THREE DIMENSIONAL GRAPHICS: A 21ST CENTURY APPROACH

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New England Institute of Technology, located in Warwick, RI, was founded in 1940 as the New England Technical Institute. In 1977 under the leadership of President Richard I. Gouse, the Board of Regents of the State of Rhode Island granted the institution the authority to offer associates in science degree programs, its name was changed to New England Institute of Technology (NEIT). In 1982, the New England Association of Schools and Colleges (NEASC) accredited NEIT. Two years later, the State of Rhode Island authorized NEIT to offer Bachelor of Science degree programs in addition to its associates degree programs. By 1990, four new bachelor programs had been added to the college's offerings. In 1995, the New England Association of Schools and Colleges Commission on Technical and Career Institutions awarded accreditation to NEIT as a baccalaureate-granting institution.

Today enrollment has grown to over 3,000 students with an offering of 26 Associate in Science and 7 Bachelor of Science degree programs, in such areas as Business Management, Computer Information Systems, Electronics Engineering, Mechanical Engineering, and Architectural Building Engineering Technology.

In 1979 NEIT began granting Associate in Science Degrees in Architectural Drafting, and in 1996 the program was revised and renamed to Architectural Building Engineering Technology (ABET), and now offers degrees in both Associate in Science and Bachelor of Science.

Teaching Computer aided design skills within the confines of a design studio came about as a response to the need to fit an ever-expanding amount of content into a finite curriculum. We began eight years ago and with a single 60 minute demonstration of 3-D CAD. That demonstration has evolved and become what we are presenting today as the studio method for an integrated curriculum. The concept of integrated curriculum, that is, teaching graphics skills within the context of a larger design discussion, is not new or revolutionary. This method is based on the curriculum used in schools of architecture and engineering from their inception until the development of computer aided design. Traditional graphics skills had always been taught in the context of the broader design curriculum. The advent of computer aided design and the need to provide training spawned an entirely new set of courses. These courses replaced the traditional methods of teaching graphics skills within the context of the curriculum with a series of training based courses. What is new regarding our current approach is the abandonment of the training based curriculum that has become pervasive in campus coursework for computer aided design and our return to this century old integrated approach to graphics education.

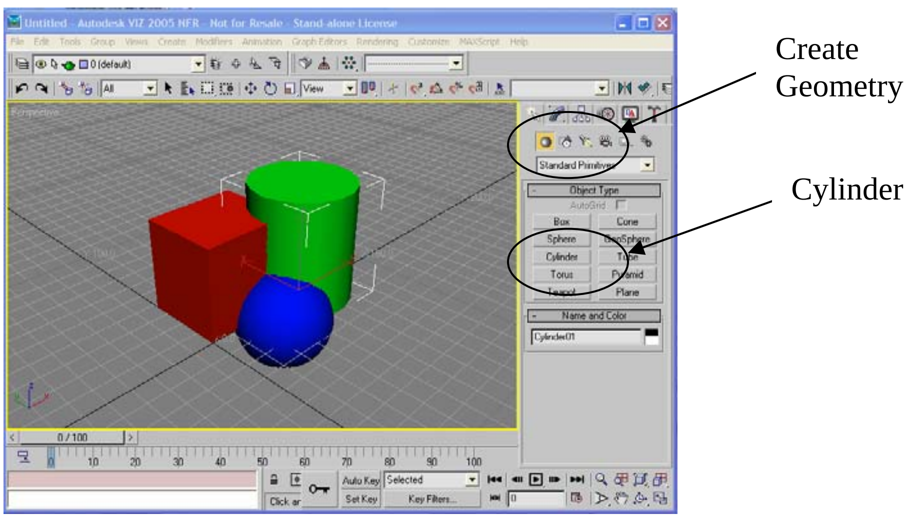
The CAD training approach, initially developed when computers and computer aided drafting became reality in our lives, was, at the time a valid approach. This approach recognized that the vast majority of students had no experience with computers, computer operating systems, hardware or software. As a result most training regimens were methodical and comprehensive. Many began with a basic review of how computers operated and certainly with an introduction to the hardware and terminology required to understand and communicate effectively regarding computers and their use.

