Design, Implementation, and Assessment of WebCT-based CNC

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Abstract

In the 21st century, the Internet has become the dominant distribution system for distance education and training. Many faculty members are expanding their traditional delivery methods (lecture, laboratory, face-to-face discussion) to include educational options ranging from web-based course supplement to the complete delivery of courses online. The choices that faculty may consider range from simply posting a syllabus to creating web-based content to enhance classroom instruction to full online delivery.

While the primary focus of web-based delivery has been in the development of standalone web-based distance education courses, more faculty are beginning to use the web to supplement and enhance classroom instruction, creating “hybrid courses.”

The authors have chosen to supplement a traditional face-to-face on-campus CNC (Computer Numerical Control) course with an online component. WebCT-based CNC materials were developed in Spring 2002 and started being implemented in Fall 2002. The materials are currently used in a junior level, MIT3060 (Manufacturing and Industrial Technology 3060), ‘CNC Machining Practices’ course. The following modules are currently available in the WebCT system.

• Course Syllabus and Information
• Lecture materials, supplements, and extra study materials
• Calendar and Tips
• Tests, labs, practice quizzes, and homework
• CNC Glossary
• Discussions, Chat, and E-mail
• Grade Book
This paper reports the step-by-step development of the WebCT materials for this course, their current implementation (lecture, lab, discussion, and examination) in Fall 2002, and a student assessment of their value.

I. CNC Technology

CNC (Computer Numerical Control) is the process of manufacturing machined parts. Numerical Control (NC) is the original name given to this technology and is still often used interchangeably with CNC. CNC technology has been one of manufacturing's major developments in the past fifty years. It not only resulted in the development of new manufacturing techniques and the achievement of higher production levels, but it also helped increase product quality and stabilized manufacturing costs.

One of the biggest problems faced in learning CNC technology (and specifically CNC programming) is finding time for the hands-on training required to effectively and consistently use a CNC program and its associated machine tool. However, using the simulation software allows students, engineers, and technicians to perform virtual machining runs of all CNC programs in a simulated manufacturing environment. Figure 1 shows a CNCeze 2.0 turning simulation practice used in CNC Machining Practices course.

![Figure 1: The CNCeze 2.0 Turning Simulator and a Virtual Machining Practice](image-url)
II. CNC Course Background

Students at Tennessee Tech have an opportunity to learn an automated system of machining in their junior year via the ‘MIT3060-CNC Machining Practices’ course. In MIT3060, students learn basic concepts of CNC, including the code for machine programming. They are able to use their programs to simulate milling or turning a piece using the CNC Simulator softwares available in the computer labs. If the simulation is a success, the students can then take the program to the CNC lab and load it into a mill or lathe to produce an actual part.

As it can be seen in Figure 2 MIT3060 is one of the eleven required core courses in the MIT department. The objective of this course is to teach CNC programming.

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*Business Elective: BMGT 3630, BMGT 4520, DS 3620, DS 3540, ECON 2020, LAW3810.
**MIT Electives: MIT 2640, 2650, 3010, 3080, 3140, 3220, 3400, 3560, 4010, 4060, 4070, 4200, 4210, 4300, 4400, 4430, 4500, 4990.

Figure 2: MIT 3060 is one of the required core courses in MIT Curriculum

Starting Fall 2000, the course curriculum was enhanced with a multimedia-aided CBT (Computer Based Training) software and CNCez, which is a Java based simulation software. In Spring 2002, a complete WebCT supplement was developed for the course and starting Fall 2002, the entire course has been delivered through WebCT. Throughout the Fall 2002 semester, nothing has been committed to paper. The syllabus, handouts, course chapters, tests, pop-quizzes, homeworks, lab assignments, lab reports, and presentations have been delivered via WebCT.

