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## Minerva

**INDIVIDUALIZED LEARNING ENHANCED BY VIRTUAL  
REALITY; *IDENTITY***

**229930-CP-1-2006-1-RO-MINERVA-M**

## **Workshop on using VR in education**

### **Proceedings**

**Universidade Nova de Lisboa**  
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Luis Gomes, Gheorghe Scutaru (Eds.)

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Workshop on using VR in education Proceedings

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Address: Faculdade de Ciências e Tecnologia Lisboa - Departamento de Engenharia  
Electrotécnica  
2829-516 CAPARICA  
Portugal  
email: lugo@fct.unl.pt

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## CONTENT

1	Corneliu COFARU, Mihaela POPESCU, Daniela FLOREA	COMPLETE -New Strategies of COMPetence Acquisition for Lifelong Learning in Energy – Transport - Environment Engineering Leonardo da Vinci Pilot Project RO/04/B/F/PP – 175016	5
2	Gheorghe SCUTARU	Socrates/Minerva Project: <i>INDIVIDUALIZED LEARNING ENHANCED BY VIRTUAL REALITY, IDENTITY; 229930-CP-1-2006-1-RO-MINERVA-M</i>	11
3	Anna-Kaarina Mörsky- Lindquist, Kennet Lindquist	Dissemination and Valorisation Strategy Guide for project partners	17
4	Gheorghe SCUTARU	Intellectual Property Rights in EU projects	31
5	Anna Marina Scapolla, Andrea Bagnasco	Metadata for Online Experiments	41
6	Massimo Mustica	Metadata for Online Experiments: Laboratorio delle Idee's point of view	49
7	Sorin-Aurel Moraru, Paul Nicolae Borza, Massimo Mustica, Ionut Ilarie Diaconu	A Remote Learning System (RLS) – from portal to semantic web	58
8	Florin SANDU, Paul Nicolae BORZA	Real and Emulated Experiments for e-Learning and m- Learning Implemented by Virtual Instrumentation	71
9	Volker Neundorf, Vera Yakimchuk, Heinz-Uhlrich Seidel	GETsoft/LabWeb - a virtual electrical engineering laboratory for first-year students	83
10	Anna Marina Scapolla, Domenico Ponta, Giancarlo Parodi, Giuliano Donzellini, Andrea Bagnasco	DIBE - Existing e-learning products	89
11	Fernando COITO, Luís GOMES, Anikó COSTA	Simulation, Emulation and Remote Experiments	99
12	Viliam Fedák, Daniela Perduková	Advanced Education in Mechatronics	111



# **COMPLETE -New Strategies of COMPetence Acquisition for Lifelong Learning in Energy – Transport - Environment Engineering**

## **Leonardo da Vinci Pilot Project RO/04/B/F/PP – 175016**

Corneliu COFARU, Mihaela POPESCU, Daniela FLOREA  
 “Transilvania” University of Brasov

**Key words:** *Lifelong Learning, Innovative Methods of Learning*

### **Abstract**

The paper presents some aspects regarding the conditions of submitting the proposal of introducing new interactive learning methods for lifelong learning in Transilvania University of Brasov: problem based and project- based learning methods, as the most appropriate for this type of learning. In the same time, the partnership, objectives, learning activities, main outcomes and dissemination of the results of COMPLETE project are presented.

## **1 INTRODUCTION**

Living in a world where the progress of science and technology is in a greater and greater progress, where individuals are confronted to problems concerning time management, e-learning, the delivery of learning, training and education program by electronic means is welcome. It replaces the face-to-face learning method as a traditional method of teaching and learning.

### **1.1 Lifelong Learning. Concept**

As it is stated in the *Memorandum* of the European Commission, the definition used for the concept of lifelong learning is: *all purposeful learning activity, undertaken on an on-going basis with the aim of improving knowledge, skills and competence*, or, in other terms, lifelong learning basically comes from the concept according to which: it is never too soon or too late for learning; a philosophical concern existing in different organisations. Lifelong learning is open to new ideas, encourages decision-making, and provides skills, attitudes and behaviours. Learning opportunities at all ages and in various contexts are offered the individuals.

The *Communication* from the Commission, 2001-*Making a European area of Lifelong Learning a reality* « revises the definition of lifelong learning to emphasise the importance of its four broad objectives of active citizenship, personal fulfilment, social inclusion, and employability, and to encompass the full range of formal, non-formal and informal learning activity.

The main issues and areas of work identified are:

**Valuing learning:** valuing formal diplomas and certificates and non-formal and informal learning in all sectors.

**Investing time and money** in learning: increased investment and targeted funding are called for, along with mechanisms for increasing private investment.

**Encouraging and supporting** learning at the work place, including in SMEs.

**Guidance and counselling:** ensure that everyone can easily access good quality information and advice about learning opportunities throughout Europe and throughout their lives.

Work should focus on **providing opportunities** to acquire and/or update basic skills, including the new basic skills, such as IT skills, foreign languages, technological culture, entrepreneurship and social skills.»

Lifelong education is a form of pedagogy accomplished through distance learning, e-learning, continuing education among other forms. For those who want to improve their qualification, bring their skills up to date or retrain for a new line of work, lifelong learning education system includes postgraduate programs.

The acceleration of scientific and technological progress is one of the major reasons for which lifelong education has become so important.

The concept of lifelong learning includes learning for personal, civic and social as well as for employment-related purposes. It takes place in and outside the formal education and training systems.

Lifelong learning implies raising investment in people and knowledge; promoting the acquisition of basic skills, including digital literacy; and broadening opportunities for innovative, more flexible forms of learning.

## **1.2 Innovative Methods of Learning**

For university, education process provides a student/trainee-centred learning and is aimed at equipping them with attitudes and skills to learn for themselves both in formal education and long after they have graduated, at recognizing that learning occurs in a wide variety of contexts both in the academic and non-academic settings, and beyond, in the community. Education in this academic context is a broad goal rather than an educational process. Trainees are taught how to plan their own research project, how to be active in organising the information and the other resources, how to learn from experts in other fields, how to integrate knowledge from different subject areas when required and, not the least, how to use different learning strategies for different situations.

The starting point in our approach in designing the goals of the project was the mismatch between what is taught to the students or former students and what industry needs.

Many institutions are moving towards problem-based learning as a solution to producing graduates who are creative, can think critically and analytically and are able to solve problems specific to different situations. One of the way we can reach this goal is the use of multimedia technology as an innovative teaching and learning strategy in a problem-based learning environment by giving the trainees in ETEE a multimedia project to train them in the skill set. This purpose is to access the trainees' skills in framing and solving problems. They work in groups and each group has to pick a topic for their project, designing it and developing it.

**Problem-based Learning and Project-based Learning – Interactive Learning Methods**

Since knowledge is no longer an end but a means to creating better problem solvers and encourages lifelong learning, problem-based learning and project-based learning is becoming popular in academic institutions as a tool to address the inadequacies of traditional teaching. This one does not encourage students or trainees to question what they have learnt or to associate with previously acquired knowledge; problem-based learning is seen as an innovative measure to encourage students/trainees to learn how to learn, via real-life problems.

