

COMPUTER SUPPORT PROGRAMMING OF CONTROL SYSTEM SINUMERIK 840D FOR E-LEARNING EDUCATION

Nadezda Cubonova

University of Zilina, Slovakia
nadezda.cubonova@fstroj.uniza.sk

Abstract. Modern information and communication technologies bring into the educational system the massive changes in the whole world. The expansion of computer techniques and new computer aided technologies gives very power tools for education enhancement to university teachers. The paper is focused on actual information and communication technologies implementation in E-learning educational process at the Faculty of Mechanical Engineering, University of Žilina, Department of Automation and Production Systems for the study branch – “Automation of Production Systems”. The article presents applied aids, methods, course and educational software from the area of technological production preparation, gives the current information about solution of tasks specified for the field of CNC machines programming of the control system SINUMERIK 840D.

Keywords: NC programming, Web, E-learning, Sinumerik 840D.

Introduction

The expansion of modern computer techniques, new computer aided technologies and mainly utilization of the Internet gives very powerful tools for information exchange and communication. The development of microelectronics, computer techniques and communication means directly has influenced mechanical engineering, too. Information and communication technologies (ICTs) are a “diverse set of tools and resources used to communicate, create, disseminate, store, and manage information, bring the massive changes into the educational system in the whole world”. Knowledge is perceptible through the multiple senses and it enables to reach the higher educational efficiency in comparing with the traditional educational form.

The most dominant form of computer aided communication is the World-Wide-Web (WWW), or simply the Web. The use of Web has been adopted into every aspect of educational life and each educational activity seems to be covered by a Web-enhanced teaching system. Well-designed Web based teaching tools can significantly enhance student learning, while decreasing the time spent in traditional classroom lectures. Web applications are popular due to the ubiquity of Web browsers, and the convenience of using a Web browser as a client. The ability to update and maintain Web applications without distributing and installing software on potentially thousands of client computers is a key reason for their popularity. Common Web applications include Webmail, online retail sales, online auctions and many other functions. Applications of computer communications can be used in many ways in education. One of the most quickly developed computer technique areas is computer graphic, multimedia, professional visualization, animation etc. The computer support of visualisation allows a new view on education. These computer support programs have becoming very significant elements of the education process. The target of their utilization is not only to teach to work with computer but especially to offer a quantity of different types of information. Mainly specialized study subjects from the engineering area required the different approach to the information presentation. Application of support programs and implementation of interactivity principles into E-learning courses promoted the student creativity. E-learning applications and processes include Web-based learning, computer-based learning, virtual classroom opportunities and digital collaboration. The content is delivered via the Internet, intranet/extranet, audio or video tape, satellite TV, and CD-ROM. It can be self-paced or instructor-led and includes media in the form of a text, image, animation, streaming video and audio [6]. E-learning brings a new possibility into the educational process at its every level. The teacher can devote his/her attention only to the explanation of more difficult problems, to improve the courses, to create new ways for better communication with students and to do the next activities for which he/she had not an ample time in the frame of the traditional learning process. Just the communication between the teacher and the student is a very important part of the learning process that has been utilised in the electronic media. E-learning courses can utilise different modern tools for the information better transfer to a student. They are for example: multimedia presentations, simulations and combination of all animation, video and text explication. At the end of course the test of the student knowledge verification can be integrated, too [2]. The present modernizing of education

at universities is the reflection of the society requirements. The *Department of Automation and Production Systems* (DAPS) at the Faculty of Mechanical Engineering is a participant in the project of the EU Operational Programme – Education: “A Flexible and Attractive Study on University of Žilina for Both Employment Market and Knowledge Society Requirements”. The group of specialists take part in solution of specific tasks solved in the framework of the activity “The Creating of Contents for E-learning”. This paper is focused on utilization of communication technologies in E-learning educational process at the Faculty of Mechanical Engineering for the study branch – “Automation of Production Systems”. The article presents applied aids, methods, course and educational software from the area of technological production preparation. Special attention is given to supporting the tool for CNC machines programming of the control system SINUMERIK 840D, developed at DAPS.

Methodology of CNC machines programming education

The pedagogical activities of the Department of Automation and Production focus on the issues of computer support and automation in the engineering industry with an emphasis on programming NC and CNC production machines and industrial robots, working with CAD systems, CAD/CAM, CAM, CAPP and CAQ, solving technical production using CAx systems and technologies, and the application of microelectronics and microcomputers in engineering practice.