Today some twenty years after the inception of computer aided design we are faced with a very different reality. Our students are well prepared to begin the discussion of computer-aided design with no introduction to the systems or hardware. Most students have already been introduced to some form of computer-aided drafting. As a result the discussion begins at a very different point. We find that the vast majority of our students are in reality, already very sophisticated computer users. When we combine this with our further understanding of the great diversity of learning styles that exist within any student group, we conclude that the more independence that can be offered to students the more effective instructional time will be. The combination of these two factors convinces us that an integrated curriculum is a superior model for instruction in computer aided design.

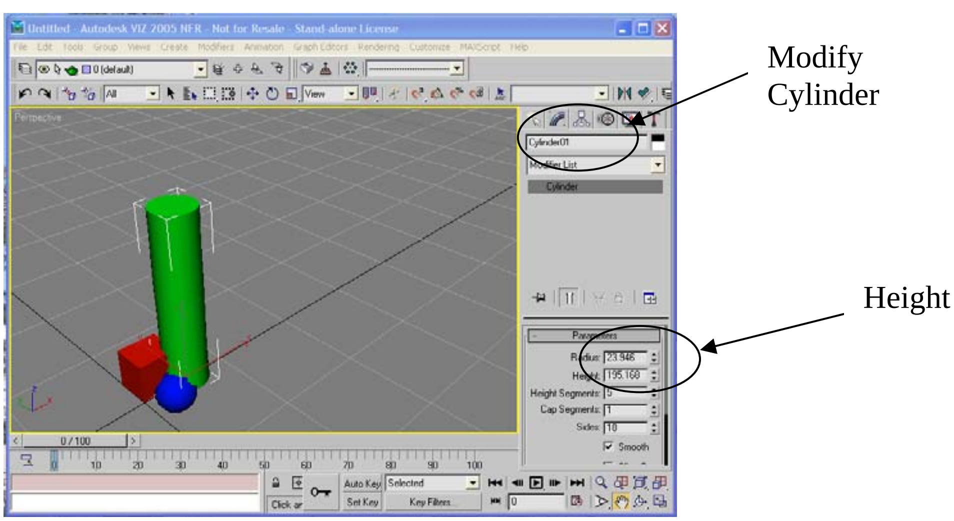
As we noted earlier the integrated curriculum and this approach to computer aided design is not based on a theoretical model, it has not been the subject of controlled trials or testing in any way. It is rather the result of an evolutionary process that has been occurring in our studios for the past eight years. Our current teaching strategies are based on three primary techniques; the first is that sophisticated users incorporate basic skills rapidly and effectively through the use of a demonstration based curriculum. This curriculum is quicker and more flexible, allowing students to develop skills more effectively, at their own pace, utilizing their own learning style. Secondly: these demonstrations must be followed with consistent studio based mentoring. This time allows the instructor to supplement the weaker students who in fact may not be sophisticated computer users, at the same time allowing students who are strong and progressing rapidly to do so. The third significant factor affecting this responds to the phenomenon that students develop skills more effectively while working on independent design projects. We find this to be a significant motivating factor; in that students creating designs of their own are generally highly motivated as a result of the pride of ownership. This is certainly very different from accomplishing assigned tasks in a training based curriculum.

We believe that this general approach has many possible specific applications. Each design or engineering curriculum will in fact operate most effectively through the use of different specific sequences of the events. We would however like to provide two examples of how we are applying this concept. The first example is from the senior year of the architectural engineering curriculum. This example involves teaching advanced modeling rendering animation skills within the context of the first, senior year studio. The second example from the mechanical engineering curriculum, reviews the use of this method with the freshman class and in fact the student’s first experience with computer aided design in the mechanical engineering program.

In the architectural engineering program we teach advanced modeling, computer based rendering and animation skills as an integral part of the first studio during the senior year. The skills are taught utilizing the demonstration and mentoring techniques previously discussed. During the first five weeks of this ten-week quarter we present a series of software demonstrations, 60 to 90 minutes each. These demonstrations occur twice a week covering the primary skills necessary to produce effective computer based renderings and animations. The demonstrations include, screen navigation, creating and modifying geometry, advanced modeling techniques, materials, cameras and lights, importing geometry from other programs, rendering and animation skills. The demonstrations recognize and take advantage of the 'graphic user interface' provided by the software and how our memory uses the interface creating a cognitive map relating information presented on screen. As a result all demonstrations are done using overhead projection of the software. For example, having the graphic user interface projected so that students can easily follow the discussion significantly enhances the student's quick understanding of creating and modifying geometry.