The query “why do we need to know this?” is replaced by the question “what do we need to know?”. Asking this later question, students become responsible for their own learning; they tap into their creative resources, they develop direction and focus. In this context, teachers become mentors and facilitators. They move among groups, directing students' discussions and energies when appropriate. The teachers-mentors cultivate skills, focus efforts, foster resourcefulness and maintain an interactive climate of learning. By using problem-based learning and project-based learning, by decentralizing the classroom, students/trainees discover the latitude to explore ideas and express themselves. They must engage others and

confront ideas to them. They feel the advantage of active learning. They can decide how to proceed and express themselves. If knowledge means information, it also means understanding. Therefore, we need to provide opportunities for the trainees to foster understanding and problem-based learning and project-based learning as interactive methods provide such opportunities.

## 2 COMPLETE PROJECT

Training in the field of Energy, Transport and Environment Engineering (ETEE) is of a major consequence in the university's educational practice.

### 2.1 Objective and Partnership

The main objective of COMPLETE project is to develop new strategies for increasing the trainers' lifelong teaching and learning competences by using interactive methods and modern training programmes in Energy–Transport–Environment Engineering (ETEE).

The partnership of project comprises:

P1-“Transilvania” University of Brasov-Romania;

P2-Gent University Belgium;

P3-Paris 7–Denis Didrot University–France;

P4-Laboratorio delle Idee-Italy;

P5-UNINOVA-Development Institute for New Technologies–Portugal; P6-

ARCE- Romania Agency for Energy Conservation-Romania;

P7-AsTEC- TEMPUS-Association for Continuing Education;

P8- INAR-Road Vehicle Institute Brasov-Romania;

P9-Louis Pasteur University-France.

### 2.2 The Aims

The specific aims of COMPLETE project are:

1. *Training of trainers in energy-transport-environment engineering (ETEE) by applying an innovative approach of the lifelong teaching and learning process:*

Updating and upgrading trainers' didactical competences through designing and developing the training programmes in ETEE (target group I) to adopt and implement two interactive, interdisciplinary and complementary methods - Problem-based Learning (PbL) and Project-based Learning (PjL) – in connection with web-based learning, peer-tutoring, mentoring and assessment - as elements of an innovative approach;

Improving the European dimension of trainers and learners through designing and developing a training module for the development of linguistic, communication and ITC competences.

2. *Producing the practical tools required for implementing this innovative approach:*

Developing and adapting an e-lifelong learning platform, taking into account the training needs in energy -transport - environment engineering, where the new e-products are included; Designing and developing e-products (e-learning objects) in ETEE domains, facilitating interactive and innovative teaching and learning methods.

3. *Applying and using the human and material resources of the partners in ETEE training programmes:*

Organizing and developing training programmes in ETEE domains (target group II) using interactive, interdisciplinary and complementary training methods. Case studies, good-

practice projects designed and developed in the frame of these programmes will enrich the e-platform resources;

Developing a Lifelong Learning Center in ETEE for delivering training programs, for counseling and expertise, facilitating the collection exchange and dissemination among partners and allowing the extension of the interactive training methods through a transnational network.

### **2.3 The Outcomes of the project:**

- Upgrading and updating of trainers' competences in ETEE;
- Developing: web-site and e-learning platform with specific functions for lifelong learning and long distance learning;
- User e-guide for the e-platform;
- Didactical software with specific topics (e-products) to include interdisciplinary and interactive methods in the field of ETEE, in Romanian and English;
- Case studies and good practice projects in the proposed area implemented on e-platform;
- Lifelong Learning Center and transnational network in ETEE.

### **2.4 Training Activities**

The courses held within the COMPLETE project for the teaching staff of the university and for the specialists and experts in ETEE domain are based on these two modern methods of learning, problem and project-based learning. The reason would be the following: it is an instructional method characterized by the use of real world problems in the fields of transport, energy and environment engineering, as a context for the trainees to learn critical thinking and problem solving skills, and acquire knowledge of the essential concepts of the course.

Using problem/ project –based learning, trainees acquire long learning skills, which include the ability, to find and use appropriate learning resources. The teacher/mentor must guide, probe and support trainees' initiatives, direct or provide easy solutions. This learning method empowers the students to take a responsible role in their learning.

Trainers have used projects as a supplement to their course of instruction. Students are involved in studying and interacting with the real world around them and a project-based learning is thus conducting educators, schools, communities, universities and other organisations to explore aspects of project-based learning. This renewed interest is due to the project opportunities conveyed by the Internet and World Wide Web. The Internet adds valuable dimensions to a project-based experience shared within COMPLETE project. Multimedia is an additional tool to meet these requirements. By using these modern technologies that facilitate the communication, we intend to further develop the student's ability to become creative and critical thinkers and analysers, as well as problem solvers, within this multimedia-oriented problem-based learning environment. Trainees, either students or experts and specialist in energy, transport and environment engineering are surveyed on their attitudes and skills as a team.

The results can show that the trainees are positive towards the project, enjoy teamwork, are able to think critically and become active participants in their learning process.

Therefore, multimedia-oriented projects, combined with interactive methods of learning can be used alternatively as innovative and effective tools in a problem-based learning environment for the acquisition of problem-solving skills in ETEE.

The group of trainees are given a survey on their progress of work and are interviewed individually. The survey consists of questions to assess their interest in group work or whether or not they were motivated in the development of their work. The survey tries to gauge their level of understanding and their critical thinking skills, as well as how they worked as a team.

This constructivist way of learning becomes more and more relevant as far as the students or the trainees participate actively in their own learning process and construct their own knowledge

## **2.5 Complete Centre**

The COMPLETE Centre can be considered a problem-based learning lab, home of an integrated research and curriculum development effort launched in 2006 in the Department of Mechanical Engineering at *Transilvania University of Brasov*, Romania.

The PBL Lab's goal is to be leaders in global teamwork together with our partners in the project.

To engage graduate and undergraduate students, faculty, and industry practitioners in multi-disciplinary, collaborative, geographically distributed problem-based learning activities. Problem-based learning is a process of teaching and learning that focuses on problem based, project centred activities that produce a product. Problem-based learning will be based on re-engineering processes that bring people from different disciplines – transport, energy and environment engineering - together.

The objectives are to develop, implement, test, deploy, and assess radically new and innovative are: collaboration technologies, learning technologies, knowledge capture, sharing and re-use technologies, workspaces learning and work that support collaborative, cross-disciplinary, geographically distributed teamwork and learning processes.

## **2.6 Dissemination of results.**

The dissemination strategy of the COMPLETE project to ensure that the project results will be used as regards the target group I and II in ETEE and potential users has in view:

- Communication among partners, target groups and potential users about the different stages and results of the running project;
- Organizing the events (conferences, seminars etc.) dedicated to informing the partners about the results of the projects;
- Organizing the demonstrations of the good practices of the project.

