

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 parts¹. 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 costs²⁻³.

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 environment⁴. Figure 1 shows a CNCez 2.0⁵ turning simulation practice used in CNC Machining Practices course.

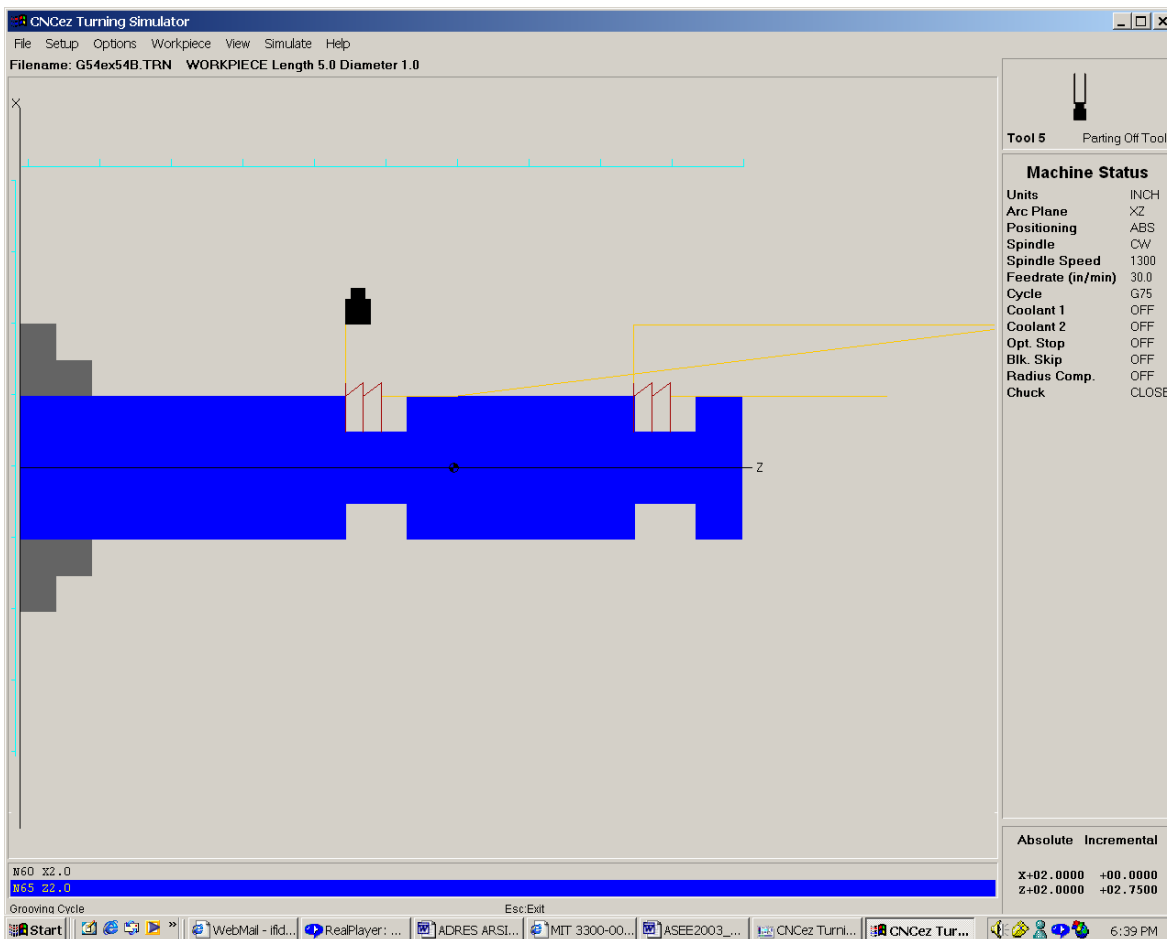


Figure 1: The CNCez 2.0 Turning Simulator and a Virtual Machining Practice

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 courses⁶⁻⁷ in the MIT department⁸. The objective of this course is to teach CNC programming.