The creation of a box, sphere and cylinder, are easy to demonstrate with most students understanding immediately.



Modification of these elements is also very simple to demonstrate. The vast majority of students require only one demonstration

We continue through these demonstrations for the first five weeks of the quarter. The demonstrations only utilize one hour at the beginning of each five-hour studio session. Students are encouraged to practice the skills as they are demonstrated or directly following the demonstrations. Students then work independently on an assigned design problem using the balance of the studio time. The work of the problem begins to incorporate the skills that are being demonstrated. Students encountering difficulty have the opportunity for more intensive tutoring during this time. Each student manages his own time and progress in accordance with his individual learning style, time commitment and ability to process the information. Students invariably complete this semester at very different levels of accomplishment, some having only acquired basic required skills others having gone far beyond. The result is that we have the time to provide more extensive tutoring to weaker students while the stronger students advance with significantly less contact.

The results of the studio in terms of graphic accomplishment are demonstrated in the following. As you can see, some students have acquired only rudimentary skills in computer based rendering whereas others demonstrate superior, significantly advanced skills.

Image one: superior, significantly advanced skills

Image two: superior, significantly advanced skills

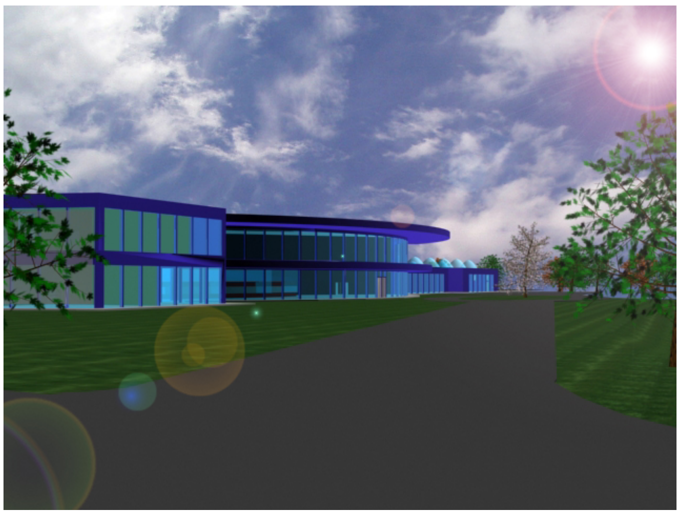


Image three: rudimentary skills

As students progress through the sequence of the three senior year studios further learning and mentoring is less formal and on an individual student requested basis. The images that follow demonstrate the progress of our students and the continuing growth of their rendering skills.

Carrie Turgeon (thesis 04)

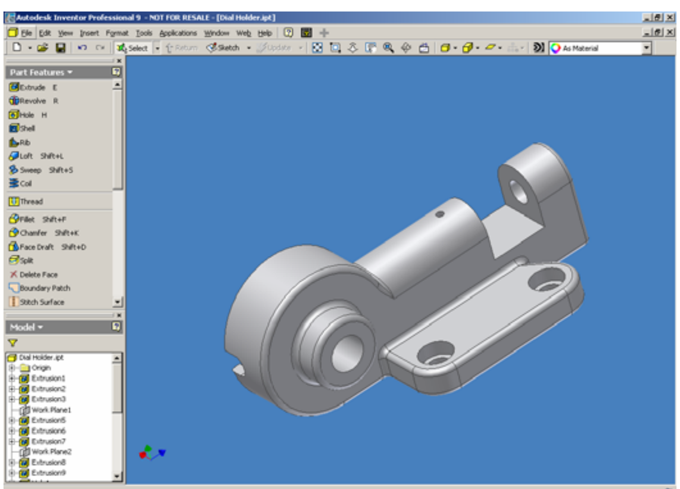
Carrie Turgeon (thesis 04)

