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AN EXPERIENCE ON SUPPORTING THE LEARNING OF TECHNICAL GRAPHICS AND IMPROVING VISUALIZATION

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Abstract: *This paper presents an experience of applying computer graphics, virtual reality and Internet resources in the teaching of technical graphics in engineering and design courses at the University of Brasilia, Brazil. Our motivation was the fact that most of the students have a lack of previous knowledge on the basis of drawings, resulting difficulties in both understanding and visualizing technical drawings. As an experimental method, we introduced VRML 3D modeling in addition to CAD and regular pencil-and-paper drawings study and practice. To better support learning, we first provided a website with animations and virtual reality resources, avoiding the usual textbook metaphor. Since 2003 we are providing a CD-ROM containing all the former website material which is updated each semester. This experience is intended to improve the learning in a way that motivates the students. Classes, website and CD-ROM material was conceived to take advantage of computers´ interactivity and animated resources.*

Key words: Distance learning, Interactivity, Internet, Technical graphics, 3D modeling.

1. INTRODUCTION

The origin of the experiments on 3D computer graphics as a tool to develop visualization in a Descriptive Geometry course comes from the early 90´s. At that time, we identified some difficulties of our engineering students related to the understanding of the projection process, the reading of technical drawings and the establishing of the relation between their own view of a real object and its views in orthogonal projections.

It is important to point out that, for most of the engineering students in Brazil, the courses of Descriptive Geometry or Technical Drawing are their first contact with formal drafting. These students, attending the first semesters of an undergraduate course, have little or none knowledge about projections, perspectives or, in many cases, even the basics of drawings.

In the late 80´s, some researchers in Brazil were proposing a different method of teaching Descriptive Geometry which we adopted: instead of the traditional point-line-plane sequence of teaching, the comprehension at first on how a solid object is orthographically projected over the planes allowed to a better understanding on how its vertices (points), edges (lines) and faces (planes) appeared as orthogonal projections.

Following this method, some steps of the process became easier for the students´ understanding. However, some students still had visualization problems, such as a lapse regarding the understanding of the relation between the representation of an object - its projections - and the many possible views of the object itself.

After making drawings based on physical solid models, the next logical step to make it easier and to assist on the understanding seemed to be the introduction, in the course, of the emergent computers´ 3D modeling technology. The availability of a simple and easy 3D modeling software allowed the students to construct and to get better visualization of the same objects they had drawn and studied before and to model, understand and draw much more complex objects. [1]