The dissemination strategy is carried out by:

- Designing, developing and providing dissemination materials;
- Establishing the ways and means of dissemination of materials;
- Using the partnership of the project for dissemination;
- Monitoring the dissemination activities.

# **3 CONCLUSIONS**

Project COMPLETE move towards the constructivist learning mode, which is student-centric. In this context, the students had to use their prior knowledge in other disciplines to breakdown the problem into component parts, and then synthesize and re-construct a possible solution.

This experience is invaluable in creating a new generation of effective problem-solvers for the current industry needs and through this responds to the requirement of Europe's policy as lifelong learning is for the European Union the guiding principle for the development of education and training policy. While promoting social inclusion and personal fulfilment, lifelong learning develops people's employability and adaptability and is therefore a core element of the job and growth strategy.

Lifelong learning promotes the goals and ambitions of European countries to become more inclusive, tolerant and democratic. It promises an Europe in which citizens have the

opportunity and ability to realize their ambitions and to participate into building a better society.

Learning and investment in human capital is associated with greater civic participation, higher-reported well-being and lower criminality. Higher levels of education and continuous learning make an important contribution to reducing inequalities and preventing marginalisation.

Lifelong learning takes a comprehensive view of the supply and demand for learning opportunities. It values knowledge and competence gained in all spheres of modern life, relevant to coping with modern society ( according to the *Communication* from the Commission, 2001 - *Making a European Area of Lifelong Learning a Reality*).

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### **Authors**

Corneliu COFARU, Prof. Ph.D. eng.

“Transilvania” University of Brasov, Automotive and Engine Department

1-3, Politehnicii, Brasov

Email: ccornel@unitbv.ro

Mihaela POPESCU, Lecturer Ph.D.

“Transilvania” University of Brasov, Foreign Language and Literature Department

25,Eroilor , Brasov

Email: mvp@unitbv.ro

Daniela FLOREA, Prof.Ph.D.eng

“Transilvania” University of Brasov, Automotive and Engine Department

1-3, Politehnicii, Brasov

Email: d.florea@unitbv.ro

**Socrates/Minerva Project: *INDIVIDUALIZED LEARNING  
ENHANCED BY VIRTUAL REALITY, IDENTITY*  
229930-CP-1-2006-1-RO-MINERVA-M**

*Gheorghe SCUTARU*

*Transilvania University of Brasov, Romania*

**Key words:** *virtual reality, e-learning*

**Abstract:**

*The paper presents the Minerva project “Individualized Learning Enhanced by Virtual Reality”. The rationale, the objectives and the expected results are presented.*

## **1 Introduction**

The Minerva Action seeks to promote European cooperation in the field of Open and Distance Learning (ODL) and Information and Communication Technology (ICT) in education. [1, 2]

The Action has three main objectives:

- To promote understanding among teachers, learners, decision-makers and the public at large of the implications of ODL and ICT for education, as well as the critical and responsible use of ICT for educational purposes;
- To ensure that pedagogical considerations are given proper weight in the development of ICT and multimedia-based educational products and services;
- To promote access to improved methods and educational resources as well as to results and best practices in this field.

Minerva supports four major types of activity:

- Projects to better understand and support innovation. These are research actions, targeted studies and comparative analyses in order to improve understanding of the impact of ICT and ODL models on the organisation of teaching and on the learning process.
- Activities to design new teaching methods and resources for the development of innovative learning environments.
- Activities intended to communicate and provide access to the results of projects in order to increase their dissemination and generalise best practice.
- Projects intended to network and encourage the exchange of ideas and experience connected with the use of ICT in education and with ODL. Cooperation is encouraged between designers, users and those in position of responsibility in education and training.

IDENTITY [3] project proposes an innovative learning scheme in which VR is the main feature. It proposes innovative VR tools to help students to learn wherever they choose at the fullness of their individual ability, considering that Individualized learning represents a mandatory part in any educational process and the more efficient is the better educational results are obtained. The material to be used will enable active, self-controlled, personalized and flexible learning. The proposed innovative scheme, which integrates the VR based e-

learning, practical laboratory activity and face-to-face tutorial, performs new trends in learning.

No.	Partner name	Country	Web address
P1	Transilvania University of Brasov	ROMANIA	<a href="http://www.unitbv.ro">http://www.unitbv.ro</a>
P2	Noema-CMI Oy	FINLAND	<a href="http://www.noema.fi">http://www.noema.fi</a>
P3	The Technical University of Ilmenau	GERMANY	<a href="http://www.tu-ilmenau.de">http://www.tu-ilmenau.de</a>
P4	DIBE - University of Genoa	ITALY	<a href="http://www.dibe.unige.it">http://www.dibe.unige.it</a>
P5	Laboratorio delle Idee	ITALY	<a href="http://www.labidee.com">http://www.labidee.com</a>
P6	Universidade Nova de Lisboa	PORTUGAL	<a href="http://www.fct.unl.pt">http://www.fct.unl.pt</a>
P7	SIEMENS PSE	ROMANIA	<a href="http://www.pse.siemens.ro/">http://www.pse.siemens.ro/</a>
P8	Technical University of Kosice	SLOVAK REPUBLIC	<a href="http://www.fei.tuke.sk">http://www.fei.tuke.sk</a>
P9	The Swedish TelePed. Knowledge Centre	SWEDEN	<a href="http://www.pedagogic.com">http://www.pedagogic.com</a>
P10	EMMERCE EEIG	SWEDEN	<a href="http://www.emmerce.net">http://www.emmerce.net</a>

The project webpage: <http://iesc.unitbv.ro/identity/>

## 2 IDENTITY project

### 2.1 Rationale and Background

Nowadays there are significant constraints for the modern educational process: time (too short), space (too few), and equipment (too expensive). Digital technology permits significant changes in the way in which learning and teaching are guided. It affects the information sources, the interactions that strengthen learning and teaching. It is remodeling the time, place and pace of education and it has the potential to increase the accessibility of education to increasing number of people. Such learning environment allows diversity, complexity and flexibility.

Existing background, in terms of infrastructure and expertise of project partnership:

*Consortium's universities:*

→ **Transilvania University**, the project promoter, has performed, in the last five years, a plentiful activity in developing new e-Learning products integrated with remote experiments. Therefore we mention here the pilot project Virtual-Electro-Lab, RO / 01/ B / F / PP 141024 and the project SoftLab RO/2002/PL 89223/EX in the frame of Leonardo da Vinci program. As a result, Transilvania University is able to provide, for this project, e-Learning products related to the following topics: Electric Circuits, Analog and Digital

Electronics, Electrical Machines and Drives, Measurement & Automated Test Systems, Home appliance systems.

