# LEARNING STRESS DISTRIBUTION IN SOILS USING A DIGITAL MULTIMEDIA TOOL

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***Abstract:*** *The available technologies of microcomputers and international communication - Internet, are powerful sources for the Teaching and Learning Process. Undergraduate courses can take advantage of these resources to help students and teachers in the classroom. Thinking on this the Project REESC - Reengineering of Engineering Education in Santa Catarina - was approved. This one-year project has involved six universities of the State, with thirty-four sub-projects dealing with most of the engineering knowledge areas <http://reesc.ctclab.ufsc.br>. This article presents the sub-project dealing with geotechnical engineering. After some considerations about the learning process in the 21st Century the package MECSOLOS is presented. The software makes use of text, images, graphical illustrations and animation to help students learning by themselves the concept of Stress Distribution in Soils. After that, an experimental application of this software to five Universities in Santa Catarina is presented. Following, some advantages and disadvantages of this computer based learning tool are commented. Finally, some conclusions are drawn placing emphasis in the change of the professor-students relationship that will occur in the years to come.*

## Introduction - the reesc project

Replying to the nation wide call for projects, REENGE No. 01/95 (Reengineering of Engineering Education), six universities of Santa Catarina (southern Brazil) through their Faculties of Engineering have presented the project entitled REESC - Reengineering of Engineering Education in Santa Catarina.

The project has been approved and was developed from August 96 to July 97.

The REESC project was conceived by forming three levels of coalition: (1) The Engineering Coalition concerned with engineering entrance exam, teaching methodology, engineering curriculum and distance education; (2) The Internal Coalition dealing with local reality of each university and the relationship between basic and professional disciplines; and (3) The Regional Coalition by forming a net of the Engineering Courses in Santa Catarina joining the following six Universities:

(a) UFSC - Federal University of Santa Catarina <http://www.ufsc.br> with the courses Mechanical Engineering, Electrical Engineering, Civil Engineering, Industrial Engineering, Chemical Engineering, Control and Automation Engineering, Food Engineering, and Sanitary and Environmental Engineering;

(b) FURB - Regional University of Blumenau <http://www.furb.rct-sc.br> with the courses Civil Engineering, and Chemical Engineering;

(c) UNISUL - University of the Southern Santa Catarina <http://www.unisul.rct-sc.br> with the courses Civil Engineering, and Chemical Engineering;

(d) FEJ/UDESC - State University of Santa Catarina - Technological Center at Joinville <http://www.fej.udesc.br> with the courses Civil Engineering, Mechanical Engineering, and Electrical Engineering;

(e) UNOESC - University of the Western Santa Catarina <http://www.unoesc.rct-sc.br> with the course Industrial Engineering;

(f) UNESC - University of the Extreme South of Santa Catarina <http://www.unesc.rct-sc.br> with the course Survey Engineering;

Thirty-four sub-projects were developed under REESC one year project. This article describes one of these sub-projects dealing with Geotechnical Engineering - Stress Distribution in Soils.

## CLASSROOM BEYOND 2000's

Nowadays traditional lecture - seminar and tutorial - are loosing space to a more interactive learning technology (Mendes, 1992). Active Learning - Issue 7 (1997) has brought to us answers to some questions which are concerning educators when taking a look into the future (Jones et alii, 1997).

In fact, some new technologies (e.g. computers, internet) can deeply change the relationship between teacher and students. Instead of having a passive participation at the classroom, the students will go to school after knowing the class subject using a multimedia tool. So, the teacher will take the role of a moderator and will use the time in the classroom to clarify doubts and possibly going deeply in the subject.

The class will become a kind of a round table, where everyone can explain the contents to the others, changing the traditional class into an interactive discussion class.

Despite this advance in the learning process, some questions still remain to be answered:

(1) Will these technologies be affordable to the students?

(2) Will the use of a multimedia tool be a step to a virtual university?

(3) Can the students take any advantage of such technologies?

## Package mecsolos

### Tool

In general, geotechnical subjects make intensely use of calculations, worksheets, graphics, etc. Such characteristics entitle this engineering subject to be learned through a multimedia tool. To prepare this tool there are at least three authoring softwares to choose from - Toolbook, Authorware, and Director. The reason why Toolbook was chosen is because it is very common used in many educational softwares. The version used was 4.0 CBT. In addition, this authoring tool has features which are well adapted to academic purposes (Brown, 1992).

To prepare the MECSOLOS package some questions had to be answered:

(1) What is the main purpose of the package? The MECSOLOS, as a prototype software, was designed to help students to learn technical subjects without teacher interference.

