

Some New Techniques in Teaching Computer-Assisted Drafting/Design (CADD)

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Abstract

In our Engineering Technology program, we teach three courses in CADD covering 2-D concepts and solid modeling. AutoCAD and Mechanical Desktop (MDT) are the primary CAD software that we use in our instruction. We want to provide our students with experience in the practical applications of CADD. Dr. Sridhara assisted a local non-profit organization that was landscaping an adult care center and needed help in drawing the layout. A group of eight students from the CADD I class visited the 50-acre campus, took measurements, worked with the organizers, prepared the layout and received credit in their course. Several other students learned their first lesson in Computer-Integrated Manufacturing (CIM). They sent the drawing files via the Internet to the department's laser engraving machine and created two-dimensional objects which were assembled to create three-dimensional models. In the CADD II class, students created solid models using MDT 5.0, sent the drawing file via the Internet to a local industry. Dr. Sridhara and the students visited the industry where they worked with the manager and technicians and converted the drawing files into SurfCAM files. These files were sent to a CNC machine and the parts were machined. This was a very good experience for the students to learn about CIM in an industrial setting. Students also learned the basics of CIM by sending the MDT files electronically to the department's rapid prototyping machine and producing physical models. Besides AutoCAD and MDT, Dr. Sridhara also teaches other solid modeling software such as Pro-Engineer and SolidWorks in CADD II and Advanced CAD classes. Students will do at least one project using these software. A group of students worked with a local industry that manufactures kitchen equipment for hospitals and restaurants and designed some parts using SolidWorks. They visited the industry several times and learned about design and fabrication of sheet metal parts. Dr. Sridhara worked with graduate students who take advanced CADD courses and developed lesson plans for Pro-Engineer and MDT for use in the undergraduate classes.

I. Introduction

In the Engineering Technology and Industrial Studies Department (ET&IS) at Middle Tennessee State University (MTSU) we offer four CADD courses. CADD I (ET 2310) deals with two-dimensional concepts including drawing orthographic views, house plans and plant layouts. Solid modeling is taught in CADD II (ET 3360) and Architectural concepts are taught in Architectural CADD (CM 3320). In Advanced CAD (ET 4330), students learn advanced topics including programming in AutoLISP and using different solid modeling software. Both CADD II and Advanced CAD courses have 500-level graduate components. Also, we have a 600-level graduate course, Advanced Technical Drafting (ETIS 6230) in which graduate students work on independent projects. All of our undergraduate students except the Computer Engineering Technology majors are required to take CADD I. Elector-Mechanical and Manufacturing majors are required to take CADD II, Architectural CADD is required for Construction majors, and Advanced CAD is open to all students.

In the department, we have Basic and Advanced CADD labs with twenty-five and sixteen workstations, respectively. There is a master workstation in each CADD lab and the Internet access is provided for all computers. Both labs have inkjet printers that can produce A-E size prints. The printers are also networked so that the students can send print files from their workstations. We have site license for eight different AutoDesk CAD software including AutoCAD, Mechanical Desktop (MDT), Inventor and Architectural Desktop. Currently, we are using AutoCAD 2002 and MDT 6.0 in CADD I and CADD II. The Inventor, MDT, ProEngineer and SolidWorks are used in the Advanced CAD and graduate courses. Dr. Sridhara used a few relatively new techniques to teach CADD at MTSU in an effort to make learning more interesting to the students.