- **Technische Universität Ilmenau** has experiences with Gender-Mainstreaming aspects in technical orientated projects with networked, interdisciplinary and comprehensive research targets and has extensive experience in producing didactical e-learning material for students in electrical engineering domain. The TU Ilmenau is the centre in the network of research, development and transfer institutions of the Technology Development Area of Ilmenau called Technologie Region Ilmenau.
- **The Department of Biophysical and Electronic Engineering (DIBE)** of the University of Genoa (IT) has an extensive experience in developing curricula and learning materials in the field of electronics and has participated in several European projects in the field of Open and Distance Learning. The specific skills, knowledge and experience relevant to this proposal include: development of interactive learning material and tools, design and maintenance of remote laboratories and instrumentation control, models, network based project learning methodology, learning object classification and metadata handling
- **Universidade Nova de Lisboa**; The main focus regarding scientific and technological issues of the group from UNL-FCT that will contribute to this proposal is around digital systems, reconfigurable and embedded systems co-design, in the framework of Electrical and Computer Engineering. The group has been involved in research and development projects at Portuguese, European and Ibero-American levels, within several programs. The following projects can be referred ESPRIT INNOVA (1996-99), IST DOTS (2000-02), Leonardo da Vinci VIRTUALELECTROLAB (2002-04) and COMPLETE (2005-07), SOCRATES EUI-Net (2004-07) and THIERS-DISS (2005).
- **Technical University of Kosice**, Faculty of Electrical Engineering and Informatics run and/or was involved into several projects on advanced E-learning from field of electrical engineering where it should be mentioned: „Human Resources for Managing Modern Broadband Telecommunication Networks“, TELEHUMAN; Leonardo da Vinci, SK/98/2/06420/PI/II.1.1.c/CONT, [www.elfa.sk/telehuman](http://www.elfa.sk/telehuman), 1999-2001 (development of 12 modules - in field of telecommunication networks; „Standardisation of Curriculum for Electrical Machines Using Multimedia“; TEMPUS, JEP CD-16127-2001, 2002-2004; [www.machines.cg.ac.yu](http://www.machines.cg.ac.yu) – development of a module in electrical machines featured with animations; „Interactive and Unified E-Based Education and Training in Electrical Engineering“, INETELE. Leonardo da Vinci, CZ/02/B/F/PP/ 134009, 2002-05, [www.tuke.sk/inetele](http://www.tuke.sk/inetele), development of 20 highly interactive e-learning modules from field of electrical engineering; „Efficient E-Learning Network Services Establishment for Education without Borders“ eEDUSER. Leonardo da Vinci, SK/02/B/P/PP/142256, [www.eeduser.com](http://www.eeduser.com), development of an educational portal enabling to create virtual classes

*Consortium's private companies:*

- **Noema-CMI Oy** is consultancy company with specialities in the areas of enterprise development, telematics, on-line learning, flexible working, virtual organisation and community building as well as development of collaborative initiatives for telematic centres focusing on collaborative work and learning for remote areas
- **Laboratorio delle Idee**; its business activities are oriented towards the following areas: business consulting (concentrating on marketing, communications, human resource management, quality systems) research, design and development of training activities (with special emphasis on equal opportunity, entrepreneurship and job creation), and the production of multimedia products, both as publisher and development partner.
- **Siemens PSE Romania** is part of the well known world company Siemens AG Germany, it provides services for PSE business units focusing on system development, system integration, product supports in the I&C, energy and solutions business for partners in Romania and world wide. The enterprise is focused on designing programs for a wide

category of applications, such as: mobile communication systems, fixed telephony systems, energy and information, learning systems, and so on.

- **The Swedish TelePedagogic Knowledge Centre, or STPKC**, is a 'Knowledge broker' organisation in the areas of telematics, multimedia, e-learning and e-commerce. STPKC is located in Nyköping, Sweden, and has a market covering not only Sweden but also Eastern and Western Europe as well as Asia and Africa.
- **EMMERCE EEIG** is a European company focusing on bringing the readiness for the future to organisations with an integrated view on both business and technology, in terms of concepts and practice.

## **2.2 Project objectives**

The overall project objective is to produce a high level quality learning environment in an academic European network ensuring an open access to improved educational resources, as well as to the best practices.

As specific objectives the IDENTITY project aims to:

1. implementing an innovative learning scheme for enhancing the individualized learning using VR;
2. improving the learning performances at higher education level;
3. assuring an efficient professional insertion;
4. encouraging introducing VR experiences in the individualized learning to better prepare electrical engineering students for life long learning;
5. improving the teaching activity by using e-courses and e-tutorial specific methods and didactical materials;
6. promoting a better understanding among different actors (students, teachers, project-coordinators, decision makers and the public at large) of the role, importance and benefit of VR for education by setting up an open pool for exchange of ideas and experience;
7. sharing the partnership's existing VR resources, based on a preliminary consolidated report, in order to contribute for a compatible qualification of students in electrical domain;
8. consolidating and expanding of the already existing collaborations, among the partners involved in the project, by an integrated, compliant and expandable VR learning resources centre with the purpose of obtaining an efficient interconnection among the project involved European universities and allowing promotion of the projects results;
9. creating of closer links between universities and local/regional industrial enterprises;

## **2.3 Target group**

The primary target group, which will benefit directly from the outputs / products and activities of the project, is composed of tutors and students enrolled in educational process at university level, in electrical engineering domain. The primary target group includes also working people and/or unemployed people involved in lifelong training and re-qualification processes.

The main section of population which eventually will benefit of the project results involves around 200-300 students (undergraduate & postgraduate), per year, as well as 100-150 participants at Continuing Education/Adult Education forms and 30 teachers/educators/trainers

The secondary target groups, which will benefit indirectly from the outputs / products and activities of the project, are:

*Organizations:*

- Industrial high-schools, technical colleges, engineering faculties, which need to meet the requirements of the labor market.
- Industrial companies, small and medium enterprises (SMEs), which need to adapt the professional profile of their employees to the newest technologies.
- Agencies for Occupational and Professional Formation, which need the best (re)training courses.

*Sector:*

The industry, particularly the electrical domain, is in a spectacular revival that requires a large number of high qualified personnel (young and reconverted) on a trans-national European labor market.

### 3 Project main expected results

- **Consolidated report concerning the using of VR and remote experiments in education**

Description: A contribution to the state of the art that contains: refreshed needs analysis, evaluation of each partner appropriate resources; benchmark the solution using remote experiment and VR which are in use today; instructions concerning the suitable solutions for existing resources integration; proper organizational pattern of EILE and VR-LRC for sharing the existing resources.

- **Project guideline**

Description: Document that states the main coordinates of the project progress including the dissemination and valorization activities time table.

- **EILE & VR-LRC design documentation**

Description: A document containing a detailed design concerning each module to be developed, technologies and tools to be used within implementation process.

- **Project web page**

Description: A web page representing the access point to EILE and VR-LRC consisting of two sections: public section that provides information on the project aims and outputs and the private section that provides access to EILE and VR-LRC.