III. What is WebCT?

WebCT (Web Course Tools) was developed at the University of British Columbia, in Canada, and is an environment for developing and delivering web-based educational activities and materials. It permits instructors to make tests, discussions, lecture materials, and sample solutions available via the web. Some course work such as homework, lab reports, and team
projects, can also be submitted and controlled via WebCT. Figure 3 presents the main web page to access WebCT materials developed for MIT3060 course. It is a requirement to have a Tennessee Tech University WebCT access code to reach this link.²

Figure 3: Main web page to access WebCT materials for MIT3060 course

IV. WebCT Development for MIT3060-CNC Machining Practices

The MIT3060 CNC Machining Practices course WebCT site is based on the text CNC Workshop: A Multimedia Introduction to Computer Numerical Control by Nanfara, Uccello, and Murphy. The homepage has twelve major links, and is pictured in Figure 4. The twelve links are:

- Syllabus
- Course Chapters
- HWs/Projects/PQs/Exams
- CNC Glossary
- Content Study Tools
- Softwares & Downloads
- Support Materials
- Information
- Calendar
- Communication Tools
- Gradebook

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• Student Tools

Figure 4: Twelve major WebCT Links created for MIT3060

Each link is described below.

a. Syllabus

The syllabus link connects student to a full syllabus for the course. The WebCT syllabus clearly states that nothing is committed to paper as can be seen in Figure 5. Paper copies of the syllabus have not been provided in Fall 2002.

b. Course Chapters

The “Course Chapters” link allows students to access to a variety of course related materials. This web page is shown in Figure 6. The coverage of each chapter is given below.

• Chapters 1 through 3 discuss the basic concepts of CNC, including its theoretical and applied aspects.
• Chapter 4 introduces students to the interface of the TORCOMP CNCez 2.0 Java Edition simulation software programs.
• Chapters 5 and 6 begin teaching students to program and run simulations. Chapter 5 describes milling and Chapter 6 covers turning, the two most important and most common uses for CNC programming. Each chapter concludes with many step-by-step tutorials to help students develop programming skills.
• Chapter 7 describes the basics of computer-aided design and computer-aided manufacturing with simple examples of creating part geometry and generating CNC code.
• Chapter 8 provides additional exercises, including questions to answer and new advanced simulations to program.

Figure 5: Cover page of the MIT3060 Syllabus

Figure 6: Eight Course Chapters available in WebCT

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c. Quizzes and Surveys

The “Quizzes and Surveys” tool in WebCT lets students take online tests and evaluations. Students can take timed online quizzes and surveys in class for a limited time period on a given day. A clock on the quiz page counts down the number of minutes assigned to the quiz once the student has begun. Students can also submit assignments and lab reports online using the assignment drop-box tool. The instructor can then grade and give feedback on these assignments and reports. Once completed and marked, the grade is made available to the student along with the instructor’s comments. Some WebCT quizzes prepared for MIT3060 are shown in Figure 7.

The Survey feature is nearly identical to the Quiz feature, except that the Survey feature is used primarily to obtain student feedback on WebCT-based CNC course.

The results of the MIT3060 survey in Fall2002 revealed that students found the WebCT-based CNC ‘very good’ overall.

d. CNC Glossary

The “Glossary” link lets students become familiar with standard CNC terminology. Students can search for definitions of CNC terms and keywords used in the course. Presently, it has 390 definitions. Most of the programming functions and terms related to turning and milling processes are available. Students found the CNC Glossary pretty versatile and handy.

Figure 8 shows the WebCT Glossary created for MIT3060. The search result of “PRZ” is given as an example.
Figure 8: CNC Glossary created in WebCT for MIT3060

e. Content Study Tools

A number of extra reading and study tools and solutions are available through this link. Some examples of the materials available are solutions to CNC lab practices, extra readings on programming, motion types, coordinate systems, and machine labeling. Sample spindle speed and feed rate calculations were also included.

Figure 9 presents the table of contents in Content Study Tools.

f. Software and Downloads

It is important that the user be able to open and read a variety of file formats (e.g. pdf, ppt, doc, etc). To help student’s view most CNC related documents, a number of helpful software and downloads is provided in this section, as can be seen in Figure 10.
Figure 10: Software and Downloads available in WebCT-based CNC

g. Support Materials

Many course related materials were included in this section. The materials currently available are shown below.

Figure 11: Support Materials created for WebCT-based CNC

h. Information

Generic information related to MIT3060 was added into this section, i.e. Tennessee Tech University, Course Instructor, Department, CNC, and Manufacturing Engineering. Figure 12 shows the information links, which are important for the MIT3060 students.
Figure 12: Information Links in WebCT-based CNC

i. Calendar

The “Course Calendar” feature lets the instructor maintain a course calendar that students can access at any time. All upcoming activities are placed in the calendar to remind students about important dates and events for the entire semester (i.e. lab schedule, report due dates, exam dates, etc.). Some examples are shown in Figure 13.