Mathew Arnold, Michael Malo (thesis 04)

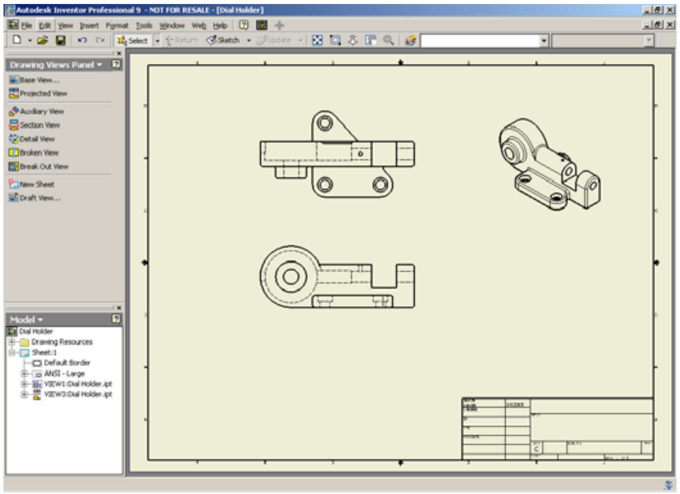
The development of the integrated curriculum in the mechanical engineering department followed our initial experiments with architectural building technology. The mechanical curriculum uses the three primary concepts developed during our experiments in the senior architectural studios, demonstration, mentoring and project based learning. These concepts are presently being applied to the incoming freshman class in the mechanical engineering technology curriculum.

In addition, the mechanical computer aided design curriculum is presently recognizing the fact that we live in a three dimensional world, this in fact is in direct conflict with the traditional progression of graphics education. Specifically as we began to discuss drawing with incoming engineering students, we traditionally introduced the concepts of orthographic two-dimensional projection drawings as a method for representing three-dimensional objects. This transition has been difficult for many students, and considering that the end result is for students to understand three dimensional solid modeling, it seems counter productive to force adherence to this traditional method of plan elevations section and orthographic projection drawing.

As a result we have abandoned the practice of initially teaching two-dimensional graphics for what we consider to be a superior method. Two-dimensional graphics however, remain a large part of what the mechanical engineering technology student must learn. This combination presents a difficult challenge for the instructors. To meet the challenge we adopted the practice of teaching three-dimensional solid modeling to incoming freshmen, this generates immediate interest and excitement from the student. Using the power of the three dimensional system to generate two-dimensional drawings we then can easily explain the orthographic concepts and related drafting techniques and standards. As the students progress into later quarters they are exposed to a total of three different solid modeling packages affording them flexibility in choosing which package they prefer for individual design projects. Much like their architectural counterparts the students then are allowed to work independently on design projects with mentoring from the instructors as needed. We like to refer to this as just-in-time education. Below is an example of a three-dimensional mechanical part created in Autodesk Inventor 9 and a two-dimensional orthographic drawing generated directly from the model.

