USING VIRTUAL INSTRUMENTATION IN
ROMANIAN SECONDARY EDUCATION

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Abstract:
ICT is playing an important role in the area of instrumentation nowadays. Started with an "old-fashioned" connection between an individual instrument and a computer, which provides the opportunity to display of measurement data on a virtual instrument panel, today, the VI applications can interfere with human activities in a very accurate way. In the last years, commercial software products for the development of virtual instrumentation systems appeared at a large scale. Most of them proposed graphical programming methods for their using and application developing. This fact made also to take VIs into consideration as an important option for the educational environment.

In Romania, the Ministry of Education, Research and Innovation created a strategy for implementing in education of the graphical programming environments and measuring computer systems. Started in 2002 with the introduction in several high schools of LabVIEW full development licenses, the teachers’ and pupils’ interest for promoting the use of virtual experiments in their classrooms became a real fact. The Socrates Comenius 2.1 European Project “VccSSe - Virtual Community Collaborating Space for Science Education” (128989-CP-1-2006-1-RO-COMENIUS-C21) has provided an important opportunity for the Science secondary teachers to be introduced and trained in the world of virtual instrumentation.

This paper tries to emphasize on the main aspects of the introducing of the virtual instrumentation in Romanian education, presenting also the main aspects of virtual experiments promoting in Dambovita County.

Keywords: Virtual Instrumentation; Virtual Experiment; IT Based Educational System; Comenius 2.1 project

1. Introduction

In 1972, Hewlett-Packard introduced a new computer on the market which was able to collect data from measurements made with different company instruments. James

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Trouchard, PhD student at the University of Austin, Texas, studied the curves obtained from experiments and listed to the printer, after which he measured with a gradual and noted the results in a notebook. It would be desirable to use the new HP computer, but he could not due to the fact that he had not HP instruments in the laboratory. Then, in association with other two colleagues, borrowed 13.000 USD and made a similar main board to that produced by HP which was able to connect a standard PC with any programmable instrument. Trouchard's idea has quickly become a business vision, which allowed replacing an 8.000 USD ready made instrument with a 3.000 USD main board that made the same things essentially. In this effectively and economically way, the user was able to connect the desired instrument in the own PC. One can say that Virtual Instrumentation was born... [1]. This new concept has completely changed how to think an application or an experiment, how to operate, transmit and communicate results between systems or partners.

Today, this innovative and pragmatic technique generates opportunities both in the world of business, as well as research and education, allowing a new approach especially addressed to engineering.

Virtual Instrumentation has five essential characteristics:

- **Substitution ability** - VI is the product that replaces widely a range of important “box” type products, both from the measurement equipment / control and hardware automation systems areas. The quality and reliability of these products is at least equal to those they replaced, at a price of up to 20 times lower.

- **New applied horizons** - the VIs enables the opening to a large field of applications that until now no technical solutions were economic viable.

- **Market generating power** - the VIs make possible the introduction of related devices and software together with PCs. As example, the *LabVIEW* solution represents a standard in the world of virtual instrumentation.

- **Sustainability** - the VIs will be incorporated in any new “box” products, becoming in this way a hard link in the user ordered system reconfiguration process. So, the hardware production becomes a materialization of the virtual-functional solutions automatically developed by the terminal production lines.

- **New paradigm** - VI gives to PC users the chance of harmonization with the natural environment as a path of sustainable development, which may compensate, at least in part, the “staying alone” phenomenon, generated by the sinking of people in the purely numerical computer universe.

### 2. Traditional vs. Virtual Instrumentation

Engineers have used the virtual instrumentation for 25 years. The specific applications are dedicated mainly to application design, testing and control both for analog and digital measurements. National Instruments, the world leader of the related industry, sells more
than six million application units in a year. The strategy of the company consists in the development of punctual technologies, able to be used or adapted to the operating systems or other tools developed by IT market leaders like Microsoft, Intel, Analog Devices etc.

A comparison between the performances of traditional and virtual instrumentation must take into account the fact that the last one takes the digital format and can be characterized by two main parameters: resolution and frequency. The comparison results are shown graphically in figure 1. It has to be mentioned also that the virtual instruments are almost consistent with the classical instrumentation, without exception, and the instrumentation software contains interfacing libraries. Thus the NI Instrument Driver Library contains over 4000 instrument drivers from more than 200 vendors [2].

![Graph showing comparison between virtual and traditional instrumentation](image)

**Fig. 1** Comparison between the performances of virtual instrumentation equipment versus traditional ones (source: [3]).