Placing this calendar information on the course WebCT site helped the students to be better prepared for course events and to plan ahead efficiently.

j. Communication Tools

The “Communication Tools” link lets students communicate with faculty and other students in the course using either synchronous (live) chat and whiteboard facilities or asynchronous (time-delayed) e-mail and discussion. Figure 14 shows the available communication tools in WebCT-based CNC course.

These features provide forums for faculty-student information exchange extending the traditional office hours into virtual space.

Discussion

The “Discussion” function lets students engage in online discussions with a small group of students, the whole class, the instructor or off-campus individuals and groups. Messages can include file attachments and web site references. Discussions can be searched for content, sender, date sent, and other search criteria.
Other than the entire class discussion group, specific discussion groups for the lab teams were also formed to increase the efficiency and communication of the labs. Figure 15 shows sample discussions from the Tennessee state map machining lab.

![Course Calendar in WebCT-based CNC](image1.png)

**Figure 13:** Course Calendar in WebCT-based CNC

![Communication Tools available in WebCT-based CNC](image2.png)

**Figure 14:** Communication Tools available in WebCT-based CNC
Electronic Mail

The electronic mail facility allows one-to-one message transfer among course participants. Messages can be searched by sender, content and date of sending. Sample e-mails can be seen in the following Figure.

**Figure 15:** Sample WebCT Discussions from ‘Tennessee state map machining lab’ group

**Figure 16:** Electronic Mail facility in WebCT-based CNC
Chat Rooms

The “Chat Room” feature lets students engage in online chat with course participants inside or outside the classroom. The chat tool can be used in conjunction with the Whiteboard tool to create small group drawings. Most of the chat rooms are exclusive to students in that course, but there is also one general chat room that allows communication among students in any course on the same WebCT server. Four of the chat rooms are accessible by the instructor, in case he or she wishes to peruse the exchanges taking place there. “Chat Room” feature is shown below.

The difference between the Chat and Discussion tools is that Chat requires the students to be online and remain online for a reply, Discussion allows students to post questions and logon at a later time to see the replies.

Whiteboard

The WebCT Whiteboard allows for real-time communication among course participants using a graphical drawing interface. A user draws on his whiteboard and all other users see what he or she has drawn. The instructor can allow whiteboards to be saved and reloaded. The Whiteboard tool can be used in conjunction with the Chat function.

A sample whiteboard is shown in Figure 18. This one was used when direct numerical control (DNC) was lectured.

Figure 17: Chat Rooms in WebCT-based CNC

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k. Gradebook

This tool allows the course students to see their grades and some grading statistics on-line. Gradebook has two features as can be seen in Figure 19.
My Grades

Each student can view his or her own scores as entered by the instructor. The student also has access to minimum, maximum and average scores for each course component (at the discretion of the instructor). Students also have access to the comments and grades for each on-line quiz written and marked by the course instructor. Sample marks are shown below.

![Grades posted in WebCT-based CNC](image)

My Progress

This tool is a quantitative visual indicator for the course students to see how much of the on-line activities they have completed in the semester. It is an interesting motivational tool for students. A sample ‘My Progress’ feature in WebCT-based CNC is shown below.

![Sample student profile in ‘My Progress’](image)
1. Student Tools

The “Student Tools” link has three elements for the MIT3060 students. They are Student Homepages, Student Tips, and Student Presentations as can be seen in Figure 22.

More versatile information on course students, and their presentations were placed in this link.

![Student Homepages](image1)

**Student Homepages**

Course students can create their own homepage for viewing by others in the same course. Students are provided with an authoring interface much like that of the course designer's. Students can add images, text, and links to their homepage without knowing html. The homepage can be called up from a number of locations, including the homepage listing, e-mail, the conferencing system, student management and student progress tracking. Figure 23 shows a list of students, who created their own homepages.