II. New Techniques in Teaching CADD

Web-Enhanced Instruction

Web-based and web-enhanced instruction is a powerful tool in Engineering Education and the advancement of the Internet technology has contributed greatly to its success^{1,2} Dr. Sridhara attended a workshop³ on Blackboard.com, a web site for course development and instruction, in the Fall of 1999. In the spring of 2000, MTSU obtained a site license from Blackboard.com⁴ and developed CourseInfo⁵ on our server for the use of faculty and students. Dr. Sridhara attended an on-campus workshop⁴ about CourseInfo and learned several new tools and techniques. Courseinfo offered many new features including unlimited disk space and easy access to the course from MTSU's home page at <http://www.mtsu.edu>. Students at MTSU are given an e-mail account as soon as they are enrolled. Instructor, students and guests (with some limitations) can access the Courseinfo login page from the home page. After login, they would be taken to *My Blackboard* page which displays the on-line courses that are offered by the instructor or taken by the student depending on the user. One can access a specific course site from here, for example, in our case it is either CADD I (ET 2310) or CADD II (ET 3360). The *Announcements* page for CADD II is shown in Fig. 1. Announcements are displayed automatically with the option of viewing all of them or those posted in the previous two weeks or four weeks. Links are provided

on the left side of this page to other sites such as *Course Information*, *Staff Information*, *Course Documents*, *Assignments*, *Communication*, *External Links*, and *Student Tools*. The *Control Panel* (Fig. 2) allows the course instructor to post/modify announcements, course material including syllabi and lab assignments, quizzes, and solution to test problems.

Many of the above mentioned sites have menus that can be accessed by all users. The instructor can access the class roster and optionally send e-mail messages to all students or selected individuals or groups. This task is made easy because the class roster is created automatically when the students enroll for the course. However, the instructor can modify the class roster using the Control Panel. Students can create their individual or group pages using the appropriate menus. They can use the *Discussion Board* to post their queries, comments and suggestions for each other or for the instructor. Students can drop their assignments (drawing files) and reports using the *Digital Drop Box* located under the Student Tools site. They can check their test or lab grades on this site and perform several other tasks. However, the instructor should make the grades available either immediately or after a certain date by setting appropriate options on the Control Panel. The instructor can access the Digital Drop Box (Fig. 3) using the Control Panel, grade the submitted material, and return files electronically with corrections, comments and/or grades.

A welcome statement with a note to look for new announcements regularly was posted under Announcements. Course syllabus was posted under Course Information providing a link to appropriate MS Word files. Creating and modifying announcements and folders, uploading files, and providing links were done using the Control Panel. In the first one or two classes, Dr. Sridhara gave a virtual tour of CourseInfo and briefly described how it would be utilized in the CADD courses. Students were helped with setting up their user name and password, and login and logout procedure. As the semester progressed, many new announcements were posted which included lab assignments, printing instructions, notes on dimensioning, test dates and time, and grade distributions. Announcements regarding guest lectures, design projects and industrial visit were also posted. Some of these announcements were modified to serve as reminders to students as the announcements are displayed chronologically. The instructor's office location, phone and fax numbers, and e-mail address were provided under Staff Information.

Folders were created for lab assignments under Assignments (Fig. 4) and links were provided to MS Word files. The *Send E-mail* and *Student Roster* tools under Communication were very useful. The author could send e-mail to all students with a click of a button reminding them of guest lectures or ensuing tests. Many of our majors work full time and attend classes only in the evenings and they found these reminders helpful. The instructor sent e-mail to individual students answering their questions on tests, assignments, sometimes providing missing data or correcting typographical errors. Several students checked their test grades online using the *Check Your Grades* tool. The *Online Gradebook* was used to post or modify grades by student or by item such as assignment or test. The spreadsheet on the other hand shows all entries and allows individual grades be entered and/or modified. It has a built-in feature that automatically adds each student's scores and also gives the class mean based on the total possible points. Optionally, the spreadsheet can be exported to MS Excel for further processing of the data. *Course Statistics* can be used to obtain feedback on how well the students have used the course

site. A report can be generated with the click of a button to view the overall course statistics, number of accesses over time, user accesses by hour of the day, user accesses by day of the week, and total accesses by user. The *User Management* tool permits the instructor to add, remove or modify users and it was used to add graduate students and remove those who dropped out after a few weeks.