- **Enhanced Individualized Learning Environment (EILE)**

Description: EILE will be dedicated to endorse the asynchronous learning part, without time-constraints, also untied to space or mobility restrictions – distance-learning and ubiquitous (mobile) m-learning, respectively. EILE provides each student and tutor with a “tailored panel” to identify the student’s learning needs and the adequate adjustments and to assure an efficient progress of each student. EILE also provides each student with access to the VR-LRC needed to learn to the fullness of their individual ability. “Tutor panel” main menu includes the following major functions: module-course information; student assistance; student progress reports, best practice guide “Student panel” main menu includes the following major functions: learning information, progress information; resources (VR-LRC) access; contacts (tutor, students, administrative desk).

**→ VR-Learning Resources Centre (VR-LRC)**

Description: VR-LRC consists of a structured, compliant and expandable learning resource repository aimed to give support to the students mostly for performing remote experiments by using VR applications (multimedia products), in order to improve the student practical skills before and after executing real experiments. VR-LRC can be accessed by EILE but it could be used separately as an independent product to be included in various e-learning platforms. IDENTITY project proposes a VR-LRC that covers a specific domain: electrical engineering. As a result, the VR applications to be included in VR-LRC will be related to the following topics: Electric Circuits, Analog and Digital Electronics, Electrical Machines and Drives, Measurement & Automated Test Systems, Home appliance systems and Industrial Process Control. VR-LRC will include not only VR applications but also traditional learning material in electronic format. VR-LRC is to integrate already available appropriate e-learning products provided by the project partnership (based on an intellectual property rights agreement).

**→ Educational report**

Description: The report presents the results of the action-research analysis concerning the EILE impact on the learning process, obtained by comparing the performances of students that are using the proposed environment (experimental group) with the performances of students using traditional learning (control group). The report will contain data on academic progress registered and the motivation / attitudes of the students which use the new learning environment, including gender differences and students profiles. The report includes Educational activities on certain subjects, teachers' notes and additional material developed by the participating institutions for implementation the system in the regular educational activity. The report is to be used by teachers and project participants in order to take full advantage of what the proposed system has to offer for their students.

**→ Examples of good practice**

Description: A handbook presenting examples of good practice describing the educational activities and additional material on chosen subjects implemented in universities located in various countries. The examples of good practices will be accompanied by quality criteria indicators used in the assessment (such as: examples of differentiation by level of difficulty, degree of attractiveness, and so on). The handbook is intended to give a complete view of matters concerning the implementation of the project.

**References:**

- [1] <http://www.anpcdefp.ro/>
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**Author(s):**

Gheorghe Scutaru, eng. PhD, professor;  
Faculty of Electrical Engineering and Computer Science  
Transilvania University of Brasov,  
Str POLITEHNICII Nr. 1  
500039 BRASOV  
ROMANIA  
Email: [scutaru@unitbv.ro](mailto:scutaru@unitbv.ro)

## Dissemination and Valorisation Strategy

### Guide for project partners

#### Compiled by:

*Anna-Kaarina Mörsky-Lindquist, Noema  
and  
Kennet Lindquist, STPKC*

**Key words:** *dissemination, valorisation*

### Introduction

This implementation chapter of the project's dissemination and valorisation strategy document has the aim to provide all concerned with the conceptual basis and the contractual framework within which the D&V strategy has been formulated. It also provides references to the documentation that has been the main guiding information sources for us when developing the D&V strategy, and thereby also facilitates for the readers of this D&V strategy document to explore further the conceptual basis for the strategy development efforts and the D&V strategic planning initiatives that have been taken so far. This introduction has been divided up into two parts, first a section provide the 'conceptual basis' for the strategy development efforts, as well as references to the 'public'/'generic' publications that have been used in connection with the documentation of the project's dissemination and valorization strategy. The second part of the introduction contains the 'contractual basis' on which the D&M strategy formulation efforts were based, as well as references to the EU programme/project-specific documents that have guided us during the formulation of the D&V Strategy, its associated D&V Strategy Implementation Plans as well as in the formulation of the D&V Implementation Guides.

### Conceptual basis for the D&V strategy

This dissemination and valorization strategy is based of three main sources of recommendations, directives and framework-providing sources for a D&V strategy development formulation effort, namely the EU recommendations on Valorisation published by the European Commission, the promotion of the usage of a Logic Framework Approach for programme and project management, and the content of the project proposal and the criteria for its selection from the EU programme.

**a. The European Commission recommendations and directives** makes it clear to us that the 'valorisation' is substantially more than arrange some 'awareness-generation' in some general and unverified manner. It sees valorization as a professional activity that assures impact on the needs that the project addresses, that it addresses specifically the achievement of the objectives, that it reaches out to and generate stated values and support for the target populations and stakeholders addressed by the project, that the project outcomes and the products/services generated by the project are accessible to, utilized and generating value for its intended users.

There are in particular three reference documents that provides in this respect the conceptual basis for this project's D&V strategy formulation, and these are;

1. **"Valorisation Strategy for the Leonardo da Vinci Vocational Training Programme",**

This EC/LdV programme document provides initially a description of the concept of valorization, followed by a description of the strategy formulation process and some

outlines some pre-conditions for valorization. It concludes with a set of examples valorization measures as well as some further reflections relevant to LdV projects

2. **“Valorisation – Down to Earth Handbook”**, The Netherlands LdV national Agency  
This document provides an introduction to the importance of validation, recommendations of the production of valorization plans, and the changes to a project that valorization brings with it. These introductory reflections are followed by practical descriptions on considerations concerning the project focus on the needs, the objectives of the project, the products it should develop and deliver, and the target groups for its initiative.
3. **“Dissemination and Valorisation Management / DVM Guide”**, EUproject.net  
This document provides initially an overview of the dissemination and valorisation management concerns, including the different ambition levels of valorisation efforts, the external support services available to EU projects. The document outlines thereafter the different components of a DVM service, outlines how those relates to the overall project management and project reporting obligations within EU project, followed by an introduction of an online solution for handling dissemination and valorization management online.

**b. The LdV programme services** for projects implemented in response to LdV call for proposals are also highlighting the importance of valorisation, and are through various services (e.g. available through their web sites and national agencies) providing projects with directives that have direct implications on how a D&V strategy is developed, documented and implemented during its project time span. There are mainly three publications that have influenced the D&V efforts in this project;

1. **“Evaluation of mechanisms for the dissemination and exploitation of the results arising from programmes and initiatives managed by the DG Ed&Culture”**, ECOTEC  
This report took an insightful look at the present and past practices of dissemination and exploitation of project outcomes, and came out with some serious and not too impressive conclusions on past practices. Through this report it was also made clear what the shortcomings were and what kind of improvements would be needed in future project initiatives. These recommendations and concerns are, on a project-level, also aimed at being addressed as part of this project’s D&V strategy, D&V planning and D&V implementation.
2. **“How to develop and excellent valorisation plan”**, presentation by LdV, ADI Unit  
This presentation highlights the differences between the earlier practiced ex-post and the presently recommended ex-ante approaches to stakeholder involvement and valorisation, followed by descriptions of the valorisation requirement in recent LdV calls, as well as how to produce valorisation plans highlighting the identification of the needs of among the addressed sectors/users, that implementation of results must be anticipated from the start, and that key players (stakeholders) must be involved from the start of the project.
3. **“EU Administrative and Financial Handbook”**, DG Education & Culture  
Even if this reference is not a document addressing specifically D&V matters, it was found to be of high importance for the D&V strategy development effort, both in terms of defining the financial and resource framework within which the D&V ambitions could be implemented, as well as for providing clarifications on the reporting, verification and accountability obligations that applies also to dissemination activities. This document also provides insights/implications also on what assessments

will be made and what reporting obligations would be expected from the project in order to achieve a full appreciation of the D&V actions to be performed.