Junior Year	sem. hrs.	sem. hrs.	Senior Year	sem. hrs.	sem. hrs.
BMGT 3510	0	3	ACCT 3520, 3530	2	2
DS 3520	0	3	*Business Elective	3	0
ECON 3610	3	0	Humanities Elective.	0	3
MIT 3200	0	3	MIT 3730	0	2
MIT 3700	2	0	MIT 4310	0	3
MIT 3710	2	0	Electives	3	3
MIT 3060	3	0	MIT 4610	1	0
MIT 3130	3	0	MIT 4620	0	3
MIT 3300	0	3	**MIT Elective	3	0
MIT 3460	0	3	PSY 3400	3	0
ME 3110	3	0			
Total	16	15	Total	15	16

***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 link⁹.

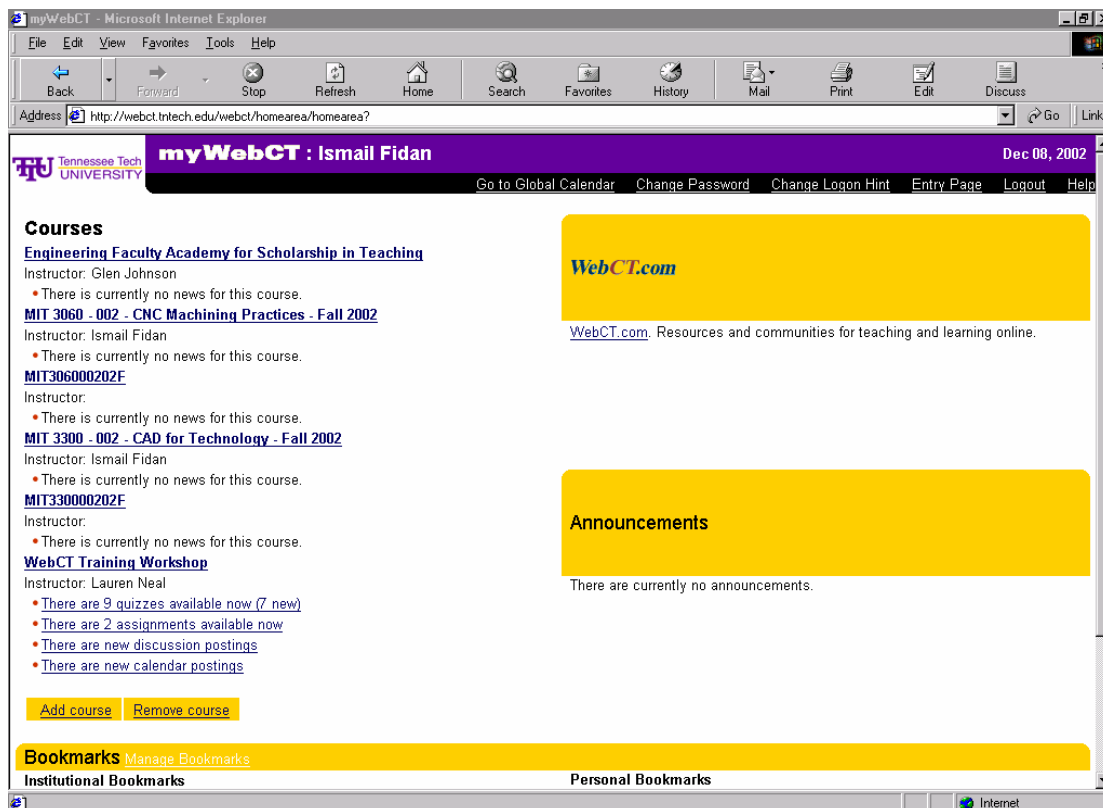


Figure 3: Main web page to access WebCT materials for MIT3060 course

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 Murphy⁴. 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

