

VIRTUAL TEACHING ENVIRONMENT APPLIED TO ENGINEERING SCIENCE IN MASTER-LEVEL EDUCATION

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Abstract: This paper deals with a presentation of inclusion of modern teaching methods in master-level engineering education process at Engineering Faculty in Braila. This paper describes how the courses are laid out in order to achieve the desired goals and how the virtual laboratory experiments should fit into the courses to promote multidisciplinary and interdisciplinary understanding. A practical example of master degree studies will be provided as an example of good practices in supporting of National educational process to become harmonized with European Area of Higher Education.

Keywords: education, mechanical engineering, master-level, virtual instrumentation.

1. INTRODUCTION

In many fields of science and engineering, virtual instrumentation has become an indispensable solution, along with theory and experiment, in the pursuit for knowledge of technology. In this paper the authors present the implementation of Virtual Instrumentation on new core courses for one of MSc-ME degree programs at "Dunarea de Jos" University, Engineering Faculty in Braila. These courses were developed in the Department of Technical Sciences, and take place in the area of multidisciplinary dynamic systems in order to reach this goal. The basic idea is to teach these courses using a unified approach to multidisciplinary systems, with virtual laboratory experience and system simulation using different software packages and applications.

Regarding the software it was considered two main directions, as follows: the first consisted by powerful and consecrated packages like Matlab®, Maple®, LabVIEW®, Working Model®, and much more others, and the second framed by self-made (or home-made) software applications using one of the common high level programming languages at this moment. Of course, the very basic idea supposes permanent focusing on an inquiry-based problem-driven approach.

Upon completion of this MSc-ME program, the students should be able to demonstrate a good understanding of design, modeling, identification, simulation, analysis, and deploy of multi- and inter-disciplinary engineering systems. Although it includes elements from computer science, applied mathematics, engineering and science, this master focuses on the integration of knowledge for the development of problem-solving methodologies and robust tools which will be the building solutions to scientific and engineering problems.

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2. VIRTUAL INSTRUMENTATION IN MASTER-LEVEL EDUCATION

Virtual instrumentation is ideal for university laboratories because each user can construct their own instrument with the help of an open, interactive, flexible and friendly system.

2.1. Goals and objectives

The objective here is to develop and teach a set of courses in multi- and inter-disciplinary mechanical engineering including virtual laboratory experience for master engineering students. The goals to be reached in are the development of the following:

- Course material and a laboratory manual.
- A unified approach to teach multi- and inter-discipline mechanical engineering as a combination of various disciplines.
- A set of virtual experiments for each discipline laboratory.
- A set of applications to teach design, modeling, simulation, identification, analysis and deploy of multi-disciplinary engineering systems among master mechanical engineering students.
- Multi- and inter-disciplinary skills among MSc-ME students.

2.2. Resources and methods

Reorganization of MSc Programs at Engineering Faculty in Braila was the perfect reason to promote new ideas based on modern teaching methods. Therefore, *Computer Assisted Dynamics of Machines and Technological Equipments* MSc program, formerly known as *Dynamics of Machines and Equipments*, was the first beneficiary of laboratory virtualization. The list of courses provided for virtual laboratories implementation was given in Table 1. Note that the rest of courses in this MSc-ME program have no other directions unless the computer applications (such as FEA, CAD) or provides the basic information in addition with this master degree program (such as *Research management, Experimental research*).

Table 1. Partial courses list for Computer Assisted Dynamics of Machines and Technological Equipments MSc Program at Engineering Faculty in Braila.

No.	Course	Index
1	Equipment - Environment Interaction and Dynamics Modeling	c-01
2	Nonlinear and Random Vibrations	c-11
3	Dynamics of Vibratory and Shocks Actions Equipments	c-12
4	Dynamics of Hydraulic Driving Components and Systems	c-13
5	Dynamics of Elevation and Transportation Machines	c-14
6	Dynamics of Embankment and Foundation Machines	c-15
7	Dynamics of Construction Materials Recycling Machines	c-16
8	Dynamics of Vibration Isolation Systems	c-17
9	Noise and Vibration Pollution Disproof	c-18
10	Computational Advanced Methods and Systems for Dynamics of Machines and Technological Equipments	c-21

Virtual instrumentation is a way to build computational models for real world, and it requires understanding of the very basic ideas of modeling and simulation. Hereby in MSc-ME program it was provided a basic course of *Dynamics Modeling*, where it is teach and emphasize the idea of models. Modeling helps the system virtualization and it enables to specify the structure and the behavior of its. Each model may be expressed at different levels of precision.