In addition we also found many useful recommendations in the UK National Agency notes on valorisation, such as the processes for constructing and planning a valorisation strategy, as well as in the recommendation notes on the engagement of partners in the valorisation efforts, e.g. through the usage of standard forms to record activities, regular submission of information, review of valorisation activities and recognition of contributions to valorisation efforts. The recommendations provided in those recommendations, as well as those provided in the above mentioned documents, have to our best ability been accommodated for in the project's D&V strategy, the developed D&V planning and implementation processes, as well as in the D&V management activities introduced and described in this D&V strategy definition document.

**c. Tools to support D&V planning and D&V implementation.** The D&V strategy development process to be presented in this document was also supported with a set of tools that enabled and were utilized for the purpose of adopting a more systematic and efficient planning and preparation process. Among these tools were publications on logic framework approach (LFA), and the planning processes presented within those, as well as a set of online tools developed specifically for implementation and support to EU projects

**The Logic Framework Approach.** Adoption of LFA is gaining an ever increasing significance on both programme and project levels within various EU-related initiatives, and so is also the case within the EU programme which this project is being implemented. There are an increasing number of publications made available concerning LFA implementation in a collaborative project context, and three of those that have been used for this project's D&V strategy development;

1. **“European Commission Project Cycle Management Guide”**, Development DG  
This first volume of a set of EU guides for supporting programme and project implementation outlines in its second (tolls) part the guide the logical framework approach, followed by description of capacity management and the recommended processes for monitoring, review and reporting, as well as the process of facilitation and participation in the initiatives taken. The guide provides in its LFA chapter also an analysis and planning process that has been found applicable also for D&V strategy formulation and implementation planning purposes.
2. **“A Project Cycle Management and Logical Framework Toolkit”**, EU/Equal programme  
This practical guide to project partnerships relates the LFA with project management and this with a quality perspective on eligibility, relevance feasibility and sustainability and as such it is also highly applicable to the project's valorisation efforts. The connections it makes to both project budget and project planning, as well as to evaluation, stakeholder involvement and partner roles and responsibilities provides for valued guidance on how to implement ex-ante oriented valorisation initiatives.

In addition to the above LFA-specific reference documents, the hands-on ‘Project Management Primer’ was also frequently referred to during the establishment of the D&V strategy, and planning of the D&V strategy implementation, in particular how it addressed management of man-days, scoping, planning and execution of the plans with partners having different visions, ROI and performance ambition levels, capacities, involvement expectations and commitment levels.

**Online project management and project planning tools.** In order to gain both a better overview of the project's planning, resource and involvement framework, as well as to better grasp what capacity and resource utilization as well as ambition and contextual

constraints that the project will have to implement its D&V ambitions within, the D&V strategy development effort was implemented with two online services initially developed specifically with the implementation contexts of EU project in mind. These D&V planning tools, available online to projects e.g. from [www.EUproject.net](http://www.EUproject.net), are introduced in the following reference documents;

3. **“An introduction to EUproject.net’s Virtual Project Office”**, by EUproject.net  
This document introduces the VCP-based Virtual Project Office (VPO) online service for EU projects. The VPO services includes both an activity and cost planning system as well as an activity reporting and progress monitoring service.

When utilizing VPO for a particular project it redefines its internal structure in accordance with the resource management and reporting rules that applies to the EU programme within which the project is implemented, and produces all the report formats that the EU programme’s Administrative Handbook, and the project contracts, stipulates.

For the purpose of easy planning, review and monitoring of this project’s activity and resource management framework in connection with the D&V strategy development/ implementation planning efforts, all project plans, project budgets and partner responsibilities/involvements have also been recorded as an online VPO service.

4. **“An introduction to the Propagator Initiative”**, by EUproject.net  
This document describes the different services developed by and provided via the Propagator initiative to EU projects. The Propagator introduction document contains both descriptions of what tools and engines, from a supply perspective, are available to projects for dissemination and valorisation purposes, and which can be acquired and utilized both within commonly used virtual communities, such as Leonardo, Minerva and/or Grundtvig Virtual Communities, or within virtual communities established specifically to a given EU project.

The document also outlines the how the end-users, from a usage perspective, can make free usage of the services developed and/or mediated from an EU project, and this either from the project’s own web services or via wider community environments to larger clusters of professionals, end-users, or sectors.

### **The D&V aspects as defined contractually defined for the project**

There are some direct implications of the above mentioned ambitions, guidelines, recommendations and directives concerning dissemination and valorization that applies explicitly and directly to this project, and this can be seen as imposing strategic and operations implications for the execution and partner contributions to this project. These implications could be summarized into five strata of partnership concerns and project performance adherences that should be secured by contractors and within the partnership as well as be reflected in both the project management and in the D&V strategy, plans and implementation activities of the project. Each of these five strata relates to what the earlier mentioned recommendations and directives are trying to tell the project.

### **What the EU directives says about D&V.**

When reading through the above mentioned reference documentation it should be obvious to any reader that there is a concrete pressure on each EU project to take the spreading of the information about the project and its outcomes beyond awareness generation and more unverified format of information dissemination, that the efforts taken in this respect should be

reaching substantially beyond the immediate vicinity of partners' normal operating context and project actors' direct networking contacts, and that the product/service outcomes should be accessible to and be utilized at least on an European-wide basis on a sustainable basis stretching beyond the project timeframe, as well as engaging its stakeholders in the D&V efforts not only in a post-production process but extensively also in all stages of the development of those products/services. This also implies that the D&V efforts ought to be both an accountable and verifiable part of the project, as well as demanding that the project in all its WPs and activities are designed to accommodate both stakeholder engagement in the project activities and that all phases (WPs) of the project are engaged in the D&V efforts and that all project partners are commitment to the D&V strategy and its implicit activities, from the project start and to time periods beyond the project time frame.