The Department of Automation and Production Systems has a good experience with creation of multimedia learning programs for several years. Multimedia educational support programs are solved and developed in the frame of many research activities. The main areas of their utilization and application are mainly CNC machines and their programming, utilization of modern CAD/CAM systems, programming and application of industrial robots and manipulators, etc. At the department the education of courses for CNC machine programming is taking place in the new “Laboratory of CNC Machines Programming” [1].



Fig. 1. Laboratory of CNC Machines Programming and PC with control panels

This laboratory is equipped with training CNC machines EMCO Concept TURN 55 and EMCO Concept MILL 105 (Fig. 1). Both machines are controlled by a commercial PC, on which *various industrial control* or a *CAD/CAM systems* can be installed. The interchangeable control is a special feature of these machines. The machines are controlled by Sinumerik 840D (Siemens).

The laboratory is also equipped with 10 PC stations with panels of control system Sinumerik 840D (Fig. 1) and control software EmcoWinNC. Students there can obtain classic information how to prepare the enter data for the control system of the training machine. Then can tune the developed NC program on PC and verify the NC program by production on CNC machine. The Sinumerik 840D is a part of the changeable control software EmcoWinNC. This software allows the user to learn up to nine different, commercially used control systems (SINUMERIK, HAIDENHAIN, FANUC..) on a single machine.

Web application for control system Sinumerik 840D programming

For more effective teaching of software EmcoWinNC – Sinumerik 840D (Fig.2), at the department an educational program Web site application – “emco training program” was developed. It is used for control of the above mentioned CNC machines. The aim was to design a system that would be primarily used locally, with students accessing the system from within the campus, as an

accompanying tool for the theoretical part of the lectures and courses. Application is available for students and is located at department Website. The content of the whole Web application is divided into two parts for the turning and milling machine EMCO separately. Because of the specified length of the article, in the text only the structure and the principle of the part that describes *Web support application for control Sinumerik 840D – Turn* (Fig. 4) will be mentioned. This part of the Web site is directly connected to the part – “*EMCO Concept TURN E55*” (Fig. 3) which contains information about the machine, its design, technological characteristics, and so on.



Fig. 2. Screen of software EmcoWinNC



Fig. 3. Screen of Web application for CNC machine EMCO Concept TURN 55

The structure of the Web support application “*emco training program*” – *part for control Sinumerik 840D – Turn* (Fig. 4) contains information which is hierarchically organized in five lessons. The content is created with multimedia elements, acquainting students step by step with the software working environment and form procedure of the NC code itself.

The main sections of this web part are described in the following:

- **Lesson 1** – contains the basic parameters and information for setting the working environment before the start of NC code creation as: coordinate systems of the machine, device configuration, operating modes of the machine, control system Sinumerik 840D and information about the tool offset (Fig. 4 – Lesson 1).
- **Lesson 2** – includes manipulation with the working environment of software WinNC SINUMERIK 840D. This lesson contains information about different types of output files, transferring them between devices and also information about 2D and 3D simulation of production on machine EMCO Concept TURN 55. In Fig. 4 – Lesson 2 is displayed as screenshot of video with work in software WinNC SINUMERIK 840D.
- **Lesson 3** – includes three ways of creating NC code – commands G and M and NC cycles that can be used in software WinNC Sinumerik 840D for a turning machine. All commands are listed in tables (Fig. 4 – Lesson 3).
- **Lesson 4** – this lesson is explaining the step-by-step process of creating NC code for a component without using NC cycles. In Fig. 4 – Lesson 4 is displayed as input screenshot of this lesson. The parameters of the components as well as the technological process are given into a list of the process. At the end of this lesson all steps of the process are explained through the videosequention.
- **Lesson 5** – contains two examples: Part 1 and Part2. NC code examples are created with the help of NC cycles. The main tool paths are covered with graphic contour of the workpiece. This method allows not only increasing the efficiency, but the visibility of NC code, resulting in a lower error rate in the whole program (Fig. 4 – Lesson 5).

The basic requirement for creation of the Web applications was that the software programs must be simple, transparent and universal, whether for student or for editor. With regard to the size and purpose of Web application at the creation freely available development products (Camtasia Studio 7, Microsoft Office FrontPage) were used.

