

WCES-2010

The use of virtual instruments in engineering education

Gilbert-Rainer Gillich^{a*}, Doina Frunzaverde^a, Nicoleta Gillich^a, Daniel Amariei^b

^a*EftimieMurgu University, Piata Traian Vuia No. 1-4, Resita 320085, Romania*

^b*Centre of Advanced Research, Design and technology - EftimieMurgu University, Piata Traian Vuia No. 1-4, Resita 320085, Romania*

Received October 30, 2009; revised December 8, 2009; accepted January 15, 2010

Abstract

Virtual instruments are used nowadays for measurement and control, but also as educational tools for students, being well accepted and stimulating innovation in the process of exploring the real world. It leads to discover interrelations, the phenomena are easier understood and theory is better assimilated. The tool can be used in real laboratories as well as in virtual laboratories, constituting a support for self-learning or distance learning. This article presents how virtual instruments can be used in engineering education, with examples from our Vibration Laboratory, together with a qualitative research regarding the perception of students to this issue.

© 2010 Elsevier Ltd. Open access under [CC BY-NC-ND license](https://creativecommons.org/licenses/by-nc-nd/4.0/).

Keywords: Virtual Instrumentation; engineering; education; distance learning; innovation.

1. Introduction

The fast development of powerful computers, with high processing speed and large available memory, equipped with adequate software has transformed the way in which engineers work. Virtual instruments have a special place in the world of measurements, permitting easy integration and flexible customization. Nowadays, virtual instruments are used as educational tools for students in various domains. On one side, are utilized to design the measurement system. On the other side, are used as simulation tools in a closed virtual world in which the user can observe the behavior of complex systems in different contexts, being of great help in understanding various phenomena.

This approach is generally well accepted by students, stimulating innovation in the process of designing proper virtual instruments. It leads also to discover interrelations, the phenomena are easier understood and theory is better assimilated. The tool can be used in real laboratories as well as at home, in virtual laboratories, constituting a support for self-learning or distance learning.

The present article aims to illustrate how Virtual Instruments can be used in engineering education, with examples from the Vibration Laboratory of the Eftimie Murgu University of Resita, together with a quantitative research regarding the perception of students to this issue.

* Gilbert-Rainer Gillich. Tel.: +40-744-790-524; fax: +40-255-210-230

E-mail address: gr.gillich@uem.ro

2. Learning using virtual instruments

Virtual Instrumentation (VI) can be used both for designing applications which simulate real-world devices and instruments, as well as for modeling and simulation of the real mechanical processes. This last facility represents an important and significant characteristic of LabVIEW, which can be used to create powerful tools in the education process. LabVIEW software, registered trademark of National Instrument Inc. (NI), represents a programming environment that include specific tools necessary for instrument control, data acquiring, storage, analysis, presentation and integrating of those features in a single system. It uses graphical programming and a special graphical language. The main goal of LabVIEW represents the creation of virtual instruments.

These characteristics make VI proper for self-instruction and distance learning. Distance learning is not widely used yet in engineering education in Romania, because of the numerous applications and labor works requested for this specialization. However, accepting that all forms of flexible education supported by information and communication technology can be classified as distance learning, in parallel with development of specific software, this type of education will find more and more place in engineering education.

3. Examples of applications

First is presented an example of using of a Virtual Instrument, created with LabVIEW software, used in learning about superposition of two harmonic vibrations situated in orthogonal plans. The vibrations are usually expressed:

$$x = a \cdot \cos(2\pi f_1 \cdot t + \varphi_1) \quad (1)$$

$$y = b \cdot \cos(2\pi f_2 \cdot t + \varphi_2) \quad (2)$$

Figure 1 illustrates the Front panel window of the Virtual Instrument, which is the interface to the user. It permits to change the values of amplitudes a and b , frequencies f_1 and f_2 and phase φ_1 and φ_2 using the buttons on the left side of the panel. A combination of these parameters gives Lissajous figures (known also as Bowditch figures). In this way students can visualize the effects of changing parameters.