***Specific to this project*** that includes implications such as;

- *All partners engaged in the full spectrum of D&V concerns and actions*
- *All WPs should have stakeholder involvement integrated into its activity design*
- *All products, services and deliverables should have an explicitly and verifiable D&V Actions*
- *All D&V-related efforts, actions and events should be documented and verifiable*
- *All stakeholder, target group and end-user contacts should be documented and verifiable*
- *All project resources utilized for D&V purposes should be accountable and managed*

#### **What the EU-Contractor project contract says about D&V.**

The EU-Contractor project contract stipulates that the project should be implemented in accordance with the project document, within the resource restrictions of the project budget, within the time frames of the project plans, and according to the implementation rules of the Administrative and Financial Handbook, and that any significant deviations from those have to have prior agreements from the EU programme prior to it being initiated. In addition it specifies that the activities taken should be reported on in the interim and final reports from the project. This includes both explicit and implicit obligations from project contractor, and the project partnership, *versa vi* the EU programme.

***Specific to this project:***

#### **What the partnership agreements says about D&V.**

The partnership agreement specifies the obligations, contributions, and expectations that the project and its contractor/management as from the partner in terms of implementing the project, adhering to the stipulations in the overall project contract, and within which time frames and resource restrictions the assigned responsibilities, contributions and involvements should take place, as well as how and in what format the reporting on the implementation of those commitments should take place. This includes both project-wide and WP-specific obligations for each project partner, as well as specific performance expectations from the project actors to be engaged in the project implementation.

***Specific to this project:***

#### **What the Project Budget says about D&V.**

The project budget specifies what types of financial resources are available for what purposes. It divides the project budget into cost categories, such as staff costs and direct costs, and it specifies the cost distribution across different parts of the project (WPs). The project budget includes cost elements that are both explicitly allocated for D&V purposes as well as cost elements more implicitly allocated to D&V. Among the latter are the staff cost allocated to

different WPs travel costs for different missions and event, as well as other costs and partner overheads as well as subcontracting costs. It is also in the project applications requested explicit indications on the percentage of the overall budget that are envisaged to be allocated to D&V. This should be considered in the light of the fact that the contractual documents demands a contract modification if there are project re-allocation of resources during the project that exceeds 10% of the initially budgeted allocations. A reduction of the initial resource allocations for D&V purposes may jeopardize the subsequent EU approval of the project.

### **What the Project Plan says about D&V.**

The project plan specifies how the project partnership has committed itself to implement its project, and this in terms of activity focus, timing of activities and deadlines, responsibility distribution, partner involvement, as well as concerning reporting and delivery of the expected outcomes, deliverables, products, and/or services. The project plan is an integral part of both the project contract and the partnership agreements, and is the operationalised interpretation of the project document with its statement of the intended needs elimination/reduction, objectives to be achieved, target population(s) to be addressed, and the products/services to be made available to the defined market(s)/context(s).

Alterations of the project plan, in terms of its content, timing or focus, in any way that may impose changes in the outcomes and/or impact of the project on the needs, the achievement of the objectives, the reaching or supporting of the originally intended target population, or the engagement of the stakeholders, and/or the impact and utilization of the developed/provided products/services, may well be considered by EU as a modification that may require contractual amendments, and if so, those should be approved by EU prior to its implementation, or it may jeopardize the subsequent project approvals. Modifications of project plans in ways that reduce the D&V impact is going to be seen as a 'significant modification' and should as such be avoided at all costs, and by all partners.

### **Four partner support components directly related to the D&V Strategy**

The project's D&V Strategy has been consolidated through, and supported by, four interwoven components. Each developed with the aim to ensure optimal efficiency and outcomes of the D&V efforts taken by the partnership with the ambition to secure the successful implementation of this project and its associated dissemination/valorization obligations and its associated ambitions to generate valued and sustainable outcomes and effects from the project. These outcomes include;

- *A phased approach to the D&V Strategy Implementation process (eight phases)*
- *A staged D&V Strategy Implementation Plan with concrete deliverables and action deadlines*
- *A partner Implementation Guide for their contribution to and responsibilities for the D&M efforts*
- *A practical handbook/instructions on how to plan, contribute, and document/report D&V actions*

The first three components are provided as part of this strategy document while the fourth component is provided as a separate document. The presentation of those components within this document should be seen as supplemented by the Dissemination and Valorisation Management (DVM) services adopted by the project, and in which VPO (Virtual Project Office) services are used as the operational platform for documenting plans, monitor progress as well as for reporting on status and outcomes of the actions taken, and in which the VCP (Virtual Community Platform) services are used for interactions, for practical implementation of online D&V actions and well as for providing support and experience exchange between partners in their performance of the D&V responsibilities. Both the VPO and the VCP

services are introduced and supported within the partnership with a separate set of guidelines, handbooks and tutorials for those that are new to online project services.

## Phases of the D&V strategy implementation

The D&V strategy implementation is seen as containing eight partially overlapping but extensively sequential phases, all to be carried out within the framework of the project. The implementation schedule as well as the desired timeframes for each of those eight phases is outlined in the D&V Strategy Implementation Plan, and the ways in which the eight phases are recommended to be implemented are outlined in the Guidelines for D&V Strategy Implementation provided in the end of this document. The eight D&V strategy implementation phases are;

### Phase 1 – Establishment of a D&V Management system for the project

The purpose of this phase is to define the Dissemination and Valorisation Management (DVM) system that should apply to the project, what DVM services to be used within the project, the extent to which those DVM services are going to be accessed and manipulated by both project partners as well as third parties that are visiting the project's online and document repositories.

This phase should also have as one of its documented outcomes firstly a project management decision on what DMS solution to be applicable to the project and its partnership, secondly a project management decision on what partner/project actor would have the coordinator responsibility for the dissemination and valorisation management (DVM), and thirdly a project-wide specification/decision on what communication structures, the responsibility distributions and the operational relationships that would apply between the DVM service and the project coordinator/'project office' services.

This phase is implemented by the project partner responsible for the Dissemination/Valorisation aspects (Valorisation WP) of the project, in close collaboration/consultation with the organization responsible for the management of the project (Coordination WP).

### Phase 2 – Definition of D&V parameters for the project

The purpose of this second phase is to ensure that the project applies an efficient and partnership wide distribution of responsibilities for the planning, monitoring and implementation of the D&V strategy throughout the project time span, and across to WP-based project development efforts. This phase should have as its documented outcomes a list of the parameters that should be addressed by the partnership-wide D&V efforts/contributions.

Each identified parameter should have a specific partner/project actor that has the responsibility to document the characteristics of the assigned parameter, suggest implementation approach for the D&V actions relating to it, specify indicators on its achievement, monitor and update/report on the progress and completion of efforts relating to the parameter as well as initiate the evaluation of the efficiency, resource consumption, outcomes and effects of the D&V efforts in relation to that parameter. Parameters should be defined for;

- *The **needs** that the project has as its ambition to address (assigned to the project coordinator)*

These parameters should be consistent with the rationale, aim and justification of the project

- *The **objectives** of the project (distributed across partners/partner representatives)*  
These parameters should be consistent with the project objectives in the project contract.
- *The **outcomes** (products/services) expected to be developed/provided for by the project*  
These parameters should be consistent with the results committed to in the project contract.
- *The **target groups** to be approached with the developed/provided products/services*  
These parameters should include all intended project involved/served end-users/stakeholders
- *The **impact** that are to be generated in the contexts intended to be approached by the project*  
These parameters should as a minimum include the national operating context of each of the partners, preferably beyond that with an online, inter-country and/or European-wide impact.