Related to the used measurement architectures, figure 2 illustrates two structures, based on similar principles, but with radically different functional philosophy: the traditional instruments are based on physical and predominantly analog processing, while the virtual is based on software processing, digital exclusively. Each virtual instrument is composed of two parts: a program and device usually provided at a reasonable price. In addition, the flexibility of the virtual solution is an important gain, because the user can customize the software acquisition, the analysis, storage, sharing and presenting data. Two facets of flexibility are illustrated in figures 3a) and 3b): using the same applications with different devices or using of the same device for multiple applications [3]. A modern evolution trend of virtual instrumentation is offered by the development of synthetic instruments which have been implemented in automated testing applications. They consist of a set of modular devices, programs, reshaped and standardized interfaces which generate signals or make
measurements using numerical techniques. In this way, a transition is made from the instrument architecture level to the system level.

![Measurement architectures: traditional (left) and virtual (right) (source: [3]).](image)

**Fig. 2** Measurement architectures: traditional (left) and virtual (right) (source: [3]).

![Using the same applications with different devices; b) Using of the same device for multiple applications (source: [3]).](image)

**Fig. 3** a) Using the same applications with different devices; b) Using of the same device for multiple applications (source: [3]).

### 3. Introducing Virtual Instrumentation in Romanian Education

The global information society - immersed in a full crystallization process today - has other rules of functioning and presents another set of values and needs. In such a society, education is adapted itself, especially through the use and integration of ICT. In this direction, virtual instrumentation represents an opportunity and also a challenge for education. In the past years, system integrators were focused to the educational sector, especially directed to higher education but with important opportunities dedicated to secondary school.
The range of available applications for education become very large: data acquisition systems, instrumentation systems with interfaces for measurement and control, signal conditioning systems, digital signal processing equipment, computer-based instrumentation for laboratory applications, advanced application software, technical support. The offers are also multiple: software applications developed by National Instruments for Windows Vista/XP/2000/NT/Me/9x as: LabVIEW, LabVIEW Datalogging and Supervisory Control, LabVIEW Vision Development Module, LabVIEW Real-Time, LabVIEW Add-on Software, Measurement Studio, Lookout, IMAQ Vision, TestStand, NI Developer Suite [4] or educational applications elaborated in accordance with the beneficiaries requirements. For developing virtual instrumentation applications and data acquisition systems, the educational environment use mainly the LabVIEW graphical programming software, because it combines very well the power of the latest software technology with the simplicity of graphical programming, offering the possibility to design easily applications for data acquisition and processing, testing and inspection or laboratory applications. In addition, the HIQ interactive mathematical software is used for numerical analysis and data presentation, modeling / simulation applications or complex data visualizing. Such software can be used successfully in laboratory conditions, accompanied by the corresponding application hardware, typically PCs or PC networks.

In Romania, the Ministry of Education, Research and Innovation has defined a strategy for implementing the graphical programming environments and measuring computer systems in education. It is known that the General Directorate for Computerization and Resources has already started a process of introducing of virtual instrumentation in secondary education, through the SEI (IT Based Educational System) program. This is a complex program initiated in 2001, aiming to offer ITC support for the Romanian education system (http://portal.edu.ro/index.php) [5]. In fact, Romania is the first country in the world where this is happened following an organized scheme, now having the chance to offer the best practices and successful examples and not to recover an existent gap in relation with other developed countries. The implementation in the secondary education has as main objectives [6]:

- familiarizing of students with a programming environment that allows them to develop new applications (this objective is addressed especially for non-informatics areas);
- equipping teaching laboratories which use experimental stands or assemblies, with computerized measuring systems.

After a period in which various copies or non-licensed software were used, the Romanian Ministry of Education acquired, in 2002, with a great support from National Instruments Corp. U.S.A., LabVIEW full development licenses for several hundreds high schools, distributing the first licenses especially in the units were the environment was already known, evaluation versions were previously used or teachers had some LabVIEW training or prerequisites [7]. This was the step when LabVIEW licensed software was offered to 133 high schools, in the first phase. This fact led to a significant increase of the
number of users and didactic applications (made by teachers themselves) and also to the emergence of various collective of teachers and students with outstanding abilities in this field.

In order to generalize the basic concepts of using LabVIEW, specific graphical programming aspects have been introduced into the syllabus of the related discipline (Computer Aided Technologies) and a manual has been also published (in 2000) \[8\]. Having in view that LabVIEW can be taught in a larger number of schools, it is necessary to develop a well organized system of training and certification of the teachers and trainers, including e-learning technologies. On the other hand, it is important that more teachers and students to start preparing specific virtual instrumentation applications.

