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MODELING AND SIMULATION IN MECHANICAL ENGINEERING EDUCATION

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ABSTRACT
Computers and technologies as teaching and learning tools are now rapidly expanding into education. Mechanical engineering generally focuses on the creation and evaluation of physical things, but covers a broad range of technical, informatics and management areas. Through modeling and simulation, students not only learn a lot more about the subject, but also often have to resolve some real problems in industrial applications of the virtual technology and thus gain valuable experience. It is a challenge to the engineering education in universities which traditionally tend to lack the integration of knowledge and skills required for solving real world problems. This rapid transformation of industry into a globally interconnected enterprise has not gone unnoticed in academia, especially in engineering education. Our paper (supported by the literature review) indicated that students' understanding of the subject matter was problematic, and that the conventional teaching strategies and resources were not up to the challenge of the very complex content being taught.
Keywords: computer simulation models, engineering education, teaching, Internet

1. INTRODUCTION
Innovation and knowledge are fundamental to the economic development, growth, and future competitiveness of world. Together they can support global, national and regional growth and prosperity.
Technology and globalization have changed the way we do business; as a result, we have seen the emergence of a lifelong learning culture, one in which education allows us to keep pace with change. IT tools provide just-in-time learning, knowledge management, simulation, and visualization. Through the use of these tools, we have the opportunity to grow increasingly aware of the fact that learning is continuous and must be pursed with zeal to maintain a firm grasp on the opportunities presented through the expanding learning environment of the 21st Century.

2. ENGINEERING EDUCATION
Engineering education is education through which knowledge of mathematics and natural sciences are gained, followed up by a lifetime self-education where experience is piled up with practice. The key

words are mathematics, physics, experience and practice. It is difficult to understand mathematics and natural sciences just from reading a text book because they are too complex subjects to be represented only in that way.
Therefore, the teachers have to solve a difficult challenge, and show how the execution process of instructions is carried out. Furthermore, another key point to be taken into account is the previous knowledge of the student and his misconceptions. Both things are essential for every constructivist approach.

Books and simulators have been used as the basic tools to explain engineering's concepts. However, the use of a simulator as a didactic resource is necessary but not enough. Traditionally, engineering education has been content-centered, design-oriented, and permeated by the development of problem solving skills. More recently, team building and collaborative problem- based learning have been added. The amount of content deemed necessary for graduates of engineering degree programs has steadily increased over the last half century.

Development of computer technologies, interactive multimedia programming languages (e.g., JAVA), and the World Wide Web (WWW) make it possible to simulate almost all of the engineering problems on a computer.
In order to use technology in education correctly and effectively the application must be supported by proven pedagogical theories. The methodology that we use in mechanical engineering combine theoretical and practical procedures based on computer supported collaborative learning [1] and [2]) and the constructional learning .

Constructivism proposes to give more significance to the learning contexts as an alternative to the memorization. The significant contexts for the constructivist authors are situations of the real world that help to put into practice the experience [3].

The learning environments must be flexible and are characterized by the fact that the same knowledge can be represented in different ways. Computer must be a supporter tool for the experimentation and building of knowledge.

3. MODELING AND SIMULATION

Frontiers of computational techniques such as Computer-Aided Design (CAD), Computational Fluid Dynamics (CFD), and Finite Element Analysis (FEA) have advanced so much that they have transitioned from being scientific tools for simulating complex physical phenomena based on conservation principles, to engineering tools for analysis and design.
Maturation of computer software technologies such as simulation and visualization has made it possible for engineering designers to analyze and evaluate in the virtual domain. These new developments have become catalysts for creation of a new field, Virtual engineering, which uses computer and internet-based design, analysis and decision making tools for developing and evaluating different design options in the virtual domain, without engaging in costly mock-up experiments [4].

Although computer hardware is a contributing technology in itself, technologies that are of greatest interest are those of multimedia and Virtual Reality (VR).
Especially in engineering education, transformation of industry into a globally enterprise has not gone unnoticed in academia. A study commissioned by the National Academy of Sciences in 2005 titled “Educating The Engineer of 2020: Adapting Engineering Education to The New Century”, describes the use of information technology-enabled learning as being in its infancy and recommends further research on web-mediated learning [5].

The study recognizes that new information technology tools will change the learning environment in engineering education from primarily teacher-centric to student-centric. An important aspect of student-centricity is that students will be able to set their own pace of learning, with teachers playing the role of guides in the learning process.

To set an example, a computationally oriented mathematics education combines traditional symbolic mathematics with computational mathematics and programming in the Matlab (Matrix Laboratory) environment. Engineering applications are explored in exercises that are taught joint with the courses in mechanics and thermodynamics.
SimMechanics extends Simulink with tools for modeling and simulating mechanical systems. It is integrated with MathWorks control design and code generation products, enabling you to design controllers and test them in real time with the model of the mechanical system.