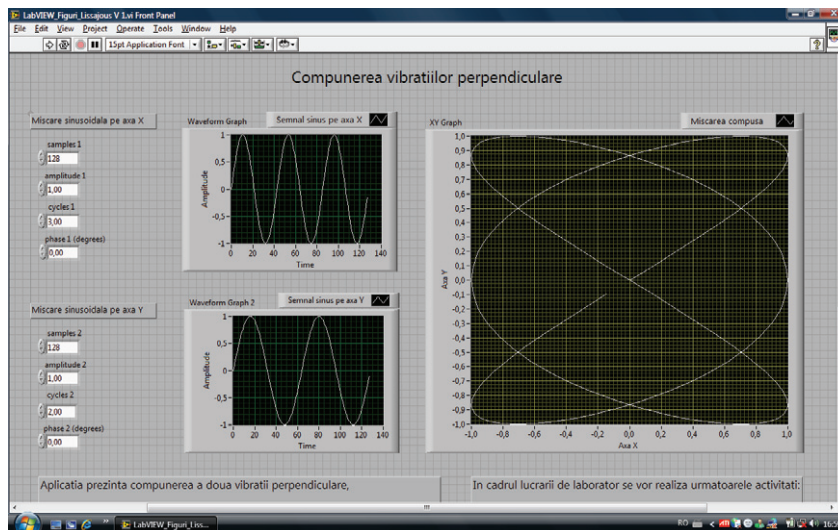


Figure 1. Front panel window of the Virtual instrument used to demonstrate the Lissajous figures

Figure 2 presents the Block diagram window of the VI, which contains the graphical source code. It is easy to be remarked the simplicity of the diagram, designed using graphical programming, an intuitive programming mode. This makes the programming environment user-friendly and acceptable even for inexperienced users.

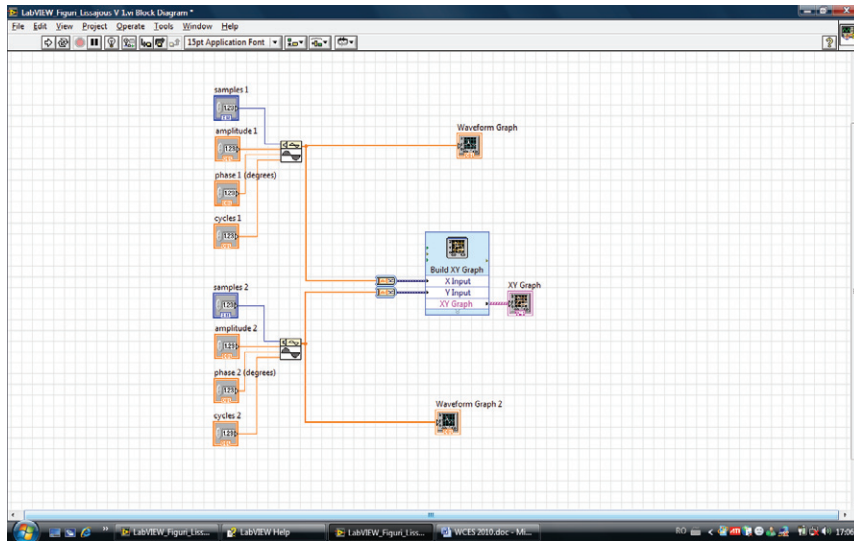


Figure 2. Block diagram of the virtual instrument

Another example refers to damage detection using the shift in frequency of harmed beams. This hands-on experiment is realized in four steps:

- measurement and processing the signal – the eigenfrequency is determined
- harm of the beam by realizing a transversal channel
- new measurement and processing of the signal – the new eigenfrequency is determined
- comparison of the two values of the eigenfrequency.

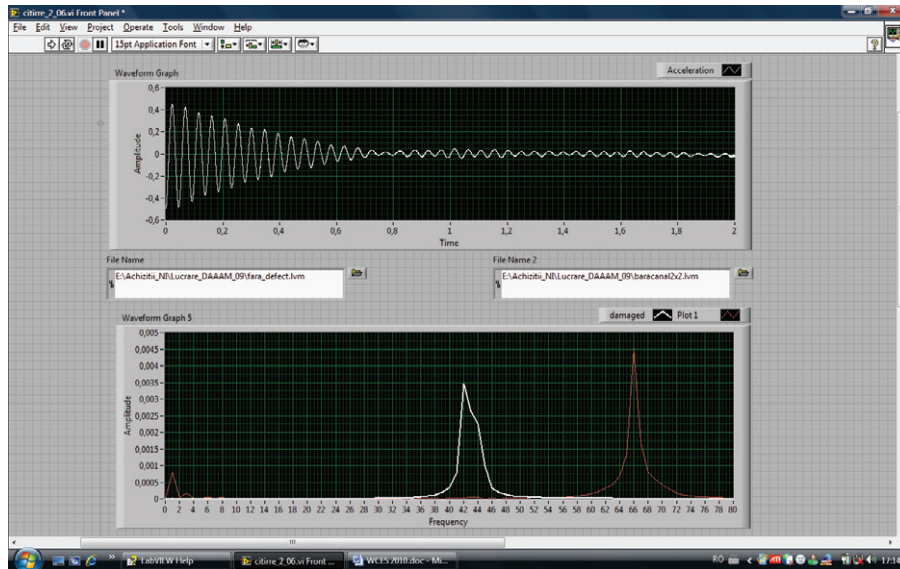


Figure 3. Front panel window Virtual instrument used to demonstrate the shift in frequency