Real World CADD Projects

A non-profit organization in Nashville, Tennessee contacted Dr. Sridhara about preparing CADD layouts for landscaping an adult care home. Eight students from the CADD I class worked with this organization and completed the project on time. In the process, the students made several trips to the home, worked with the manager and residents, took additional measurements and prepared layouts for planting trees on several acres around the home. The students received credit for their final project in the course. A local sheet metal manufacturing company that specializes in designing stainless kitchen equipment for hospitals and restaurants wanted some parts to be designed. The engineer in charge of the project was looking for potential students and some of our Advances CAD students undertook the task for their final project in the course. Our students got an opportunity to learn SolidWorks, a solid modeling software that was used at the company. They worked here in our CADD lab as well as at the company's design department. They had a chance to discuss the project with other engineers and technicians at the plant. It so happened that at a later stage the same company wanted to hire an engineer with experience in both Mechanical Desktop and SolidWorks. One of the students who worked on the project for the company got the job because of his advantage over other applicants.

Basics of Computer Integrated Manufacturing

We have a laser engraving machine in the department's machine shop. Students in the CADD I class (Spring, 2000) designed and drafted objects of geometrical shapes of their interest. The drawing files were sent electronically from the CADD lab to the laser engraving machine where they were converted to the appropriate format to produce the parts out of plastic sheets using a 0.004-inch diameter laser beam. Students assembled these parts to create physical models as shown in Fig. 5. They not only enjoyed working on this hands-on project, but also learned the basics of computer-integrated manufacturing and the significance of fits and tolerances related to manufacturing.

A student who worked as an engineer at a manufacturing company in Nashville was taking CADD II in our department. The company made plastic parts using computer integrating manufacturing techniques. For individual projects, he and a few other students designed parts in our CADD lab using Mechanical Desktop 5.0 and the drawing files were sent electronically to the company. Students and Dr. Sridhara visited the company where the engineer/student downloaded the DWG files, translated them to DSN files for Surfcam 2000. The DSN files were then converted to CNC codes and the parts were manufactured as we were observing. During this demonstration we learned how the x, y and z movements of the cutting tool was controlled by the CNC program.

In 2001, one of our colleagues purchased two rapid prototyping machines through a grant. One of the machines operates like a 3-D printer building parts in layers. Each layer is made of 0.004-inch thick plaster-type material coated with a bonding agent. The other machine (Fig. 6) has a tool head that has x, y and z movements and machines the parts out of ABS plastic (Fig. 7). Both machines accept solid model (DWG) files created using Mechanical Desktop and convert them into appropriate format for building/machining. In the Fall of 2001, a graduate student in the CADD II class built two prototypes (Fig. 8) for her additional project using the 3-D printer. The student created the solid models using MDT 5.0 in our CADD lab and sent the drawing file to the 3-D printer work station electronically where it was converted to the appropriate format and the parts were built. She also turned in a written report describing the procedure in detail. The two prototypes are currently used in CADD I to teach the basics of multiview drawing.

Lesson Plans for the Mechanical Desktop and the ProEngineer

About four years ago, we started teaching Mechanical Desktop in CADD II. There were no textbooks available for version 2.0 at that time. Dr. Sridhara worked with a graduate student who was taking Advanced Technical Drafting and prepared lesson plans for CADD II and Advanced CAD. These lesson plans are based on the tutorials that came with the software. The student developed a professional quality manual and received credit towards his term project. This manual is still used to learn the basics of MDT even though we are currently using version 6.0. Two years ago, we received a free copy of the student version of ProEngineer. With the help of a graduate and based on the tutorial CD-ROM that was provided with the software Dr. Sridhara prepared lesson plans to teach ProEngineer in Advanced CAD. The credit should go to the graduate student for preparing a good-quality instruction manual that has already become popular among many undergraduate students who are taking CADD I and CADD II.