Regarding the tools for modeling, software engineering provides UML (*Unified Modeling Language*) standard that means a code visualization approach with 13 different diagrams. A lot of software packages are based on or includes this standard. Other development packages supply user friendly graphical tools for building and analyzing the model (as such well known LabVIEW® software). The ordinary trend is to move to the model driven development in the embedded system engineering.

Another trend in modeling and simulation is to develop a self-made application, using a high level programming languages or math-oriented software's, dedicated to analyze a practical problem at one time [1], [2], [3]. This means a very profound approach of the reality, but a reduced feasibility regarding the future upgrades.

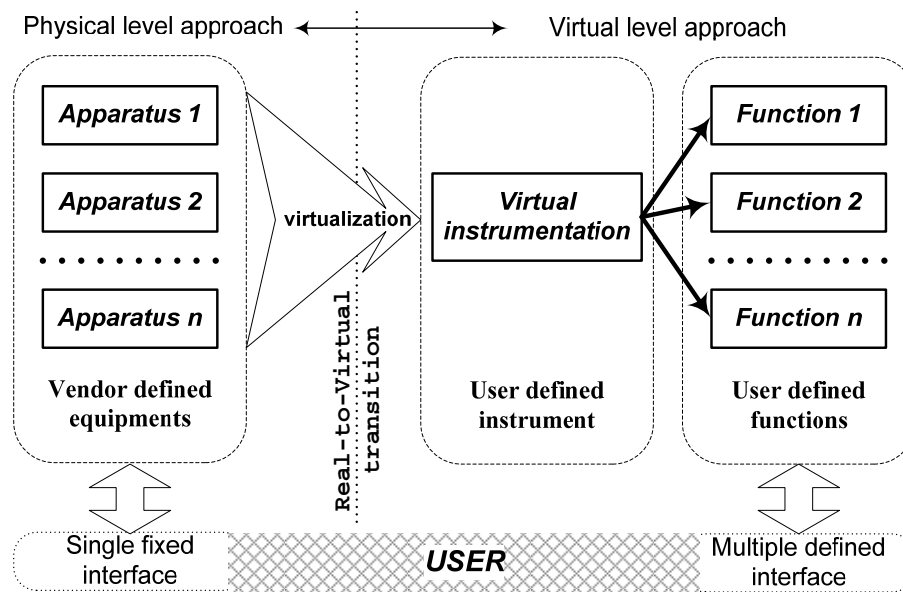


Fig. 1. Real-to-virtual world transition schematics.

Whatever the tools adopted for virtualization, the basic essential aspects are commonly and the schematic diagram of these was presented in Figure 1. This kind of virtual instrument helps to bring closer the reality through the separately physical instruments replacing with a set of virtual applications with the same functions at least. Acquiring real data and building the model is the main advantage of this approach.

In Figure 2 is depicted another schematics that shows a deeply linkage between modeling, simulation, analysis and deploy. Taking over the essential data from the real system leads to a proper model for it. Next, it will be simulate, analyze, modify the initial hypothesis, and return to the model, until the results will be suiting for deploying.