- Student Tools

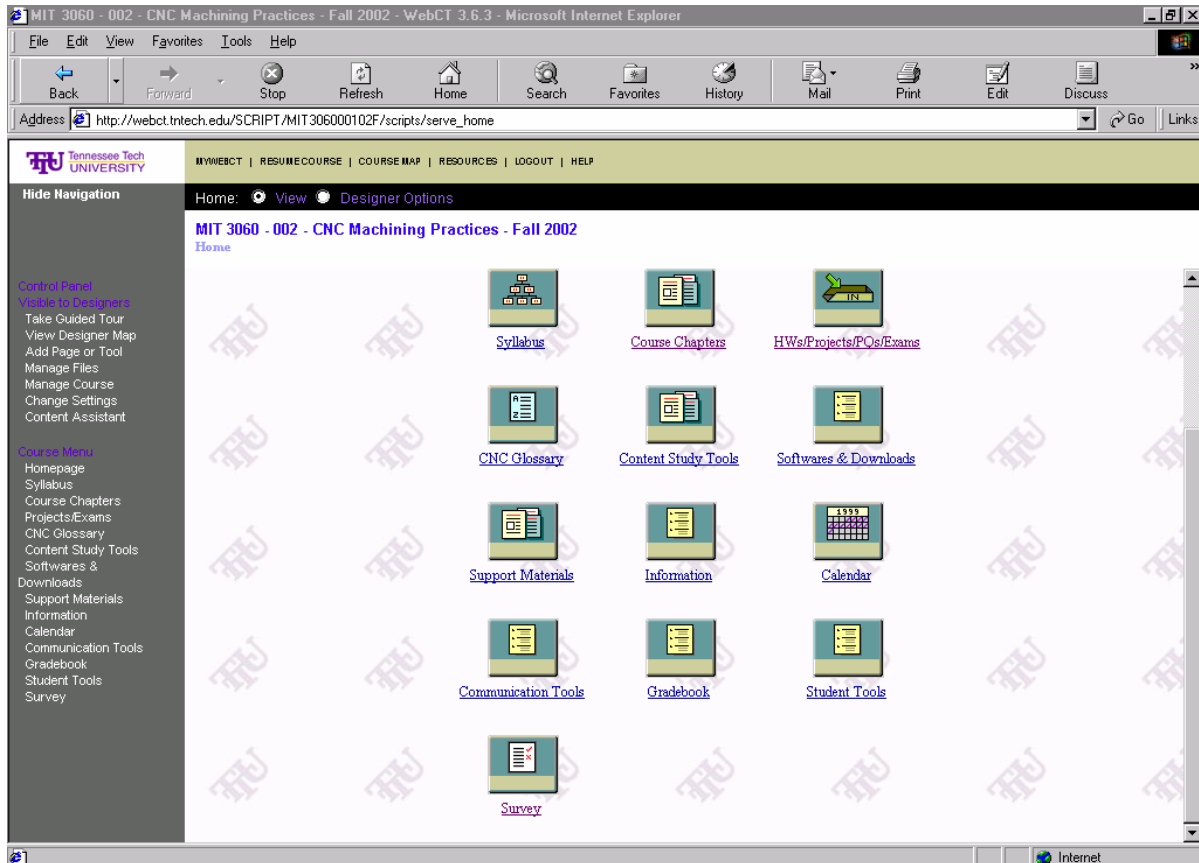


Figure 4: Twelve major WebCT Links created for MIT3060

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 programs⁵.
- 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.

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- 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.

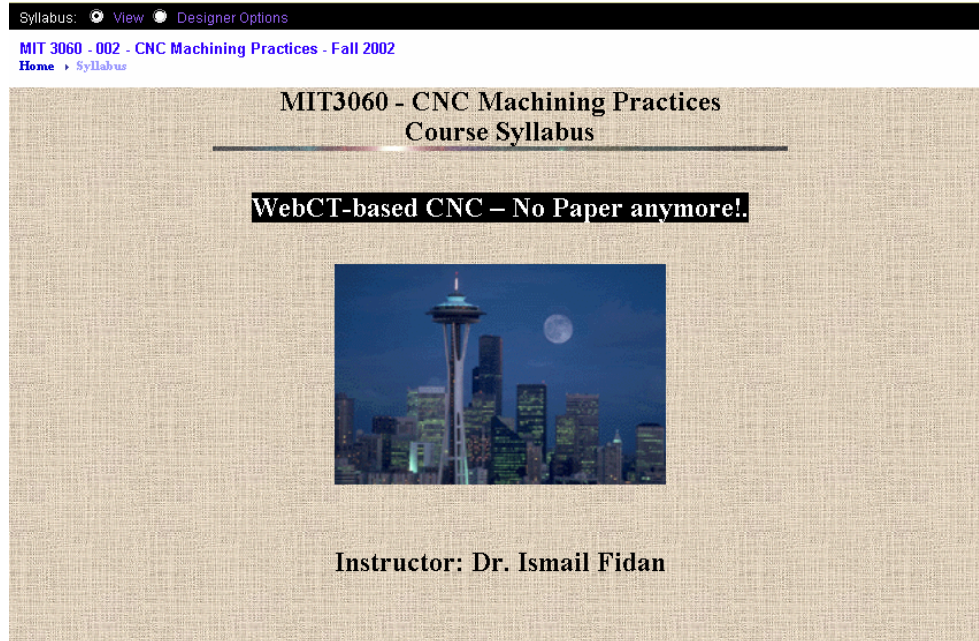


Figure 5: Cover page of the MIT3060 Syllabus



Figure 6: Eight Course Chapters available in WebCT

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.