III. Conclusions

Web-enhanced instruction saved a considerable amount of time and effort for the instructor as assignments, and other instructions were posted on the course site eliminating the need for hard copies. As the assignments were made available on the CourseInfo site well in advance, the students could start the next one without waiting for the instructor to give the handout. Many a time the solid model files were much larger than 1.44 MB. The digital drop box saved a lot of time and effort for everyone and eliminated the need for floppy or zip disks to turn in the assignments. It also helped the instructor as well as students in keeping track of when what item was turned in and whether it was graded/returned or not. However, such a course could only be taught in a master classroom with sufficient number of good computers and printers with appropriate Internet access. Also, it required additional effort on the instructor's part in preparing all course materials well in advance and making them available on the course site. The hands-on projects in CADD courses and the industrial visit helped the students learn the basics of computer-integrated manufacturing. It also helped them understand the significant contribution of CADD in industry.

IV. Bibliography

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3. "A Workshop on Web-Based Instruction," Organized by the Tennessee Board of Regents, Dickson, Tennessee, October 1999.
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5. "Introduction to CourseInfo," Organized by the Office of Information Technology, Middle Tennessee State University, Murfreesboro, Tennessee, June 2000.

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Dr. B. S. Sridhara is a professor in the Department of Engineering Technology and Industrial Studies at Middle Tennessee State University. He received his B.S.M.E. and M.S.M.E. degrees from Bangalore University and Indian Institute of Science, Bangalore, India. He received his M.S.M.E. and Ph. D. degrees from Stevens Institute of Technology, Hoboken, New Jersey, and Auburn University, Alabama. Dr. Sridhara has published several peer-reviewed articles in the areas of Acoustics, Vibration, finite element methods, and Engineering Education.

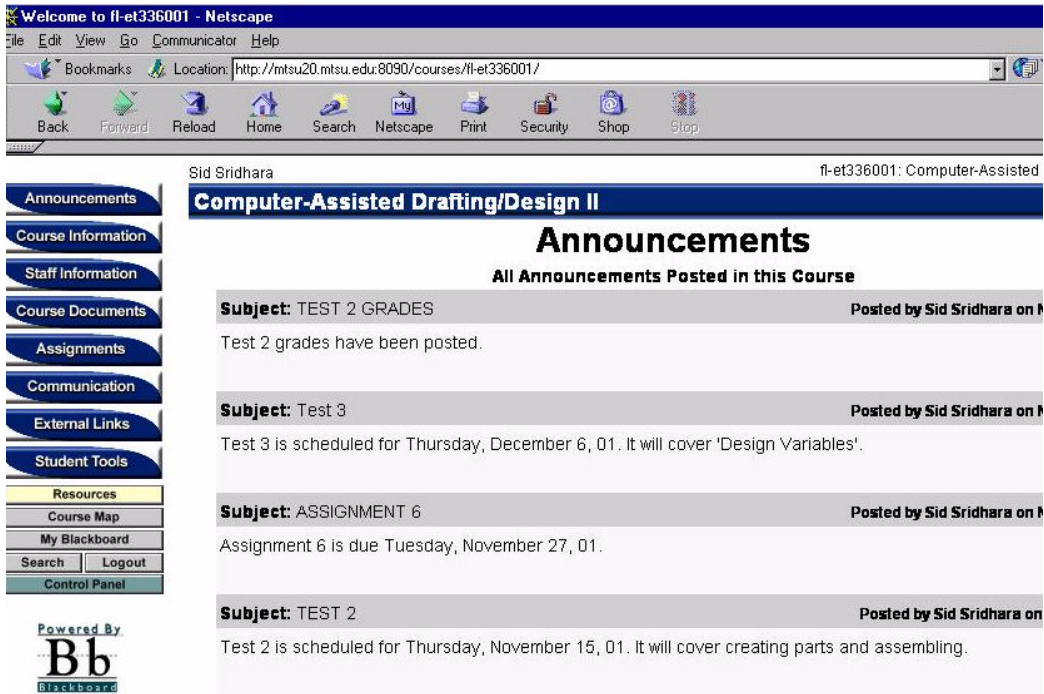


Fig. 1. CADD II Announcement Page with Links to Other Menus.