In Dambovita County, there are already schools, teachers and students with great interest in the field of virtual instrumentation, some of them having good results till now. Here, it can be mentioned the following schools: National College Ienachita Vacarescu Targoviste and the Aurel Rainu Fieni and Spiru Haret Targoviste High Schools which have laboratories equipped with virtual instrumentation systems at this moment.

In the implementation process of virtual instrumentation in schools - proposed by the Romanian Ministry of Education, Research and Innovation - several difficulties were met. Even that the syllabus provides hours for graphical programming, some teachers prefer to replace them with classical programming. This fact is happening due to the existence of alternative textbooks whose content does not match the established syllabus and also to the lack of information or interest from teachers. In addition, many software licenses already distributed are not used either due the low level of collaboration between teachers and also to the lack of information related to the equipment or its inefficient using. The training of the teachers is still unsatisfactory both to the reduced number of training centers and as result of low quality of training. For reducing of the mentioned aspects, several actions have been proposed:

- checking (more carefully) the way of how the syllabus is implemented;
- equipping the laboratories with computer systems dedicated for measurement and providing related funding for acquisition, installation, maintenance and debugging;
- designing, developing and distributing of special experimental stands for didactic applications;
- organizing of actions for presentation and dissemination with a view of increasing the teachers’ interest for the virtual instrumentation area;
- informing students directly with the purpose of training with a view to create a general favorable opinion;
- organizing of training sessions and awarding accredited certificates;
- uploading of free training materials on Internet;
- supporting the schools in which the virtual instrumentation applications are used successfully.
Today, the European context provides opportunities and ideal frameworks for innovation and allow for experimentation with new approaches to various problems or new approaches to new problems. This is also the case for the projects which try to transfer specific skills related to the use of virtual instrumentation for educational purposes.

4. The VccSSe Project

The Project “VccSSe - Virtual Community Collaborating Space for Science Education” (a three-year Socrates Comenius 2.1 European project - 128989-CP-1-2006-1-RO-COMENIUS-C21 - started in October 2006) [9] offered an important opportunity for the Sciences secondary teachers to learn how the virtual instruments can support the development of virtual experiments and how to apply teaching methodologies and pedagogical strategies based on VIs to the teaching process.

The project activities have been designed targeting to different groups. Beside the local coordinators, tutors, researchers, local educational authorities, more than 360 teachers participated to the training modules organized as a course called “Virtual Instrumentation in Science Education” (organized in 2 editions) that introduced the specific virtual instruments concepts, available software packages, pedagogical methods and also particular and didactical elements for some very used VI software: LabVIEW, Cabri Geometry, Crocodile Clips and GeoGebra [10].

87 Romanian teachers started the training modules and 45 finalized the training phase by creating of a learning object which consists of a lesson plan and (at least) one virtual instrument ready to be implemented in the classroom. The teachers’ products are included in the Products Matrix (build as a database for educational virtual experiment) in the project web-site (http://www.vccsse.ssai.valahia.ro). Here, it can be found information concerning the teachers’ products, the experiment files and lesson plans. Figure 4 illustrates the Matrix for the products created by the in-service teachers trained in Targoviste, during the second edition of the course. In Targoviste, 13 teachers attended the first edition of the training modules and other 11 finalized the second one. 11 products were created for lower secondary schools, 6 for upper secondary schools and 7 products were also designed for primary schools (most of them for Mathematics lessons) [11].

Consequently, over 900 Romanian pupils participated to the lessons created by their teachers. All of them expressed a very favorable feedback related to the using of virtual experiments presented during the Sciences lessons.

5. Conclusions

The widespread introduction of graphical programming in the educational process can only have beneficial effects and the equipping of didactic laboratories with computerized measuring systems represents a necessity similar to the endowment with measuring devices. In order to obtain the desired sustainable development effect, the complex process
Virtual Instruments and Tools in Sciences Education - Experiences and Perspectives

of implementation should allow efficient adaptation to the exponential development of technology and to achieve the active participation of teachers who will decide on the experimental configurations and have the opportunity to improve, develop or change the software applications.

On the other hand, introducing virtual instrumentation represents a solution extremely cheap for the modernization of school laboratories and its effect on the students can be compared with the transition from the use of abacus and calculus ruler to the pocket calculator and PCs. Consequently, the current problem is not whether virtual instrumentation should be used widely, but how quickly will take this process in term of time. The VccSSe project offered a very favorable answer coming from both teachers and students concerning the introduction of virtual instrumentation / virtual experiments in the Sciences lessons.

![Fig. 4](image_url)  
*Fig. 4 The VccSSe Products Matrix created by the Targoviste in-service teachers (edition II).*

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References