MYWEBCT | RESUME COURSE | COURSE MAP | RESOURCES | LOGOUT | HELP

HWs/Projects/PQs/Exams: View Designer Options

MIT 3060 - 002 - CNC Machining Practices - Fall 2002
Home > HWs/Projects/PQs/Exams

Assignments
To view and grade assignments completed by your students, click Submissions below.

Current date: Dec 09, 2002 00:14

Title	Availability	Grade Results
<input type="radio"/> HW1	From: Aug 27, 2002 15:00 To: Sep 03, 2002 16:00	/ 100 [Submissions]
<input type="radio"/> HW2	From: Sep 03, 2002 12:00 To: Sep 10, 2002 16:00	/ 100 [Submissions]
<input type="radio"/> Test 1	From: Sep 12, 2002 15:05 To: Sep 12, 2002 17:30	/ 100 [Submissions]
<input type="radio"/> Test 2	From: Oct 17, 2002 15:05 To: Oct 17, 2002 20:00	/ 100 [Submissions]
<input type="radio"/> PO1	From: Sep 10, 2002 16:00 To: Sep 10, 2002 18:00	/ 100 [Submissions]
<input type="radio"/> PO2	From: Oct 31, 2002 15:30 To: Oct 31, 2002 16:55	/ 100 [Submissions]
<input type="radio"/> Lab 1	From: Aug 29, 2002 15:00 To: Sep 05, 2002 18:00	/ 100 [Submissions]
<input type="radio"/> Lab 2	From: Sep 05, 2002 15:00 To: Sep 12, 2002 15:00	/ 100 [Submissions]

Assignment Options
To delete an assignment, select an assignment on the left, select Delete, and click Go.
 Add
 Delete

Reorganize Assignments
Select an assignment on the left, select an action below, and click Go.
 Move item up by
 Move item down by

Figure 7: WebCT quizzes prepared for MIT3060

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’ overall¹⁰.

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.

MYWEBCT | RESUME COURSE | COURSE MAP | RESOURCES | LOGOUT | HELP

CNC Glossary: View Designer Options

MIT 3060 - 002 - CNC Machining Practices - Fall 2002
[Home](#) > [CNC Glossary](#)

Glossary
[View All](#) | [Search](#)
[A](#) - [B](#) - [C](#) - [D](#) - [E](#) - [F](#) - [G](#) - [H](#) - [I](#) - [J](#) - [K](#) - [L](#) - [M](#)
[N](#) - [O](#) - [P](#) - [Q](#) - [R](#) - [S](#) - [T](#) - [U](#) - [V](#) - [W](#) - [X](#) - [Y](#) - [Z](#)
 Others

Search Results: "PRZ"	
PRZ	Part Reference Zero

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.

MYWEBCT | RESUME COURSE | COURSE MAP | RESOURCES | LOGOUT | HELP

Content Study Tools: View Designer Options

MIT 3060 - 002 - CNC Machining Practices - Fall 2002
[Home](#) > [Content Study Tools](#)

Table of Contents

- [1. Recitation Documents](#)
- [2. Feed Rate and Spindle Speed Calculation](#)
- [3. Lab Exercise Solutions](#)

Hit Counter **00050**

Figure 9: Content Study Tools for WebCT-based CNC course

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.

MIT 3060 - 002 - CNC Machining Practices - Fall 2002

[Home](#) > [Softwares & Downloads](#)