This information is connected also to other disciplines like Strength of materials, by using Inertia moment and Young modulus as parameters to determinate theoretically the deformation of the undamaged and damaged beam. Realizing a series of experiments and correlating the values of frequency, damage dept and damage location, a model describing the behavior of the beam can be determined.

4. Quantitative research regarding the perception of students to use of virtual instruments in education

To find out the perception of student regarding the use of virtual instruments, a quantitative research was developed, taking as target group the students of mechanical engineering in the 5th semester. From 72 students, 45 have answered, the questions and corresponding answers are given in table 1. As a characteristic of the target group, it has large experience in using the LabVIEW program, consisting of 28 hours of applications in the laboratory.

Table 1. Answers to the Questionnaire

Question	Strong reject	Reject	Neutral	Accept	Strong accept
Resources (hardware and software) to use VIs are available				14	31
Is it easy to use VIs			2	21	22
You have used VIs mainly for measurements	29	18	7	1	
VIs can substitute seminars and problem solving	35	5	2	3	
The VI makes me understand better the phenomena				17	28
The use of VIs makes self-learning more facile		1	3	24	17

As shown in figure 4, the students appreciate in a very large measure that resources consisting in PCs and programs are available at the university, so that the use of VIs in education didn't consist an administrative difficulty. They also appreciate, a fact which we consider normal after a big amount of hours spent for applications, that the use of VIs didn't consist a technical problem. With this two questions we intent to determinate the acceptance of VIs in the education process.

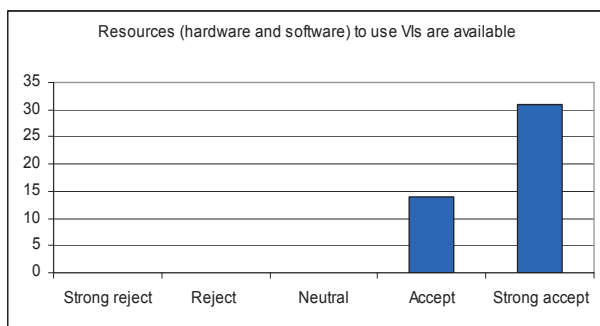


Figure 4. Availability of resources

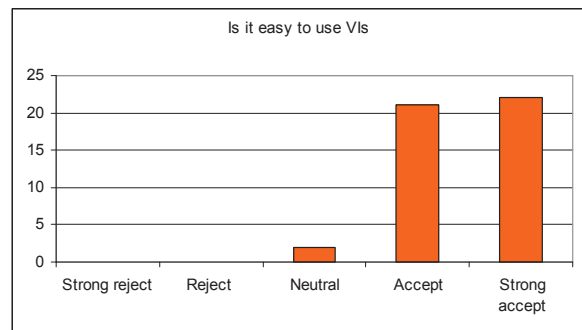


Figure 5. Easy handling

The next two questions are dedicated to express the opinion regarding the mean of using VIs. The answers at the first of them, as shown in figure 6, reflects that they are not exclusively used for measurements or control of processes. So, Vis are used also for education, but students strongly appreciate that they can not substitute seminars and problem solving, figure 7.

