the Internet which allows the constant sharing of e-learning based CNC teaching material, and the further development of e-learning based CNC educational contents.

In order to develop the appropriate virtual content, the equipment, methods, curriculum and techniques currently used for CNC training by the organisations in the partner countries were observed, collected and evaluated. The selected materials were used to create a new and common international curriculum. Five important factors that contribute to learning were taken into account in order to prepare the CNC curriculum: Motivation, Aptitude, Presentation, Repetition, and Practice with reinforcement. The approach for developing the appropriate training material was based on these factors, combined with carefully selected key concepts in CNC training. The result is a 28 session Curriculum, implemented in the Virtual Training Centre, which aims at setting the standard CNC virtual learning in vocational training systems.

2. CNC Training

Computer Numerical Control refers to the use of a computer to control and monitor the movement of a machine. The machine could be a milling machine, lathe, router, welder, grinder, laser or waterjet cutter, sheet metal stamping machine, robot or many other types of machines. A CNC training course should consist of the tuition of CNC programming methods and their application on actual conditions of processes. Its main task should be to make any trainee at any training level capable of handling and programming CNC machine tools.

CNC training usually takes place under supervisory attendance that emphasizes the technological character of the training object. Additional support of appropriate teaching material such as media and methods (slide-shows, movies, multimedia, demonstration of manufactured pieces, visits to machine shops is often used. Furthermore laboratory exercises are necessary for the understanding of each topic of the subject, some taking place under actual conditions and other on paper. This way, the trainee can easier understand the CNC machine programming, its applications and he can face the technical problems encountered during the manufacturing of the parts. A large amount of programming exercises can help the trainee to understand the theory in a better way, offering him the sense of the quantity of the skills that has to obtain and the difficulties that he is going to encounter, according to the machined part geometry. To accomplish all these objectives, the exercises included in the curriculum, should include data from real working conditions, as much as possible.
3. A common CNC Curriculum

Each European Country has a different curriculum in CNC training. During the first stages of the project, the equipment, methods, curriculum and techniques currently used for CNC training by the organisations in the partner countries were observed, collected and evaluated [1-3]. The selected materials were used to create a new and common curriculum. Five important factors that contribute to learning were taken into account in order to prepare the a common CNC curriculum:

- Motivation
- Aptitude
- Presentation
- Repetition
- Practice with reinforcement

The approach for developing the appropriate training material was based on the following key concepts:

- Know your machine (from a programmer’s viewpoint)
- Prepare to write programs
- Understand the motion types
- Know the compensation types
- Format your programs in a safe, convenient, and efficient manner
- Know the special features of programming
- Know your machine (from an operator’s viewpoint)
- Understand the three modes of operation
- Know the procedures related to operation
- You must be able to verify programs safely

This approach combined with the important learning factors finally led to a CNC training curriculum including 28 sessions:

1. Machine configuration
2. Speeds and feeds
3. Visualizing program execution
4. Understanding program zero
5. Measuring program zero
6. Assigning program zero
7. Flow of program processing
8. Introduction to programming words
9. Preparation for programming
10. Types of motion
11. Introduction to compensation
12. Dimensional (wear) tool offsets
13. Geometry offsets
14. Tool nose radius compensation
15. Program formatting
16. The four kinds of program format
17. Simple canned cycles
4. Adaptation of the Curriculum into the virtual training center

In the report “Studies in the context of the E-learning Initiative: Virtual Models of European Universities” [4], a key concern was how virtual mobility is being supported in European universities through ICT integration and e-learning. The study found that the majority of universities face major challenges in promoting ICT integration. ICT strategy is very important and those universities that have an ICT strategy are significantly ahead in integration of ICT in administration and organisation and networking. Integration of ICT and e-learning is politically important in the EU in terms of internationalisation and globalisation of education, student demand and interest in increasing the quality of education through ICT [5-8]. At the national level, integration of ICT should become a key priority with national and regional institutions making a commitment to ITC and the development of networks. There must be increased national flexibility with a commitment to support common standards of quality and assessment and to develop national and international metadata standards. For all these reasons the designed common curriculum for CNC was implemented into a Virtual Training Centre. To develop the virtual training centre, a communication website was developed in order to manage the activities and tasks to be carried out by the partners. Then, an interactive teaching program was developed and put into a website to form a virtual training centre (figure 1).

The common curriculum developed for this purpose was the core of this training centre. The site, along with the interactive teaching program, was divided into four main areas, "News", "Exchange of views", "Projects and Networks", and "Information Resources". With these, users would be able to access a newsletter, a bulletin board, online surveys and survey reports, information on VET networks, an electronic library with references, a bookshop with downloadable publications and a number of databases. In the main core of the CNC training material, simulations and practical exercises are included into the interactive training centre (see figure 2, 3, 4, ..).

The feedback of the implementation of the VTC in training centres has been recorded and evaluated in order to produce the final version. The evaluation procedure included content (topics, language used, modules), methods (progress, different levels of difficulty, and range of resources, situations and practical cases) and technology (ease of installation, interactive nature and use without a tutor).
The main aim of the VTC for CNC aims is to be an interactive platform, a meeting point for policy-makers, social-partners, practitioners, researchers and all those with an interest in CNC field of vocational education and training. Experts in the field are able to share and exchange knowledge and experience with associates within and outside the European Union. This will foster the long-term viability of the Centre.

Figure 1. Interface for http://www.vtcforcnc.com.

Figure 2. Interface for commands
Figure 3. An animation for M00 command

Figure 4. An animation on command M05
5. Conclusion

The integration of ITC in this virtual learning environment for CNC, the development of the VTC and the common training curriculum are focused on the EU goals of internationalisation and globalisation of education, student demand and interest in increasing the quality of education through ICT. At the national level, integration of ICT has been a key priority with national and regional institutions making a commitment to ITC and the development of networks. Furthermore, major national objectives include an increased national flexibility with a commitment to support common standards of quality and assessment and to develop national and international metadata standards. This common Virtual CNC Curriculum addresses the priorities expressed here. Furthermore, the Virtual Training Centre addresses the strategic objectives mentioned above: improving the quality and effectiveness of education and training systems in the EU by developing skills for the knowledge society, ensuring access to ICT for everyone, increasing recruitment to scientific and technical studies, and making the best use of resources. Facilitating the access of all to education and training systems by providing open learning environment, making learning more attractive, and supporting active citizenship, equal opportunities and social cohesion is the other strategic objective that can be achieved through this virtual training centre. The experiences and knowledge gained during the implementation of this Centre can be used in developing and improving other training programmes in particular in the area of new information technology applications in related sectors.
REFERENCES