The figure displays a series of screenshots from the 'emco training program' website, illustrating its structure and content. The main page (top) features a navigation menu with links for Home, Lesson 1 through Lesson 5, and Downloads. Below the menu is a video player showing a classroom setting. The text on the page describes the website's purpose: to provide effective procedures for learning basic program codes for CNC turning on the EMCO Concept Turn 30 with a Sinumerik 840D. The information is organized into five lessons, each with multimedia elements. The screenshots below show the following content:

- Lesson 1: Description of control system** - Includes text about WinCC software and a video player.
- Lesson 2: Working environment of software EmcoWinNC** - Shows a screenshot of the EmcoWinNC software interface.
- Lesson 3: NC code description** - Displays a list of command types (G, M, NC blocks, NC codes) and a screenshot of NC code.
- Lesson 4: Step-by-step NC program creating** - Shows a 3D model of a component and text describing the step-by-step process.
- Lesson 5: Example of component - Part 1** - Includes text about 3D simulation and a screenshot of a 3D simulation of a component.

Fig.4 Example of Web application structure and screenshots of “emco training program” for control Sinumerik 840D – Turn

Creation of Web applications consisted of the following steps:

- *creation of program animations for turning and milling operations in Flash format by the appropriate software Camtasia Studio 7,*
- *insertion of these animations to a Web site set up in an environment of Microsoft Office FrontPage,*
- *insertion of all the necessary information how to operate in the software WinNC – Sinumerik 840 D.*

Incorporation of Web application Sinumerik 840D to the E-learning education in ŽU Žilina

The University of Žilina has the centralised information system for aid of e-Education: E-learning – admittance into LMS (MOODLE). In this e-Education system the teacher can create or actuate his/her courses for the subjects that he/she is teaching. The student has admittance only to the subjects which he/she is studying [2]. Input in the LMS MOODLE is possible through the university Web site “http://www.uniza.sk/”. DAPS is in process of preparing and implementing such e-content for E-learning form of study in several areas. For example, for the area of programming NC machines there were prepared and placed e-materials for teaching the course "Programming of manufacturing machines and robots" (Programovanie výrobných strojov a robotov). The course contains a weekly overview of teaching activities according to its curriculum. In the course there are one week tutorials with lessons from the course curriculum. The communication between the teacher (tutor) and student is done on electronic platform. Similarly text documents of lessons (in pdf., doc.,pps.,or xls. format), link to the Web application (Fig. 5), testing, study records and other communication in the course can be carried out on electronic base [4].

The screenshot displays the Moodle course page for 'Programovanie výrobných strojov a robotov'. The interface includes a top navigation bar with the course title and user information. On the left, there is a calendar for March 2013 and a list of key events. The main content area shows a weekly overview for the week of September 21st to 27th, listing activities such as 'Fórum novínok', 'Podklady na cvičenia - skriptá v elektronickej podobe', 'EMCO F1CNC', 'EMCO 5CNC', 'Sinumerik.840D', and 'Web aplikácia Sinumerik 840D'. A red circle labeled '1' highlights the course title 'e-Learning ŽU PVS R11ng.' and another red circle labeled '2' highlights the link 'Web aplikácia Sinumerik 840D'.

Fig. 5. Example of E-learning education University of Žilina: 1 – page of the course PVS R; 2 – link of the Web application Sinumerik 840D

Conclusion

Improvement of the quality of education at technical universities presently requires, except laboratories equipped with the latest technology and machinery, also the implementation of advanced technologies in the educational process. Use of E-learning and Web applications in the process of teaching technical subjects opens up new possibilities for the creation of specialized training courses and controlled access for students.

From the analyses of E-learning it can be concluded that success of E-learning depends heavily on the approach of a student to the educational process [5]. All other factors are secondary; educational processes where the student is not considered to be the most important element cannot be successful. It

is necessary to realize that educating is both an individual and societal process. Implementation of E-learning does not end-up in creating a suitable technological platform but it is only beginning of the process.

A new approach to E-learning requires definition of a solid methodological process driven by the desired objectives and focused on the education recipient – student.

The teaching aids and software applications mentioned in this article are intended for teaching at the department and appear to be very effective tools in the field of NC machines programming education.

Developed web applications and their utilization bring to students and teachers the following advantages:

- effective support in education of the object from the area of CNC machine programming and process plan creation,
- relative time-saving of the education process – wider area for the student practical tasks solving,
- improving of the educational process,
- individual education aids for other cooperating university workplaces in Slovak and Czech Republic, or Poland (TU Zvolen, MTF Trnava, UJEP -Ústi nad Labem, TU Poznan, TU Cracow).

Another advantage of utilization of this web application is that students will be able to use control system Sinumerik 840D for solving their theses (Bachelor's and Master's thesis), that extends them further opportunities to gain practical skills in the applications of the control system which can be used in their future employment.

In making these works the students generally solve a specific problem or task (the real workpiece from production) directly from production companies. The students will be able to demonstrate their skills also to their potential employers, dealing with something real, not just a theoretical task [3].

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