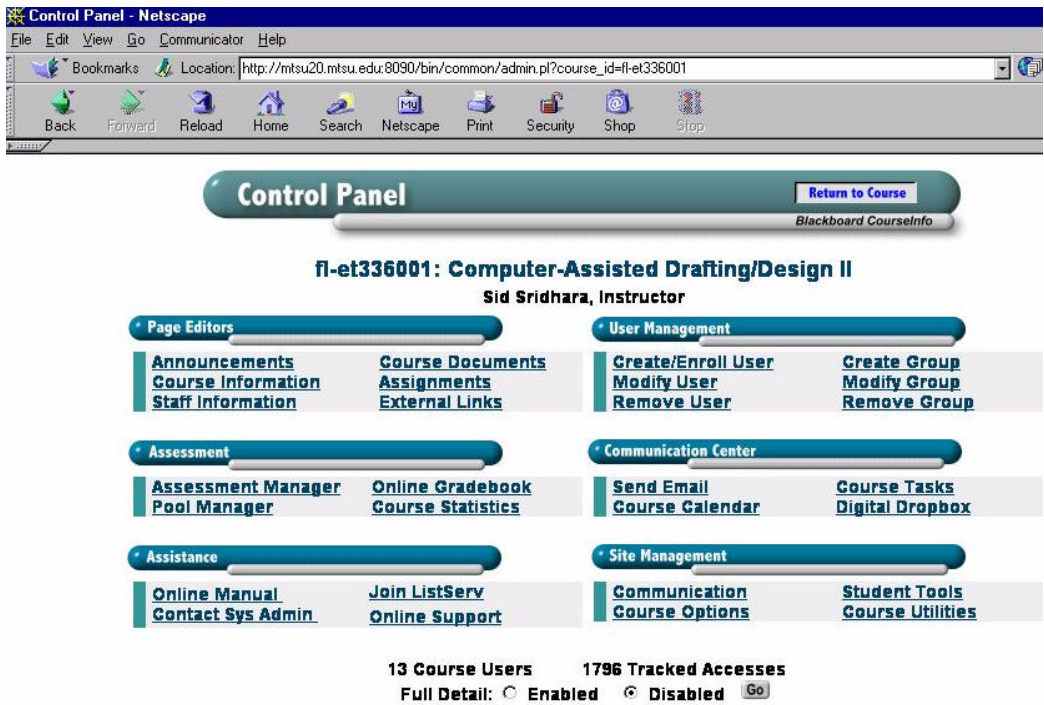


Fig. 2. Control Panel with Different Edit Options.

Uploaded by	Link Name	File Size	Received on
Wfa, Wfa (Word File)	Individual Project 2 (Word File)	6752256	Oct 25, 2001
Wfa, Wfa (Word File)	Individual Project 2 (Adjuster Base)	442312	Oct 25, 2001
O Gann, O Gann (Word File)	Assignment 5 Rev1	456955	Nov 15, 2001
Wfa, Wfa (Word File)	Assingment-6	289162	Nov 27, 2001
Wha, Wha (Word File)	I guess I overlooked it	751593	Nov 27, 2001
Hudgins, Wfa (Word File)	assignment4	499203	Nov 27, 2001
Diana, Wfa (Word File)	Asst-6	333327	Nov 29, 2001

Fig. 3. Student Files in the Digital Drop Box as Seen by the Instructor.

Assignments

[Top]

Current Location: Assignments

- ASSIGNMENT 1**
[Click Here](#)
- ASSIGNMENT 2**
[Click Here](#)
- INDIVIDUAL PROJECT**
- ASSIGNMENT 4**
[click here](#)
- ASSIGNMENT 5**
[Click Here](#)