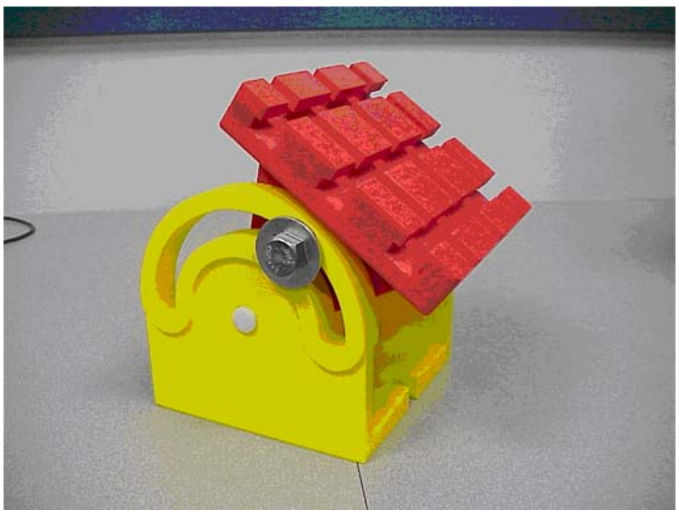


Parametric model of die holder



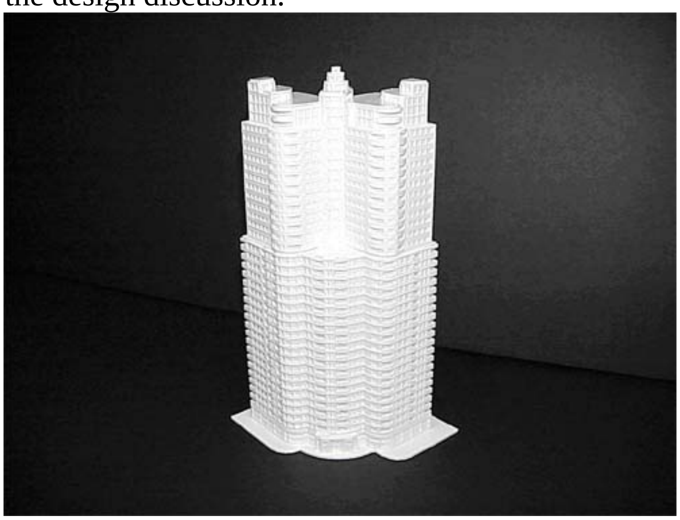
Generated orthographic projections of die holder

The implementation of 3 dimensional modeling has enabled not only advanced graphics, but also the use of rapid prototyping models. Below are a few examples of mechanical models from design studio class. There can be nothing more exciting to a student, than to see a computer-generated design either architectural or mechanical transformed into a real model. Mechanical students especially benefit from a rapid prototype model enabling a quick check for form, fit, and function.

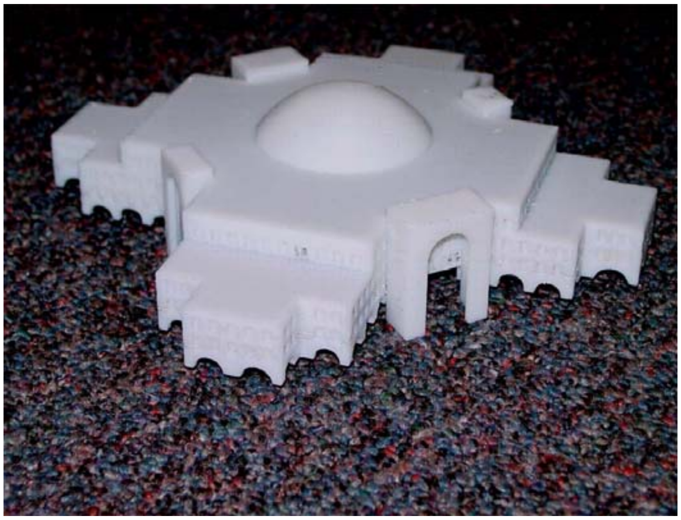

Mechanical Engineering: swing table design project

Mechanical Engineering: oil filter wrench design project

For architectural students creating three dimensional representations of proposed projects has always been an integral part of the design process. The emerging architectural applications in rapid prototyping are a significant enhancement to architectural projects, providing a greater level of detail than previously attainable while releasing students from the time consuming labor intensive hand building process. Incorporating this rapid prototyping technology is yet another example of the advantages of an integrated curriculum, this technology is being taught in the studio to interested students on an as needed basis. There are no formal classes, instruction is simply integrated into the design discussion.



Architectural Engineering: high rise design project



Architectural Engineering: low rise design project

In conclusion, the interest and excitement level of the students has increased resulting in an increase in the intensity of design projects both architectural and mechanical. The advantages of the demonstration / modeling approach leaves us with greater flexibility, allowing a quicker more fluid response to individual students and their specific needs. We are also better positioned to respond to today's rapidly changing CAD software environment. The return to an integrated curriculum enhances our ability to include specific engineering content in courses that are concerned with the development of our student's graphics skills. As we continue deeper into the future and as graphic programs become ever more sophisticated, we anticipate that this approach will allow us to continue more fluidly without the need to reevaluate our approach. We are also constantly mindful that our primary concern and the largest measure of our effectiveness and success is the level of interest that our students demonstrate.