(2) What reasons will make the user prefer the package to a text book? Normally, multimedia packages have text, photographs, animation, graphics and user interfaces which will make possible communication between user and computer. These characteristics have an enormous appeal and motivate the user to open and navigate in the software package.

(3) What information should be presented in the software? The information should be restricted to the software subject and do not try to present everything about the subject. In general, a broad view of the subject is essential and then open three or four paths to be followed by the students, covering the most important parts of the subject.

(4) How the information would be passed to the user? Sounds, images, text, animation, and interactive communication between students and computer are the software main features. This is the powerful part of a multimedia tool.

(5) How the user can find a specific information within the package? Navigation is generally used to find information in a multimedia package (Jonassen, 1988). Icons, hotwords, and summaries can be used to find the asked information. If the user get lost during navigation or the organization of the subjects induces changes in the user's mind during navigation, the software quality must be improved.

### Presentation

The MECSOLOS package is presented in 3 1/5"disc and CD-ROM medias. There is an self-installation capability after user authorization. The package uses a book metaphor. There are icons to flip pages forward and backward in a book fashion. There are also only two types of hotwords - red and green words. The red words take the user to a specific part of the software related to that word (e.g. references, or any item of the summary). To return to the original red word just click in the small globe at the icon bar. The green words open a small window with additional information about that word. This window is closed by clicking inside its field. In some windows there is also a question mark icon that works in the same way as green hotwords.

This is all the user should know to run the program.

### Topics

To learn the geotechnical subject "Stress Distribution in Soils" the student should be introduced to the subjects (a) Distribution of the external loads; and (b) Distribution of the soil self-weight loads. The latter is presented in the MECSOLOS package.

The language used in the software is Portuguese.

The package has the following content:

- Front page
- How to navigate in the software
- Authors
- Preface
- Main Summary
    1. Introduction
    2. Objectives
        - General
        - Specifics
    3. Stress distribution due to soil self-weight
        - 3.4 Origin of stresses
            - Water unit weight
            - Grain unit weight
        - 3.5 Soil unit weight
            - Dry soil
            - Wet soil
            - Saturated soil
        - 3.6 Soil stratigraphic profile
            - Thin natural soil profile
            - Thick natural soil profile
            - Simplified profile
        - 3.7 Deduction of the stress equation
        - 3.8 Effective stress principle
            - Study motivation
            - Principle equation
            - Variation of the effective stresses due to water table fluctuation

- Principle importance to Soil Mechanics

3.9 Distribution of the self-weight stresses for permeable soils
- Introduction
- Solved exercises
- Influence of the variable Time
- Artesian and phreatic water tables
- Proposed exercises
- Conclusion

3.10 Distribution of the self-weight stresses for impervious soils
- Introduction
- Solved exercises
- Influence of the variable Time
- Artesian and phreatic water tables
- Proposed exercises
- Conclusion

3.11 Distribution of the self-weight stresses for impervious soils
- Introduction
- Solved exercises
- Influence of the variable Time
- Artesian and phreatic water tables
- Proposed exercises
- Conclusion

12. Conclusions
13. References

## Comments

Figures 1 and 2 present two windows of the software package.