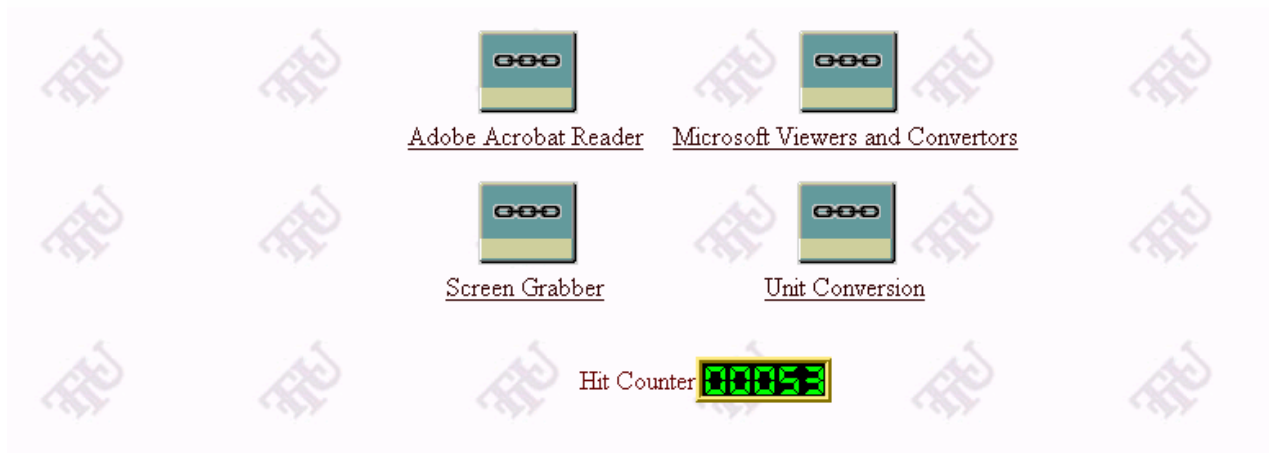


Figure 10: Software and Downloads available in WebCT-based CNC

g. Support Materials

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

MIT 3060 - 002 - CNC Machining Practices - Fall 2002

[Home](#) > [Support Materials](#)

Table of Contents

1. [CNC Gallery](#)
2. [Sample Old CNC Projects](#)
3. [Process Planning Form](#)
4. [Setup Sheet](#)
5. [Guidelines for Effective Presentations](#)
6. [TTU Logos and Pictures](#)
7. [Access to MasterCAM](#)
8. [Access to CNCez](#)
9. [WebCT Support Links](#)
10. [CNCez Support](#)
11. [The CNC Workshop Frequently Asked Questions List](#)
12. [CNC WorkShop JAVA VM, and CNCez Classes Update Installation](#)
13. [How to get a CNC Workshop](#)
14. [Milling and Turning G&M Functions](#)



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.

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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.

Calendar: View Designer Options

MIT 3060 - 002 - CNC Machining Practices - Fall 2002
[Home](#) > [Calendar](#)

To compile a list of entries, click [Compile](#).

[Previous Month](#) [Next Month](#)

To view, add, or edit the daily schedule, click a hyperlinked date below.
Note: All private entries are italicized.

	Sun	Mon	Tue	Wed	Thu	Fri	Sat
View Week			1 - Move G & M Codes	2	3 - TN State Map Machining	4	5
View Week	6	7	8 - Milling Lab	9	10 - Deep Hole Drilling Lab	11	12
View Week	13	14	15 - Fall Break-No Class	16	17 - Test II	18	19
View Week	20	21	22 - We will meet at 4:45PM today - Submit your Final Project Proposals today - Start Turning	23	24 - Reports due via WebCT.	25	26
View Week	27	28	29 - New Chapter: CNC Turning	30	31 - Move Turning - Milling - Reports - Halloween!!!!!!!!!!!!		

Figure 13: Course Calendar in WebCT-based CNC

Communication Tools: View Designer Options

MIT 3060 - 002 - CNC Machining Practices - Fall 2002
[Home](#) > [Communication Tools](#)



[Discussions](#)



[Chat](#)



[Mail](#)



[Whiteboard](#)

Hit Counter 

Figure 14: Communication Tools available in WebCT-based CNC

MIT 3060 - 002 - CNC Machining Practices - Fall 2002

Home > Communication Tools > Discussions > Winter



Discussion Messages: Winter / [Manage Messages](#)

Return to [Discussions](#)

Compose Discussion Message

Search Mark All As Read Update Listing

Select topic: Winter Show all / [Show unread](#) [Threaded](#) / Unthreaded

Select all Select none Apply to selected message(s) below Compile Go

Subject	Author	Date	Status	Attachment
<input type="checkbox"/> 15. Dlscuss you TN Map Machining Project	Ismail Fidan (MIT306000102F)	Tue Oct 08, 2002 13:51		
<input type="checkbox"/> 17. Re: Dlscuss you TN Map Machining Project	Justin Lingerfelt (jll6862)	Tue Oct 08, 2002 15:55		
<input type="checkbox"/> 18. Re: Dlscuss you TN Map Machining Project	Michael Livesay (mhl4983)	Wed Oct 09, 2002 18:46		

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

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.