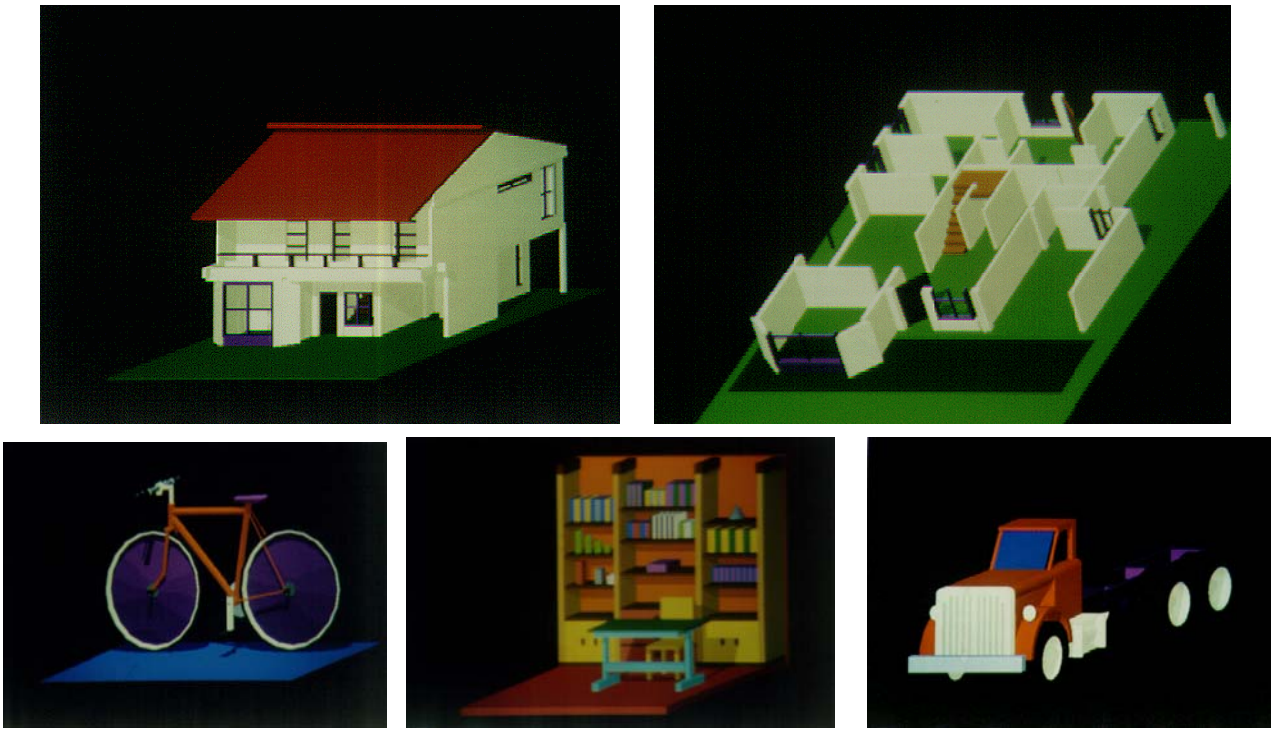


Figure 1 – Five 3D models from 1991´s first semester Descriptive Geometry students

This experiment was held from 1991 to 1993 and showed that the virtual 3D models could be a future way to replace orthographic views, which were identified as a large part of the visualization problem.

A few years later, the courses of Descriptive Geometry and Technical Drawings were merged into a one-semester course. Returning to the teaching of this new technical graphics course, we followed the trend of using CAD instead of pencil-and-paper drafting in class. However, after one semester using computers to draw, it was clear that the students were getting much more involved with the software, its commands and its resources than with the understanding and visualization of the drawn objects. They were making drawings more based in the resources of the software than in the techniques and rules of representation.

From that time on, we discouraged the use of CAD, returned to pencil-and-paper drafting and started to explore other resources and new technologies. Since 2000, we introduced the use of very simple and didactic photogrametry and VRML (Virtual Reality Modeling Language)

modeling tools to construct and visualize complex 3D models and to do exercises in parallel to pencil-and-paper drafting, as we did in the former Descriptive Geometry classes.

It is important to notice that, for us, any software is always just an instrument for achieving the desired results, i.e. representation and better visualization of the objects. The tool must be as simple and easy as possible, hence the students can focus on the process of construction and visualization and NOT on the learning of software commands. This is the reason for not using software such as 3D Studio or other complex 3D modelers in these first semester courses.

From the second semester of 2000, we brought the experience of visualization and interactivity to the Internet, providing to the students a website designed with animation and virtual reality resources, avoiding the usual textbook metaphor [1].

Figure 3 – The discipline's homepage started in a newsletter format. The right image is the current homepage.

Since 2003, we are providing a CD-ROM containing all the former website material which is updated each semester. The intention of all this experience is to improve and to support the learning in a way that motivates the students, young people, who are used to play video and computer games. Classes, website and CD-ROM were conceived to take advantage of computers´ interactivity and animated resources.

2. THE WEBSITE CONCEPTION AND DEVELOPMENT

The first guidelines for the construction of a local, learning supporting website, came in 1998 from two issues that we identified in some so-called distance learning courses all over the world.

- First, because web design did not develop its own language, designers were using the textbook metaphor in education. Websites composed only by text and figures were called distance-learning courses, although, in most cases, they were simply chapters of books or notes of classes in a web page format. These e-texts had no other attractive than a valuable spreading of the information over Internet. Typically, the destiny of these texts on screen was the return to the printed format. An inquire among the students of the

University of Brasilia showed that most of them, even today, print all the contents of a textual website in order to read it later.

- Second, although the technology allowed interactivity and much more, it was frequent to see poorly designed webpages using easy special effects or animations just to mask their bad concepts, and not to contribute for a better contents.

These two issues clearly pointed out one solid way to construct a website, if we wanted it different and better than the others we were used to see:

- If there was a so remarkable superiority of the printed text over the electronic one, we should avoid, as much as possible, text-only static contents. If the contents of a local website needed too much text, it would be better and require less effort to provide paper copies directly to the students.
- If the technology on the Internet allowed to do animations and to be interactive, we should take advantage of these facts for our courses contents, which were, in nature, essentially visual.