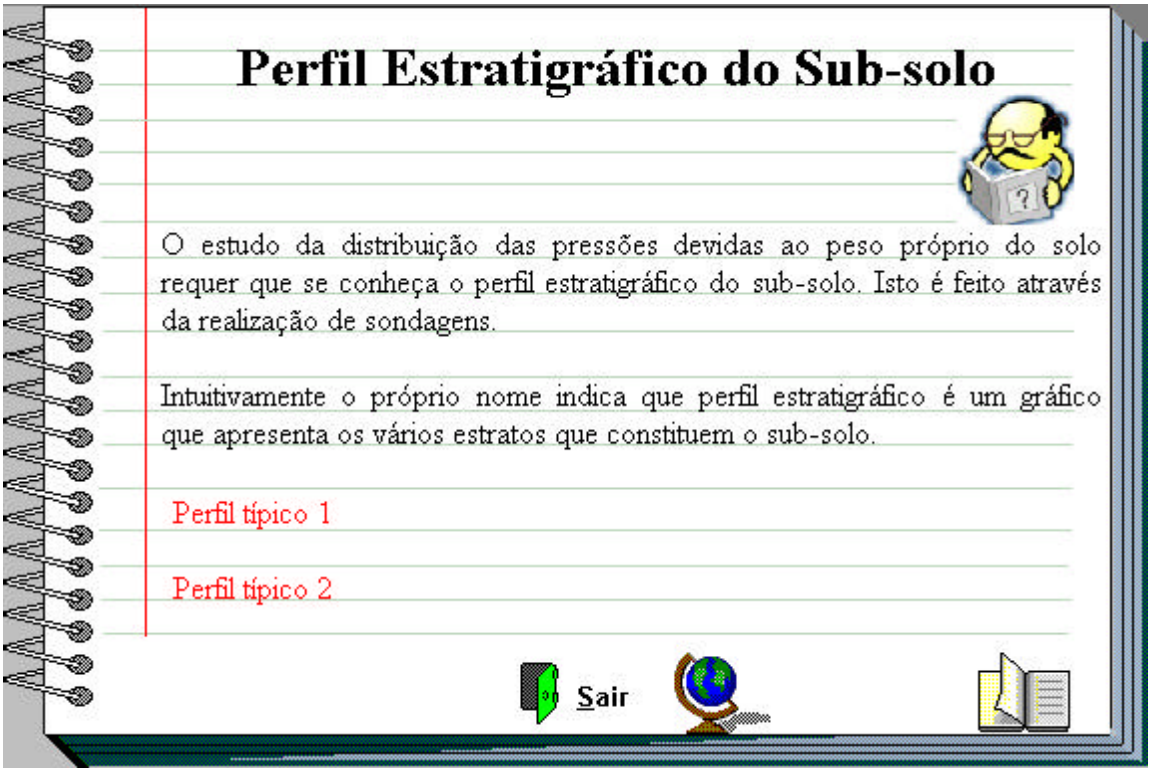


Figure 1 - Soil stratigraphic profile window showing red hotwords, question mark icon and icon bar (leave the software, small globe, and flip page forward).

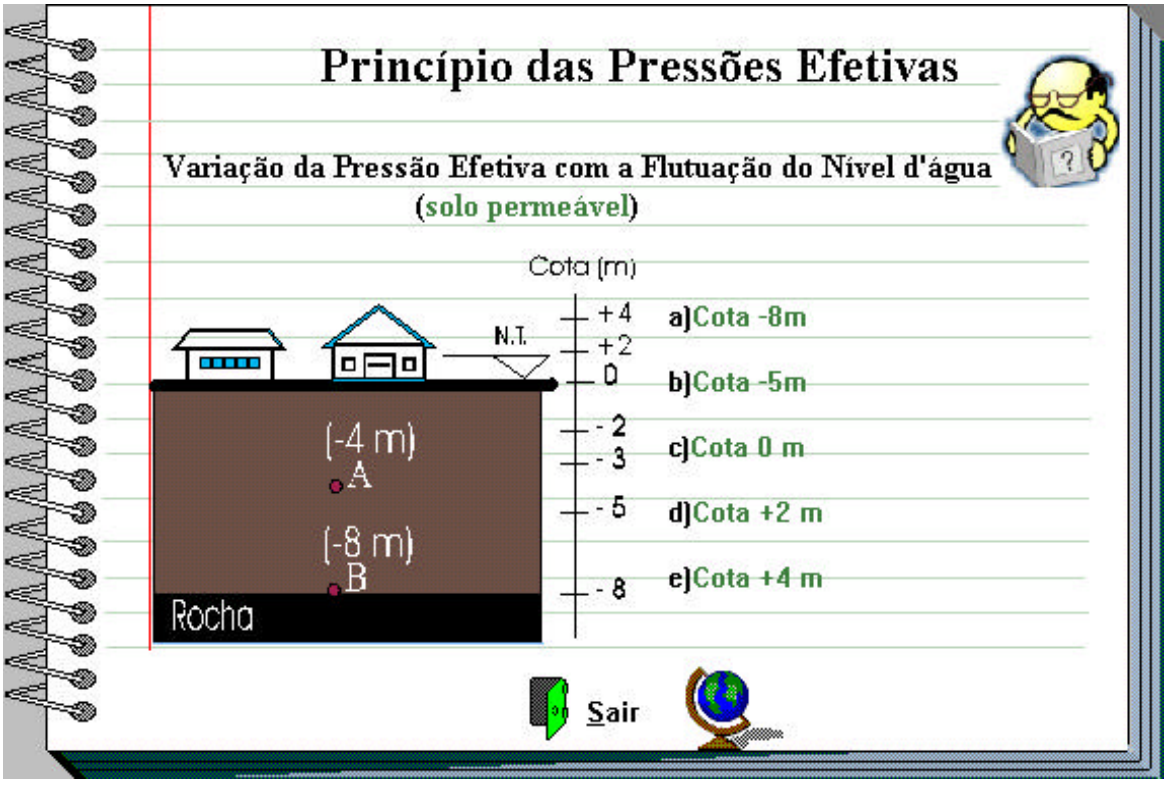


Figure 2 - Effective stress principle window showing green hotwords, question mark icon and icon bar (leave, and small globe).