Information technology enables online access to labs which has the potential to reduce equipment costs and even to allow sharing of specialized equipment between institutions. Examples of online laboratory Web sites are showed in Table 1, however, how well these online labs satisfy the ABET engineering accreditation requirements engineering criteria has not been rigorously assessed or specifically addressed [6]. This is an area for future research.

Table 1. Computer animations and examples of online laboratory Web sites, All URLs were active as of April 2008.

Resource	**Web site**
National Institute of Standards and Technology (NIST)	http://www.mel.nist.gov/melhome.html
Computer animations of physical processes	http://physics-animations.com/Physics/English/index.htm
Boston University	http://scv.bu.edu/
N. Simonson & Company	http://www.virtlab.com/Curriculum/phys.aspx
Cyberlab	http://www.cyberlab.org/
LabMentors	http://labmentors.com
Lab-on-Web	http://www.lab-on-web.com
University of Texas	http://www.robotics.utexas.edu/simulations/
Johns Hopkins University	http://www.jhu.edu/~virtlab/virtlab.html
MIT	http://weblab.mit.edu/

Strategic manufacturing is a hot topic today. Manufacturing simulation should be treated as a key component of strategic manufacturing. Manufacturing simulation focuses on modeling the behavior of manufacturing organizations, processes, and systems. Organizations, processes and systems include supply chains, as well as people, machines, tools, and information systems. Other examples of manufacturing simulation applications include: the modeling and verification of continuous and discrete manufacturing processes (e.g., machining, sheet metal forming, injection molding, semiconductor fabrication), offline programming of robots and other machinery, site selection, layout planning, ergonomic analysis of manual tasks and work area layout, process and system visualization, dispatching rules and evaluation of scheduling algorithms, and business process engineering. Simulation models are built to support decisions regarding investment in new technology, modeling of supplier relationships, materials management, human resources and expansion of production capabilities.

4. CONCLUSIONS

Teaching engineering courses follow the traditional pattern: mathematic, theory, analysis, modeling and design. This is followed by laboratory exercise in order to highlights the particular theoretical concept. The use of modern teaching method to simplify the theory like multimedia, internet, simulation software and visualization will enhance the conceptual understanding.
Simulation software can change the way the engineer approach problems, also student find pleasure by being active in the computer exercise. The availability of multimedia and Virtual Reality techniques with simulation features initiates a new appearance for learning applications, real-time presentation of 3D data. Learners attach great importance to most possible authentic event experience and to high-grade real movement in the learning space.
The use of computer simulations in engineering science began over half a century ago, only in the past decade or so have simulation theory and technology made an impact across the engineering

fields. For example, a host of technologies are on the horizon that we cannot hope to understand, develop, or utilize without simulation.

Advances in mathematical modeling, the speed of computers, computational algorithms, and the science and technology of data-intensive computing have prepared the way for unprecedented improvements in the health, productivity, security, and competitiveness. Progress will require significant breakthroughs in research, changes in the research and educational cultures of academic institutions, and changes in the organizational structure of educational system. For the engineering fields, advances in computer simulation offer rich possibilities. Full exploitation of the new capabilities, however, must await basic research into the scientific components of computing modeling and simulation, among other areas.

5. REFERENCE

[1] Lorenzo Moreno, Carina Gonzalez, Ivan Castilla, Evelio Gonzalez, Jose Sigut: Applying a constructivist and collaborative methodological approach in engineering education, Computers & Education, Volume 49, Issue 3, November 2007

[2] A. Martinez, Y. Dimitriadis, B. Rubia, E. Gómez and P. de la Fuente, Combining qualitative evaluation and social network analysis for the study of classroom social interactions, Computers & Education, Volume 41, Issue 4, December 2003.

[3] R.A. Knuth and D.J. Cunningham, Tools for constructivism. In: T.M. Duffy and D.H. Jonassen, Editors, Constructivism and the technology of instruction: a conversation, Lawrence Erlbaum Associates, Hillsdale, NJ 1991.,

[4] Bryden, M. and McCorkle, D. “Virtual Engineering,” Mechanical Engineering Magazine online, http://www.memagazine.org/backissues/membersonly/nov05/features/virteng/virteng.html, November 2005

[5] The National Academy of Sciences, “Educating the Engineer of 2020: Adapting Engineering Education to the New Century,” Washington D.C., National Academies Press, 2005

[6] ABET, Inc., formerly the Accreditation Board for Engineering and Technology NI for ABET Accreditation: Top Five Reasons, http://zone.ni.com/devzone/cda/tut/p/id/5594.