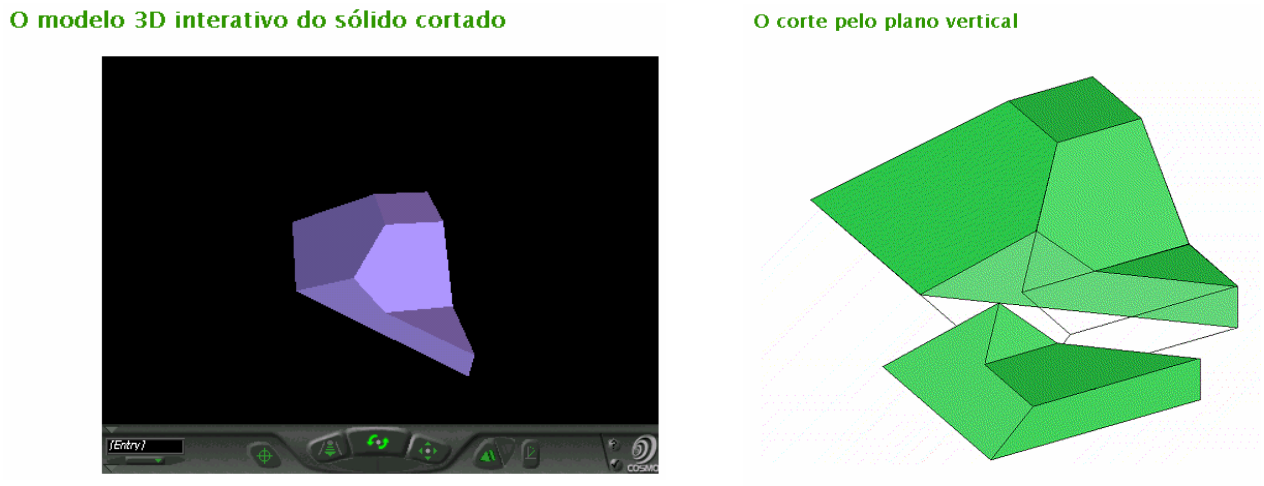
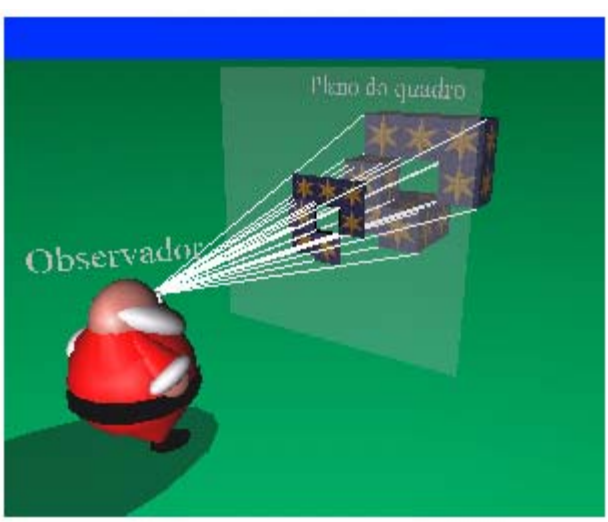
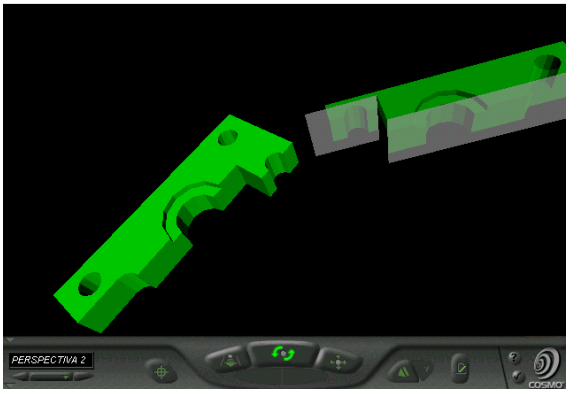


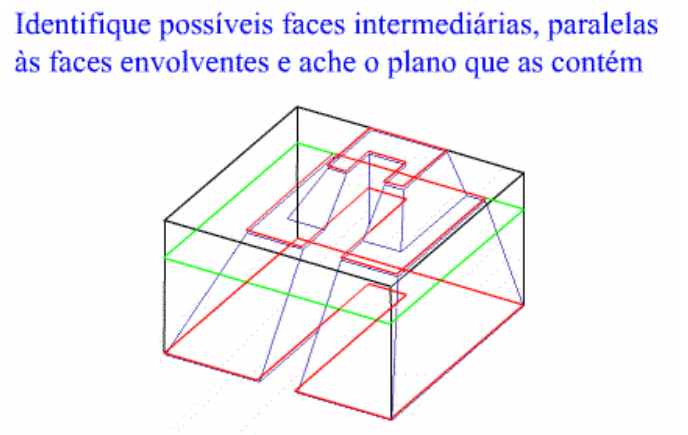
Figure 4 – Exercises are always illustrated with 3D VRML models and, sometimes, with 2D or 3D animations – or both.

These two guidelines oriented the construction of the website. The first version was more like a newsletter. In this early website, we used to put proposals of exercises and their solutions, news, announcements and tests solutions. Since the beginning, either VRML interactive models or a few animations accompanied all the exercises and the short theoretical explanations.