Mail: View

MIT 3060 - 002 - CNC Machining Practices - Fall 2002

Home > Communication Tools > Mail > Inbox

<input type="checkbox"/> 76. Your Previous Experiences	Luke Ash (la8463)	Tue Aug 27, 2002 13:27	
<input type="checkbox"/> 78. SME	Justin Lingerfelt (jll6862)	Thu Aug 29, 2002 14:45	
<input type="checkbox"/> 79. Your Previous Experiences	Michael Livesay (mhl4983)	Thu Aug 29, 2002 18:11	
<input type="checkbox"/> 97. Missed Thursdays Class.	Michael Livesay (mhl4983)	Thu Sep 05, 2002 16:14	
<input type="checkbox"/> 99. Trouble with software disc.	Michael Livesay (mhl4983)	Mon Sep 16, 2002 14:02	
<input type="checkbox"/> 102. Software problem	Michael Livesay (mhl4983)	Tue Sep 17, 2002 11:09	
<input type="checkbox"/> 104. What do you think about Section I (Very first three chapters)?!	Michael Livesay (mhl4983)	Tue Sep 17, 2002 15:48	
<input type="checkbox"/> 105. Need calculus help	Michael Livesay (mhl4983)	Tue Sep 24, 2002 11:48	
<input type="checkbox"/> 106. Late for class	Michael Livesay (mhl4983)	Tue Sep 24, 2002 15:50	
<input type="checkbox"/> 107. requesting your help.	Michael Livesay (mhl4983)	Wed Sep 25, 2002 21:06	
<input type="checkbox"/> 109. homework 3 questions	Michael Livesay (mhl4983)	Mon Oct 07, 2002 13:41	
<input type="checkbox"/> 111. HMWK 3 submission	Katherin Bullard (kdb6257)	Tue Oct 08, 2002 11:16	
<input type="checkbox"/> 112. I will be absent 10-10-02	Brian Clemenshaw (bsc4093)	Tue Oct 08, 2002 16:40	
<input type="checkbox"/> 113. Jury Duty	Michael Livesay (mhl4983)	Tue Oct 08, 2002 20:43	
<input type="checkbox"/> 115. Need to makeup exam 2	Michael Livesay (mhl4983)	Mon Oct 21, 2002 11:23	
<input type="checkbox"/> 117. CNC Project Proposal	Brad Connelly (btc4389)	Tue Oct 22, 2002 13:57	
<input type="checkbox"/> 118. Prject proposal	Michael Garcia (mdg4013)	Tue Oct 22, 2002 16:33	
<input type="checkbox"/> 119. class proposal	Luke Ash (la8463)	Tue Oct 22, 2002 16:40	
<input type="checkbox"/> 120. CNC project	Matthew Waycaster (mpw4727)	Tue Oct 22, 2002 16:49	

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.



Figure 17: Chat Rooms in WebCT-based CNC

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.