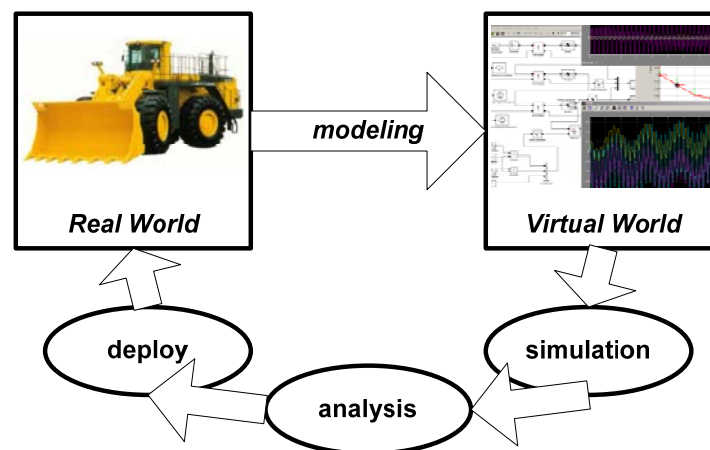


Fig. 2. Complete cycle of modeling-simulation-analysis-deploy.

2.3. Implementation and results

Courses structure presented in Figure 3 reveals the natural approach of the entire teaching process. The courses indexes have the significance in Table 1. The schematic in Figure 3 has except the improper disciplines for virtualization as it was presented in the previous paragraphs. The first course enables to understand what a dynamic model is and to learn how it was build and how it works. This course offer the right support for sketching, creating, using and developing of a dynamic engineering system model.

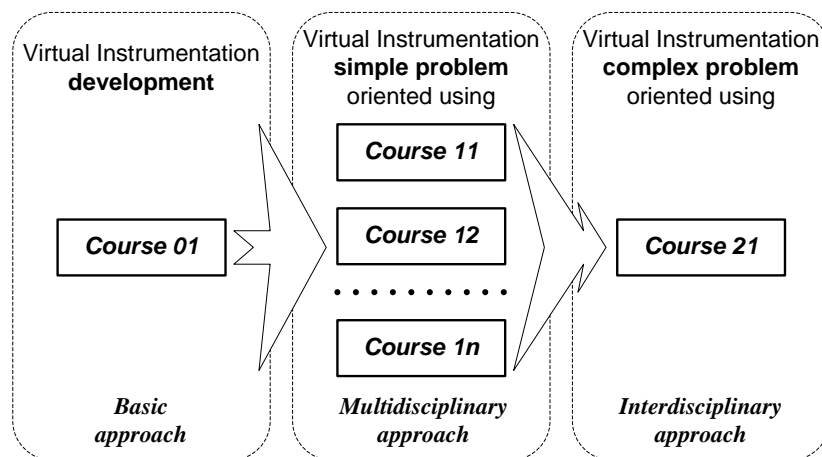


Fig. 3. Basic structure of MSc-ME courses in order to use the virtual instrumentation.

The next category of courses includes the proper frame to understand and solve simple problems. Each mechanical area used in technological equipments analysis has its own support. At this point the virtual instruments will be created in one of the provided software packages, as a function of its purpose. The last category includes a course which offers the basics for complex and advanced problems solving. It supplies multiple software platforms to create, use and develop a dynamic model for technological equipments.

There are three essential phases in the previous concept: design - adopting of proper research algorithms for model and build it; prototyping - implementing and integrating models for simulation and analysis; deploying - prototypes can be scaled to the reality such as customer wanted. According this, the presented MSc-ME program provides a large set of practical examples of virtual instruments in computational dynamics of machines and technological equipments and uses them in teaching and learning environments.

3. CONCLUSIONS

The engineering higher education must develop continuously. In the future there will be appear or develop also other more dedicated environments for teaching and learning build based on virtual instrumentation concept. It is important to understand also the key skills which are needed in the work of an engineer as the expert designer and developer of the new applications. To understand the higher level of abstraction by using the computational models and virtual prototypes is not very easy but to increase this understanding is one key task of the engineering teaching. Every teacher has some answers to the challenges that appear permanently. Also, the teachers and the students have to use various methods and techniques such as: collaboration learning, team works, problem based learning, learning in practice, learning by doing, e-learning, virtual learning environment etc.

Hereby the virtual instruments provide an excellent solution, because of a major reduction for laboratory equipment costs. Learning based on virtual instruments is an excellent tool to improve engineering higher education because of its flexibility, which can be used to overcome the complexity of the master-level engineering education opposites to other fields of education.

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