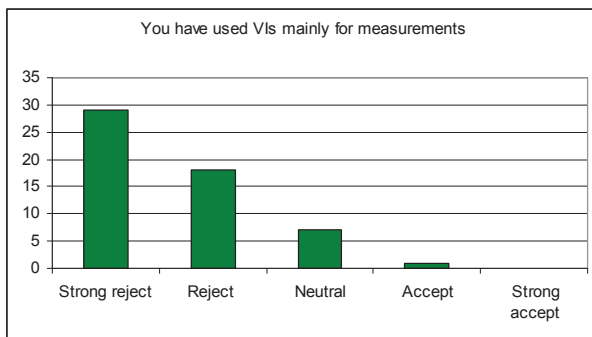


Figure 6. Use of VIs

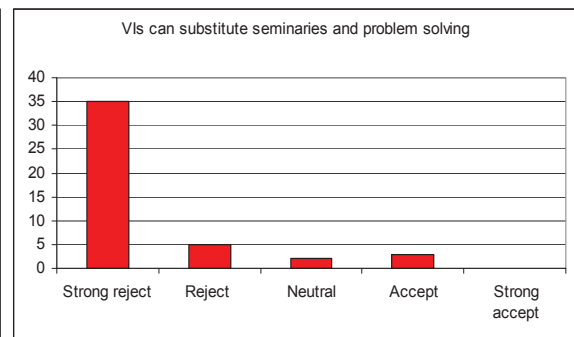


Figure 7. Substitution of seminars

Even so, virtual instruments are a powerful tool to increase performance in the learning process by clarifying complex phenomena in visual mode or by developing experiments, making facile the understanding of the real world. This facts are reflected both in figure 8, were the usefulness in assimilating dense information is researched, as well in figure 9, by demonstrating that VIs are a support for individual teaching.

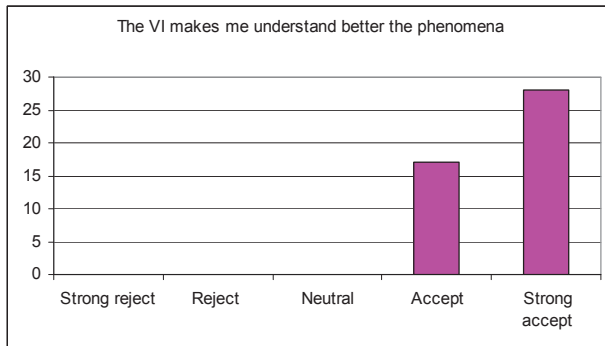


Figure 8. Support in understanding phenomena

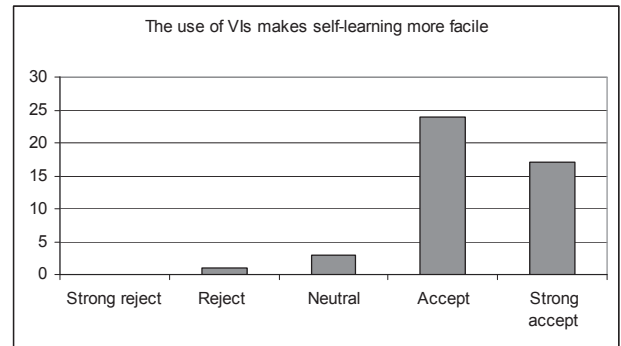


Figure 9. Utility in self-learning

Additional to these remarks, we can say that the use of virtual instruments makes the learning process more interesting, attract students to engineering studies (which are sometimes hard and exhaustible), stimulating in the same time creativity and innovation.

5. Conclusions

Students can be attracted to engineering studies trough the use of ICT in regular lessons and development of hands-on experiments, which make studies exciting and challenging According to this study, students accept to use virtual instruments for the educational process, being attracted by the flexibility and versatility of these tools which can change the social dynamics of the classrooms.

It can be also mentioned that virtual instruments increase the panel of means for educators, and together with other media like Java applets and supported by theoretical explanations, improving the quality of education.

References

- Dumitrescu, C., Olteanu, R. L., Gorghiu, L. M., Gorghiu, G. & State, G. (2009). Using virtual experiments in the teaching process. *Procedia Social and Behavioral Sciences*, 1, 776–779.
- Gillich, G. R., Amariei, D., Gillich, N. & Amariei, O. I. (2009). Premio – an electronic platform for entrepreneurial training. *Procedia Social and Behavioral Sciences*, 1, 2380-2384.
- Olteanu, R. L., Dumitrescu, C., Gorghiu, G. & Gorghiu, L. M. (2009). Related aspects to the impact of virtual instruments implementation in the teaching process. *Procedia Social and Behavioral Sciences*, 1, 780–784.
- Takayama, S. & Kariya, K. (2003). Heuristic Learning Tool on User Interface of Virtual Instrument. *Measurement science review*, Volume 3, Section 1, 61-64.
- Zaimovic-Uzunovic, N., Lemeš, S. & Petkovic, D. (2001). Virtual instruments – a chance to teach engineering at a distance. *International Conference on Engineering Education*, Oslo, Norway, Session 7D1, 24-26.