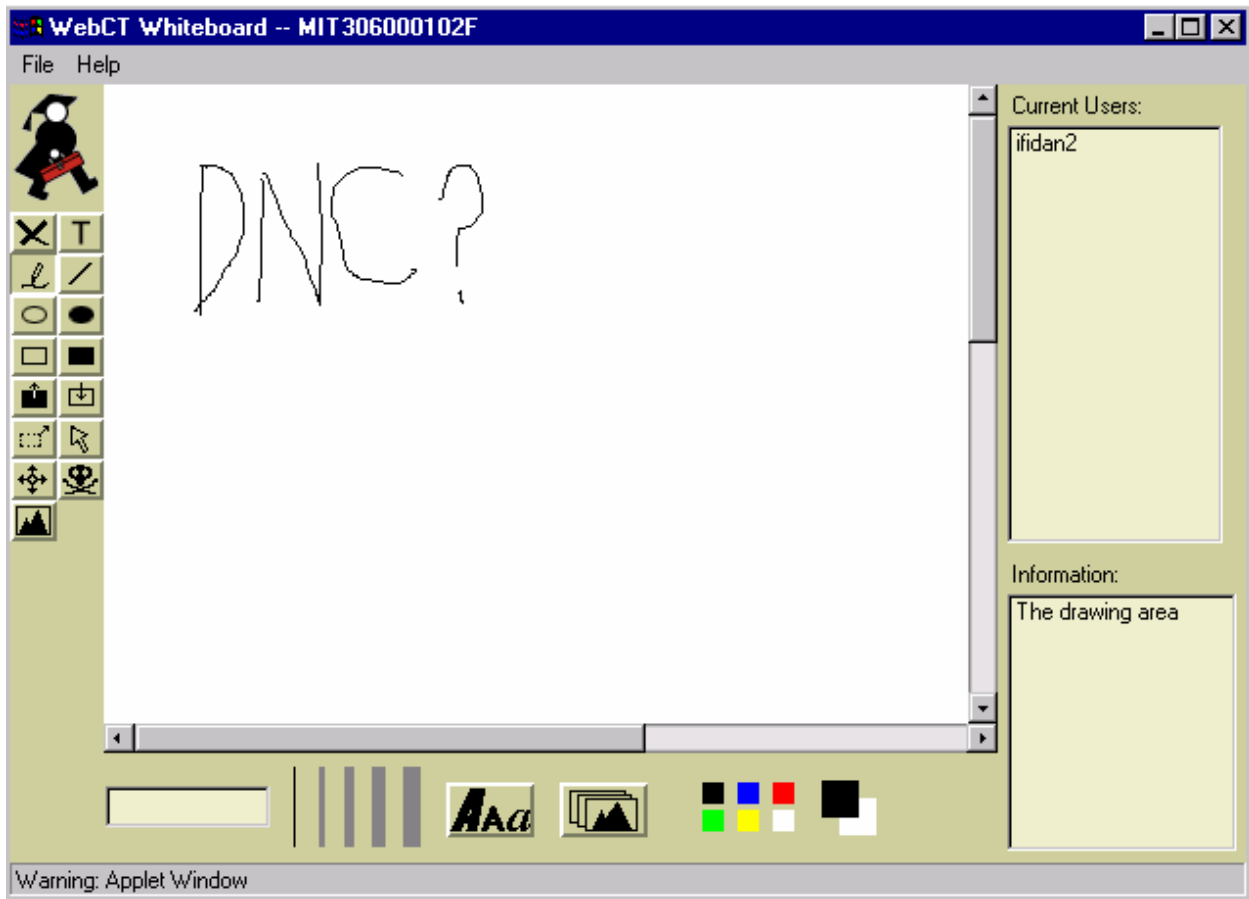


Figure 18: Whiteboard feature in WebCT-based CNC

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.



Figure 19: Gradebook features in WebCT-based CNC

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.

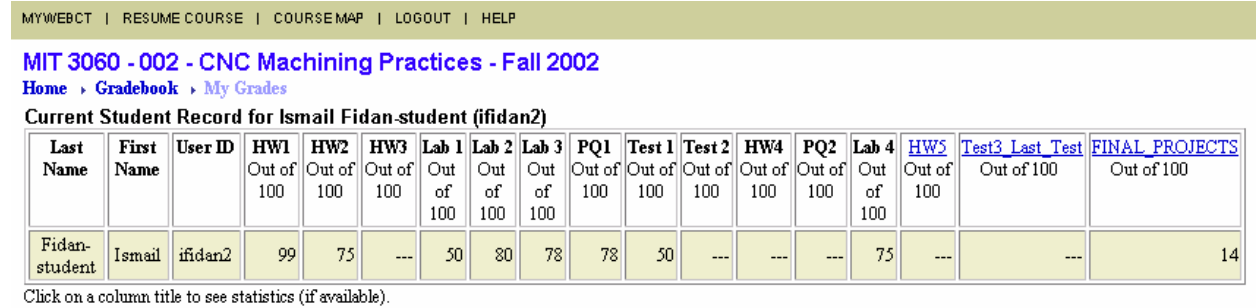


Figure 20: Grades posted in WebCT-based CNC

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.

MIT 3060 - 002 - CNC Machining Practices - Fall 2002

[Home](#) > [Gradebook](#) > [My Progress](#)

Student Profile

Full Name: [Ismail Fidan-student](#) User ID: [ifidan2](#)
 First login: [May 02, 2002 15:49](#) Last login: [Dec 09, 2002 00:47](#)
 Total number of accesses: [265](#) Last page visited: [Chapter 6: Turning](#)

[Show history of content pages visited](#)

Distribution of Visits for Ismail Fidan-student (ifidan2)

Page	Count	
Homepage	134	
Organizer Pages	93	
Content Pages	13	
Glossary	2	
Discussions	Count	
Articles Read	22	
Original Posts	1	

Number of Content Pages Visited by Ismail Fidan-student (ifidan2)

Number of different pages visited: [8](#)
 Total number of pages: [25](#)

Figure 21: Sample student profile in 'My Progress'

I. 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.



Figure 22: Student Tools link in WebCT-based CNC

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.