As the website evolved, new interactive and animated material has been developed and added to compose a menu of pages which included the curriculum, exercises, past tests solutions, theoretical explanations, news, rules and standards, links, free software, etc.







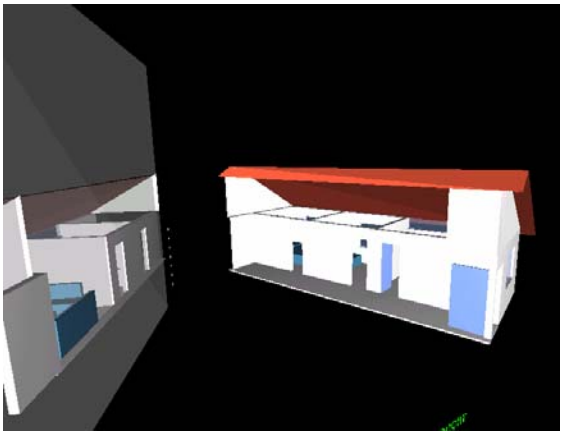


Figure 5 – Tests and theorethical contents are also illustrated with 2D or 3D interactive, animated material.

All this material was conceived to be an additional, supporting tool, in a way that the students could reinforce their learning outside classroom. It was not intended to be a truly courseware as this would demand much more resources, such as interdisciplinary teamwork or online feedback.

3. SOME ISSUES ON THE EXPERIENCE OVER INTERNET

A number of researchers in and outside Brazil are working with computers, animations, virtual reality and Internet resources in order to teach, to solve or to minimize problems related to the technical graphics - Descriptive Geometry included in this body of disciplines. We all seem to share similar questions: how to improve on the assistance of the visualization's development; what is the most efficient media to disseminate the knowledge; what kind of technology to be used; how to use the available technologies; how to motivate the students to study taking advantage of the provided material, software, method or technology; etc.?

From some previous experience, we were reasonably sure that the students would be stimulated to access a website and to use the interactive resources provided in its pages. For two years, we have provided to them a free access website full of information, 3D interactive models and animations, library of problems and tests, etc. in addition to the classes. The monitoring of the site showed that there were a large number of accesses.

But something was wrong. The feedback of the tests did not show such an improvement in many students' visualization or knowledge.

After all, we realized that the students were not really using the site in its full potential. An inquire among the students identified the following facts:

- although recognizing that the website material was very helpful and of easy understanding, few students were accessing the site to reinforce class contents; many were considering that they had seen and learned enough when the contents and the material of the site - animations, models, etc. - was shown and explained in class; these students would only access the site again the day before a test;
- many students were actually accessing the site but were NOT staying connected enough time to use and explore the provided resources;
- most of the students were not exploring the site and searching for information as they used to do in recreational ones;
- many students alleged problems in their connection to the Internet as a reason to not access the library of exercises and tests;
- most of the students have tried to print the contents of the site. However, there were many 2D and 3D models and animations that were not possible to print. Consequently, the students asked for printed materials;
- many students were satisfied in just reading the proposal of a problem and then accessing and visualizing its solution, which included VRML 3D models. They were not trying to solve the problem by themselves.

Once again, there was an indication of the need of printed material even among young people used to stay in front of a computer's screen for hours. Maybe the problem is that they cannot bring with them a connected computer all around the campus for taking a look any time, any place.

Furthermore, there was a connection problem: many students used dial-up connection to access Internet from home. Staying connected for long time could represent an undesirable expense. This might partially explain why some students did not dedicate enough of their time to explore the site.

4. CHANGING TO A NEW MEDIA

From the Internet experience, we started to explore the possibilities of replacing the website with a new media, independent of connections or limitations of time use, less susceptible to go offline, etc. Some qualities of a CD-ROM seemed perfect to solve or minimize at least some of the issues:

- a CD-ROM is portable;
- a CD-ROM is a reliable and large enough media to content all the course material;
- it is independent, more stable and faster than an Internet connection and its traffic;
- it does not have an appeal to navigate outside the contents.
- it can easily include and play large files, AVI animations and even videos;

In the second semester of 2003 we decided to replace the website with an updated CD-ROM which includes short, interactive lessons on difficult topics - typically projections, perspectives, sections and the basics of the course. These lessons are illustrated with new 2D and 3D interactive animations.

5. CONCLUSION

The teaching method for the learning technical graphics and developing visualization turned out to always be an improvement of the experience in 1991/1992, using advanced resources such as Internet, animations, virtual reality or 3D modeling in VRML (Virtual Reality Modeling Language) combined with traditional pencil-and-paper drawings.

We are always testing and seeking for improved ways of supporting learning with new material and resources. We do not have consistent 2004 results but there are indications of an improvement in the interest on the CD-ROM material.

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