As has been said before, the MECSOLOS package is a pilot experience on using computer to learn geotechnical subjects. This software was developed to help undergraduate engineering students to learn by themselves some basic concepts of Soil Mechanics. This new educational technology makes it possible. The student can get the software from the teacher, or from the geotechnical group web page and install it at any available computer of his use. During the period of studying students can clarify doubts and difficulties in understanding the subject with the teacher, either personally or by electronic mail. After a pre-defined period of time, say two or three weeks, may be more depending on the complexity of the software contents, the students will get together with the teacher in the classroom. This round table type meeting is useful to exchange experience on the software subject. After that, an evaluation through a quiz or through a short informal test is provided.

Although this procedure can be understood as a virtual learning university, this is not the case. Teacher and students must discuss the subject in the classroom.

## Experimental application to santa catarina universities

There are four Universities which has been offering for many years Civil Engineering degree in Santa Catarina. Two other Universities just began to offer this same degree in 1997. Altogether there are six Universities offering such course. In November 1996 the first meeting of the Forum of Geotechnical Teachers in Santa Catarina was called. The objective of the Forum is to discuss all aspects involved in teaching geotechnical subjects. In the first semester of 1997 five Universities were visited and an experimental use of the MECSOLOS package was done. More than three hundred engineering students had the opportunity to use the software. The evaluation sheet were filled up and the results were very positive. Most of the students have said that the package is self-explained and very user friendly. Also have said that it was very easy to navigate in the software and very easy to learn the concepts presented. A very auspicious conclusion was that they would rather learn from this software than from the traditional tutorial lecture. Some criticisms were presented on the complexity of some drawings included in the software.

## Ergonomics, advantages and disadvantages of a multimedia tool

### Ergonomics

As any other tool, this multimedia tool must fulfill some ergonomic requirements to be accepted by the user. The following criteria were taken into account in the MECSOLOS package:

(1) **User conduction -** to give to the user the decision during software navigation;

(2) **Cognitive effort reduction -** to allow the user easily understand the software contents, therefore increasing learning efficiency;

(3) **User controlled -** to allow the user get the software under control deciding the way to be followed;

(4) **Adaptability -** is the software capacity to answer according to the user expectation;

(5) **Error management -** is the software capacity to avoid interruptions during the study session due to user errors or misunderstandings;

(6) **Consistency -** to allow the user become familiar to the software as early as possible during the study session;

(7) **Self-explained orientation -** to avoid user getting lost during software navigation; and

(8) **Compatibility -** is the software capacity to reach user characteristics such as memory, perception, habits, age, expectations, etc.

## Advantages

Some relevant advantages of a multimedia tool, to achieve the requirements of the teaching and learning process, can be listed. A multimedia tool:

(1) allows user to exercise his self-control during the study session;

(2) motivates user to go deeply in the subject;

(3) allows user to learn at his own pace;

(4) makes possible user to study any time of the day at his choice; and

(5) makes possible user to feel more self-confident in learning by himself.

## Disadvantages

Taking a close look to a multimedia tool, it is also possible to identify some important disadvantages. A multimedia tool:

(1) requires a significant effort to be prepared;

(2) requires a computer to be available;

(3) requires a place with a specialized infrastructure installed;

(4) requires high cost investments;

(5) requires a team of specialized people to prepare the package.

## Conclusions

A close view of a digital multimedia tool was presented. The software, named MECSOLOS, allows the undergraduate engineering students to learn the geotechnical concepts of Stress Distribution in Soils. Requiring only a limited assistance of the teacher, the students can navigate through the text, images, animation and graphics by themselves. The content of the package is also presented, including a copy of two windows, as examples. This multimedia tool was prepared using the authoring software called TOOLBOOK, and was considered a pilot experience in learning through an electronic tool. Some ergonomic aspects of the software were discussed and some advantages and disadvantages were also presented. An experimental use of the package in five universities was done, involving around three hundred students. The results were considered very positive, not only for the tool itself but also for the new learning technology. It is possible foresee a great future for such multimedia learning tools.

## Acknowlegment

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