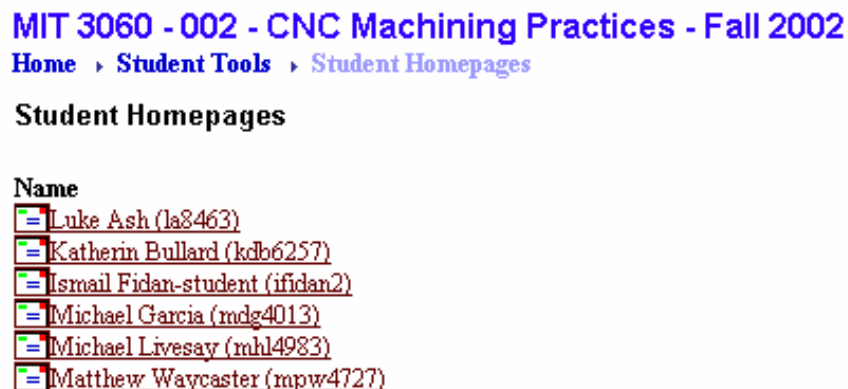


Figure 23: MIT3060 students who created their own homepages

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.

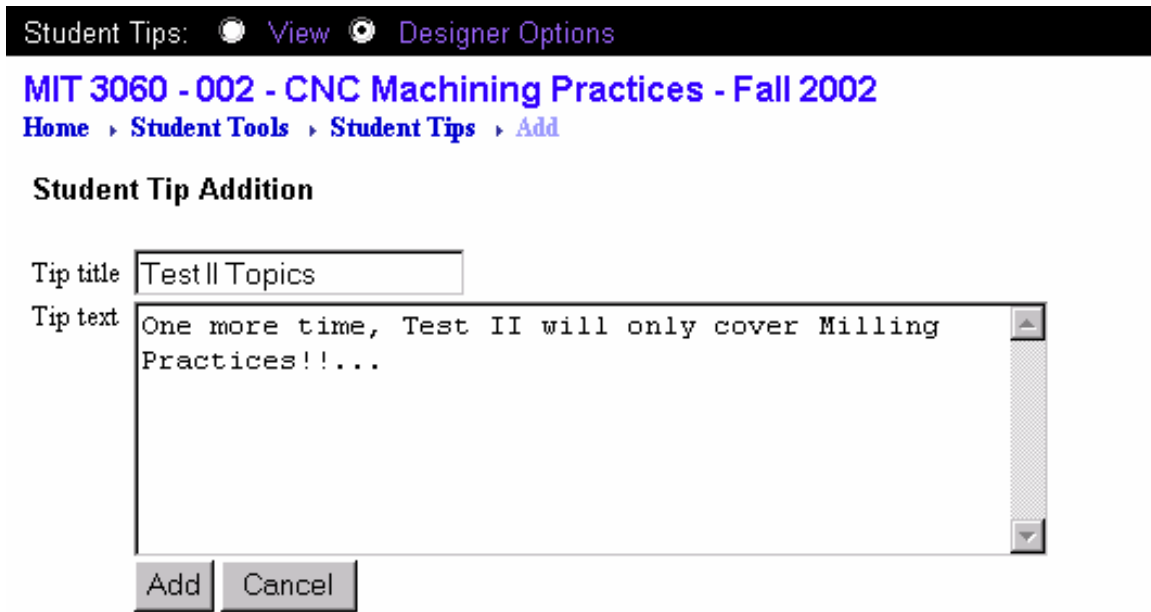


Figure 24: A Sample Tip in WebCT-based CNC

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.

[MIT 3060 - 002 - CNC Machining Practices - Fall 2002](#)
[Home](#) > [Student Tools](#) > [Student Presentations](#)

Student Presentations

To view a project, click its linked title in the Project column. (If the title is not linked, the presentation is not yet in place.) If the Group column contains links, click a group name to view the members of the group. To import files to your presentation, click Edit Files.

Note: Please remember to name your first page index.html.

Mail	Group	Project
	Earth	You are Group 1
	Fall [Edit Files]	This is a group for CNC Lab.
	Space	You are Group 2
	Winter [Edit Files]	This is a CNC Lab Group.

Group Members

Winter: [Brent Hickman \(bwh5500\)](#), [Christopher Lindner \(cll8368\)](#), [Eric Schuler \(eks1733\)](#), [Ismail Fidan-student \(ifidan2\)](#), [Jonathan Hobbs \(jdh1710\)](#), [Jessica Ward \(jhw4216\)](#), [Justin Lingerfelt \(jll6862\)](#), [Michael Livesay \(mhl4983\)](#), [Matthew Waycaster \(mpw4727\)](#)

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

V. Conclusion

WebCT has been extensively used in many engineering and technology courses and its advantages have been reported in numerous publications so far¹¹⁻¹⁹. On the other hand, currently there is no CNC course offered via WebCT as reported by WebCT²⁰⁻²¹. 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

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