![MIT3060 students](image2)

**Figure 23: MIT3060 students who created their own homepages**
Student Tips

The instructor uses this tool to communicate with the students outside the classroom and at off-hours. Suggestions and hints for student homework, labs, and reports are given to students. Some of the important upcoming activities are also announced with Student Tips. Students use these tips and reminders in their labs, homeworks, and presentations. A sample tip is shown below.

![Student Tip Addition](image)

Figure 24: A Sample Tip in WebCT-based CNC

Student Presentations

Individual students or student groups can use the WebCT presentation tool to make in-class presentations. The course designer can give authoring privileges to a single student, a group of students, or to the entire class. Students with authoring privileges can upload pre-prepared web pages to their area for view by all course participants. This tool is useful for displaying course projects, student work, student newsletters and more. Figure 25 shows the student presentation groups in lab 2.

![Lab 2 student presentations in WebCT-based CNC](image)

Figure 25: Lab 2 student presentations in WebCT-based CNC

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V. Conclusion

WebCT has been extensively used in many engineering and technology courses and its advantages have been reported in numerous publications so far\textsuperscript{11-19}. On the other hand, currently there is no CNC course offered via WebCT as reported by WebCT\textsuperscript{20-21}. This pioneering development transforms the traditional CNC instruction into WebCT. In teaching the WebCT-based CNC course during the Fall semester 2002, WebCT created a convenient and versatile environment for the instructor and the students to interact. This new development effectively enhanced the instructor’s course delivery (IV-b, c, d, e, f, and g) and increased the students’ course comprehension (IV-c and e). Details about the various specific WebCT tools in MIT3060 and the manner in which these tools were utilized in delivering the course were included in this paper. In conclusion, some useful features of the WebCT-based CNC are outlined below:

- Helps the instructor to easily create a web environment through which he or she can effectively interact with the registered students.
- Helps practicing the cutting edge technological tools in classroom and labs makes students more technology conscious and up-to-date.
- Eliminates the amount of floppy disk, zip disk, and paper-based homework, test, pop-quiz, and report submissions.
- Helps students and instructors easily take care of missing lectures, labs, and make-up exams.
- Enables the students to access a wide variety of important course related documents whenever they need it.
- Enables the instructor to share course information with others easily.
- Allow students and instructor to be able to contact each other easily.
- Makes grading much easier. Paper-based submissions, floppy-disk/zip-disk compatibility issues faced before are eliminated. Electronic submissions allow instructor to be able to grade student works within a much shorter time frame. The graded work can then be archived and traced easily.
- Returns the scores to students more quickly and conveniently in a confidential way with statistics.

Bibliographic Information


20. http://www.webct.com/content/viewpage?name=content_showcase

Biographical Information

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Ismail Fidan is a faculty member at the MIT (Manufacturing and Industrial Technology) department of Tennessee Tech University, Cookeville, TN. He began his academic appointment in August 2000. Dr. Fidan received his PhD in Mechanical Engineering from Rensselaer Polytechnic Institute in 1996. He is a senior member of IEEE and SME, and member of ASEE, NAIT, ASME, TAS and SMTA. Dr. Fidan is the recipient of 2003 Tennessee Tech University Exemplary Course Project Award, 2003 SME Outstanding Young Manufacturing Engineer Award, 2002 Provost 'Utilization of Technology in Instruction' Award, 2002 Technology Award by The
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Lauren L. Neal is a member of the Academic Computing Support staff in Information Technology Services at Tennessee Tech University, Cookeville, TN. She earned her bachelor's degree in business administration with an emphasis in management information systems in 1998. Ms. Neal works in the Institute for Technological Scholarship for training and supporting faculty with using Instructional Technology in their instruction. She is the recipient of Tennessee Board of Regents Innovation Award, Regents On-Line Degree Program Trailblazer Award, Tennessee Tech’s Outstanding Professional Award, and RODP Certificate of Achievement.

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R. J. Clougherty, Jr. is the Director of the Institute for Technological Scholarship and Director of the Web Design Program as well as an Associate Professor of English at Tennessee Tech University. He is the recipient of numerous teaching and distance education awards for his online teaching, and is a WebCT Certified Trainer. Dr. Clougherty received a PhD in Modern Letter from the University of Tulsa in 1991; he has been a Fulbright Hayes Scholar at the University of Uppsala, Sweden, and his work, both scholarly and creative, has been translated into four languages.