Powered By **Bb** Blackboard

Fig. 4. Assignments Folder with Links to Appropriate Files

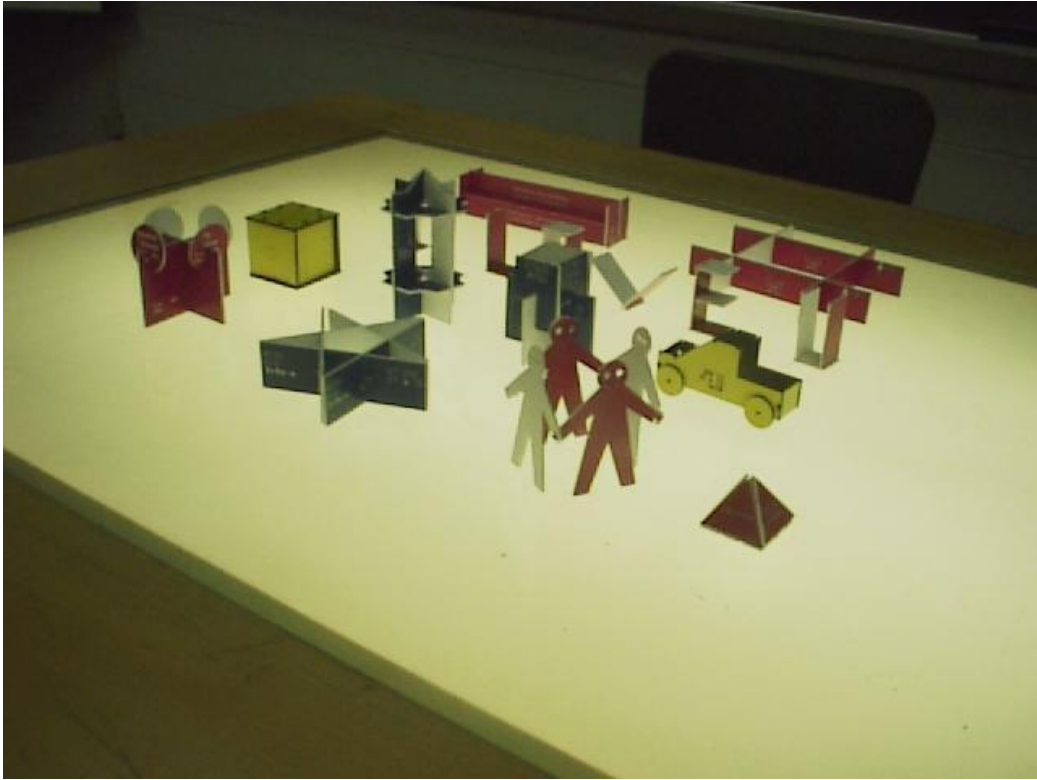


Fig. 5. CADD I Student Projects Created Using the Laser Engraving Machine.

