Engineering Education Procedures Based on Compute Simulation Resources as an Alternative for Laboratory Facilities

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Abstract.

When teaching the majority of the disciplines of an Engineering Course, of any specialty, it is of fundamental importance that theory classes could be connected to experimentation, in order to give to the students the necessary perception of the actual applicability of any new knowledge. In developing countries it is nearly an utopia to try the application of the full experimental teaching methodology, in face of the high costs of laboratory facilities that only a few Schools of Engineering can afford. As a consequence, a significant number of professionals are not really prepared after finishing their courses, demanding a long time of training after graduation and, frequently, a personal deception with the career. It is in this scenario that the availability of computational resources adapted for mathematical simulation appears as a methodological alternative to experimental classes, with the creation of virtual laboratories that imply in a very significant reduction in costs.

Introduction.

With the accelerated development of computers technology verified especially in the last decade of 20th century and with the Internet great popularization and vertiginous growth, it was opened an enormous range of possibilities for the change of methods in the teaching process. This fact has special relevance for the neediest countries in financial resources, where one of the main limiting factors for the expansion and qualification of college level courses is the laboratory facilities high costs, being this particularly significant in the Engineering courses cases, where the experimental practice is fundamental for student's professional development.

The computer was going adopted as a virtual experimental teaching tool in the secondary level for some time already, for the teaching of physics, chemistry and biology mostly and, in this context, the INTERNET has shown to be a powerful diffusion vehicle of these programs and of this methodology, being replete of web pages[(1)] about the variedest matters, with virtual experimental exercises very detailed . This ones applications, however, have a common and important characteristic : the necessary hardware and software resources are relatively simple and a lot accessible and, perhaps, this is the only reason to be so spread. Few doubts on the validity and benefits of these application for the learning acceleration nowadays remain.

The higher education, especially Engineering, has differentiated characteristics that make more restricted and specific the development of applications aiming at substitution or complementation of experimental laboratory classes . Without a doubt, the most obvious inquiry is the

need for high resolutions of image resources and calculation power, although these are exactly the computing topics that have been more developed, thus opening a universe of perspectives for applications.

The Beginning.

The initial computer applications in engineering had as main objective to facilitate the tedious but necessary execution of mathematical calculations in order to verify procedures of mechanical, electric or structural resistance. It was a time without drawings or colors and mostly without man's inter-activity with the computer, with restrict interest just for the engineering professionals, but not for the students, even because the equipments high costs restricted very much their application at schools, unless in specific computing education courses.

From decade beginning at 80's, with the starting production of personal computers with more appropriated technical characteristics, mostly those relative to the images generation, the computers were almost immediately applied from the pure numeric calculation to drawings generation and, following, for the creation of the primitive CAD programs for personnel use. At this moment it was inevitable that the engineering courses would incorporate the computer as a didactic tool.

Near the 80's decade final, there was a significant increase in personal machines computational power accompanied of an also significant reduction in hardware costs and this allowed that mathematical modeling projects and engineering processes programs could be developed and used with reasonable adaptation for the personal machines and, consequently, this promoted significant changes in the methods of engineering project and research. So that these methodology changes had influenced the learning process was a very few years matter.

Finite Element Analysis

Among all of the computer programs used in Engineering, without a doubt those that deal with the application of the method of the finite elements are the more widely used. The essence of the method[(2)] is in the numerical discretization of continuous nature functions and it was first applied in problems of engineering of structures and for the calculation of lineal deformations, but the development of solutions based in this method nowadays practically includes all the areas of Engineering. Ally to the computing power of the current machines, the method came to be the main modeling system and simulation of present time, having woke up the general interest of software companies that have made available several of these specialized kind of programs, with several levels of use easiness and also several ranges of price that, however, are still low when compared with the costs of actual laboratorial equipments for experimental teaching.

The integration of computer programs designed for creation of models established on the finite elements method with other programs directed to geometric drawing and with specialized programs for three-dimensional graphic design has created a new generation of systems that has made it possible to create virtual computer models very similar to the real world, endowed of a

very important capacity of iteration with the designer. When these systems are taken to the class room, they can facilitate enormously the engineering learning, regardless of the always present additional need to teach the students how to handle the systems, but this is always a professional qualification requisite.

Virtual Engineering

The sophistication of such systems already has reached levels where it is possible to admit to use the virtual reality terminology to denominate the projects analysis process. Herein also the Internet is once again a knowledge sowing powerful tool, where one can find a lot of WebPages specialized in divulge this subject[(3)] .

The utilization of virtual reality techniques in the engineering education can restrict a little the student's capacity for understand a real problem when compared to a real experiment but, on the other hand, it astoundingly increases the possible inclusion of themes to explore, in a experimental point of view.

Other but no less important factor for the adaptation of the virtual method experimentation which receives the subtitle name of this topic, resides in the fact that, as time passes, more and more the virtual reality systems become familiar and is lived by the students in their everyday lives, making it a more attractive teaching method for the young beginner and this, consequently, tends to increase the grade of assimilation of natural concepts. It is necessary that the educator keeps always in alert state for the possible deviations of a mathematical model from the reality, but this can't be an impeditive factor for the method application.

Virtual Laboratories

The natural following step to the concepts application related with the virtual reality technology as an engineering teaching tool remits immediately to the virtual laboratories concept, where the differentiation main factor is the massive shared resources utilization through the Internet. Some experiences are already being implemented[(4)], but the number of applications is increasing and certainly represents an advance regarding the applications of local characteristics because, at least, they propitiate the agilest change in information, increasing the quality control of the results and, consequently, decreasing the experiments mistake margin.

Costs

As in every and each new development, although all the natural initial doubts, when there is an economic advantage, if the cost-benefit relation is checked and it is verified favorable, it almost turns inevitable the continuity of the process and its continuous improvement, which finishes for suppressing the disadvantages and reinforcing the benefits. Many examples of similarly cases of this statement has existed along the history and certainly the virtual laboratories constitute one more case.

The versatility and multi-disciplinarily of computerized systems applications allow to reduce significantly the course with laboratory characteristic implantation costs at the same time that propitiate the enlargement of the roll of possible laboratory type experiment kinds . This cost-benefit relation should lead, in a very near future, to a generalized expansion of these systems

Conclusion

As a function of the discussions presented in the previous items, it is possible to affirm that the utilization of the virtual laboratories for the teaching of experimental matters in the engineering courses only has to contribute for the students formation quality, at the same time that propitiates reduction in the operational costs, factor that is of fundamental importance always, but especially in the cases of countries with limited national budget. To reinforce even more the method advantages for the developing countries, there is the fact of the intrinsic need for change of information among all the participants of the process, which feeds the knowledge exchange that consequently contributes for the differences minimization among engineering professionals from different regions of the world , factor which is of fundamental importance for a non-exclusion social and professional condition in the globalized society that is coming fast in the near future.

References

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(3) Virtual Reality Internet Links - http://www.insead.fr/CALT/Encyclopedia/ComputerSciences/
(4) Virtual Laboratories Internet Links- http://www.nln.met.ed.ac.uk/links.htm

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