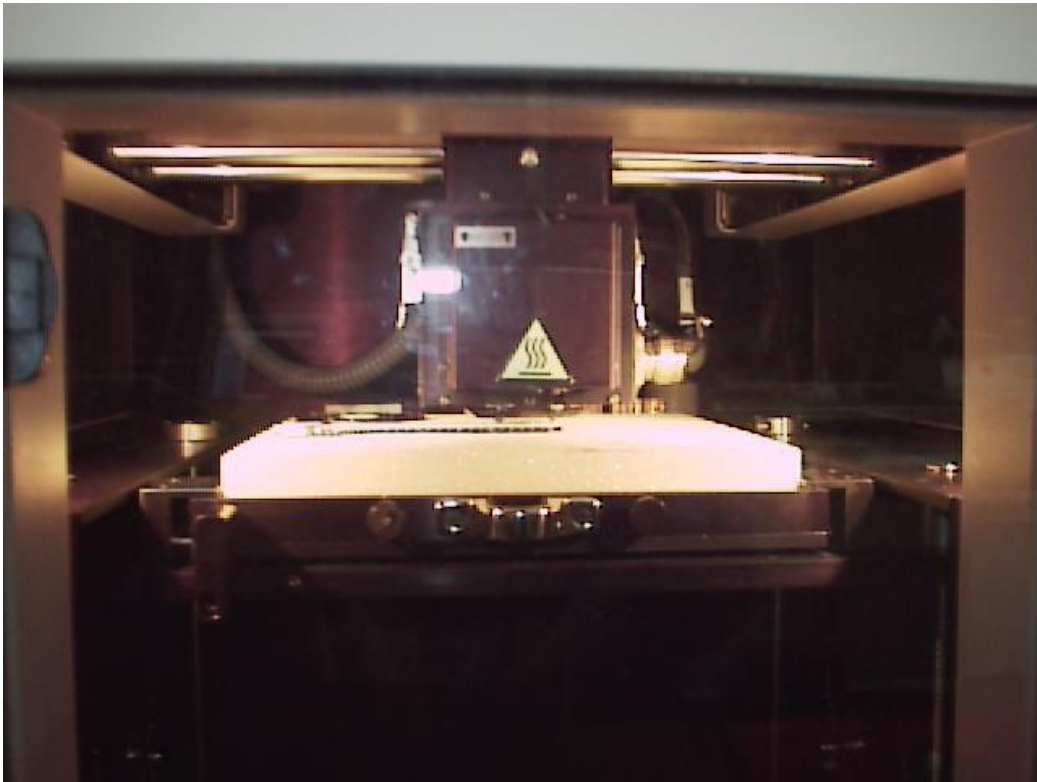


Fig. 6. A Close-up View of the Tool Head of the Rapid Prototyping Machine.

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Fig. 7. Parts Made out of ABS Plastic using the Rapid Prototyping Machine.

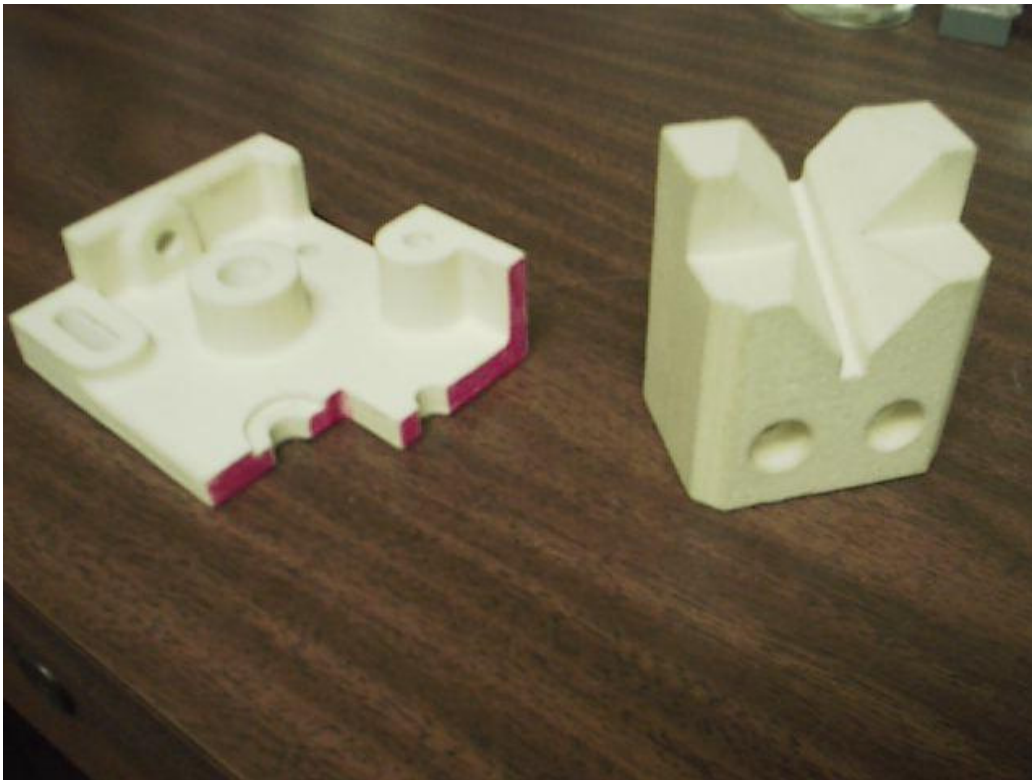


Fig. 8. Models Built in Layers Using the 3-D Printer.

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