This phase is to be structured by the partner responsible for Valorisation, and implemented in close consultation with the project's management group or the overall project coordinator/contractor.

The structure of the D&V parameters, in terms of which specific needs are to be attended to, what needs to be documented, monitored and addressed by the project's development efforts, should be conveyed to all partners through the project's DVM service, and these parameters should be explicitly referred to in the subsequent D&V planning and performance activities of the project partners, as well as by all cost and activity reporting by all project actors engaged in respective WP and D&V action.

### Phase 3 – Planning of D&V Actions for the identified D&V parameters

The purpose of the third phase is to initiate the distributed responsibility-sharing across the partnership for the implementation of the D&V strategy, and the first step in this respect is to initiate the definition of a D&V plan for each of the D&V parameters identified during phase 2. Ideally the responsibilities for each of those parameters should have been assigned across the partnership.

The parameter definition should start with the 'needs' and 'objectives' parameters, followed by the 'target group' and 'product' parameters, and thereafter the definition of the 'impact' parameters. Each parameter should include the information stipulated for the parameter category it belongs to, predefined through a standard specification format (available as print-based or as online forms), and should also include indications of inter-connections with parameters in other parameter categories.

The outcome of phase 3 is a complete set of definitions of the focusing areas of the project's D&V efforts (one definition for each of the D&V parameters listed under respective parameter category).

For each of the 'target group', 'product', and 'impact' parameter descriptions there should also be produced a set of D&V Action Specifications, each on a separate print-based or online form. These Action specification forms should also act as the progress reporting tool for the implemented D&V actions, and be stored in a common repository enabling sorting/filtering by D&M parameter, by WP, by time period as well as by responsible partner/project actor.

All the parameter definitions should also be reviewed and updated regularly, so that the parameter documentation always is up-to-date, and portray the actual status and orientation of the project's D&V efforts, as well as containing active links and up-to-date references to all

related D&V activity status reports, and with each of those having complete and updated versions of support documentation.

#### Phase 4 – Preparation of D&V Tools/Instruments for D&V Implementation

From the specifications of the planned D&V actions generated during Phase 3 it will also be possible to identify what D&V media and means should be developed and made available at what project time periods, in what volumes and with what dispatch facility, and the purpose of Phase 4 is to secure the timely availability of the desired D&V tools/instruments, as well as the reproduction and dispatch capacities for its production, usage facilitation and feedback generation from the receiving end of the D&V initiatives taken. The requirements for D&V tools/instruments will be reviewed on periodic basis (quarterly) and the production schedule for the D&V tools/instruments will be updated with regular intervals (at least semi-annually) in connection with an assessment/review of the overall D&V progress, per WP and per project partner.

The outcomes of the Phase 4 should be a set of D&V tools/instruments matching the demands defined through the D&V parameter specifications and their associated D&V Action Specification Sheets. Each D&V tool/instrument that needs to be developed, acquired or compiled, will also be documented on a separate D&V Action Specification Sheet, with responsible and involved partners/project actors identified and with the expected characteristics and delivery timing expectations documented together with the indications of present status, as well as with the available reference documentation being associated to it.

#### Phase 5 – Implementation and recording of D&V Actions taken

The fifth phase is the very core of the project's D&V efforts, and should be given its needed attention, priorities and resource allocations that have been portrayed in the project specification document, and demanded from the EU programme supporting this EU project initiative. The D&V activities defined through the WP and D&V Strategy Implementation Plans should be given its timely attention and the expected completion dates, the implicit qualities and the expected volumes and impacts should be assured from each WP coordinator as well as from each partner representative.

The activities of this phase should include all those parameters and action elements that have been identified, defined and refined during previous phases, and implemented during this phase with the tools and instruments made available through the previous phase.

These phase five implementation activities should include as an integrated component of and engagement in D&V-related actions also project actor record keeping on the involvement/progress/ outcomes of D&V actions, to be maintained on continuous, or at least on and monthly basis.

The outcomes of the fifth phase should be a solid, embrative, extensively integrated and comprehensive dissemination and valorisation practices implemented WP and partnership-wide for all the parameters initially identified in phase one, and incrementally refined throughout the progress of the project. The fifth phase should be ongoing activity up to the end of the project, and beyond.

#### Phase 6 – Reporting on progress and outcomes of D&V efforts

The sixth phase is closely interwoven with the fifth phase as the project's internal reporting processes, implemented on an on-going and continuous basis, is directly connected with the ongoing monitoring and quarterly reporting, commenting and approvals from the D&V Coordinating partner.

A summary status report and evaluative review of the overall progress of the partnership-wide contributions to the project's D&V ambitions is composed by the D&V Coordinating partner is conveyed to the project coordinator and the partner responsible for Project Evaluation, as

well as subsequently shared with the project's steering committee and/or the overall project partnership, either as online announcements or through project-internal progress reports.

The project-internal progress reports on the status of the D&V strategy implementation, recommended to take place quarterly, are in preparations for the project's Interim report compiled into a qualitative and quantitative D&V report, shared with the project partnership and submitted to the project contractor for inclusion in, or for providing inputs to, the Interim Report to the EU programme. Similar qualitative and quantitative D&V report is also produced as inputs to the project's Evaluation Report as well as to the project's Final Report to the EU programme.

The outcomes of this phase should in other words become a set of regular (quarterly) project-internal reports on the progress of the D&V implementation across partners and WPs, shared with the project partnership and acting as inputs to the D&V Reports for the project's Interim and Final Reports. These reports, and its supportive documentation, should also be made available to the external evaluators, auditors and assessors from the national agency and/or EU programme representatives, e.g. for the usage in connection with the next phase of the D&V strategy outlined below.

#### Phase 7 – Assess and verify impact and effects of D&V contributions

The purpose of phase seven is to assure both the overall project partnership as well as concerned third parties, stakeholders and financial support providers that the project is not only producing valuable outcomes, but that the project also have made sufficient arrangements for making the outcomes accessible, available, utilized and appreciated by those for which those initially were claimed to be developed for, to be mediated to and to be utilized by. Such assurance should be consolidated by the partnership through valid evidences, utilization traces and by feedback and/or responses from its intended target populations.

The basis for the assessment and verification activities that such assurances calls for will extensively be inter-connected to the indicators and sources for evidence indicated in connection with the parameter definitions during phase two, through the recording mechanisms and repositories that are connected to the tools and instruments developed/introduced in connection with phase five, as well as records and documents generated by the partnership in connection with the project-internal reporting processes that were introduced for the sixth phase.

The outcomes of this phase should be documentary evidence of how and what extent the project D&V actions, its information, know-how, produces and services have reached, been utilized and made an impact on the market and target populations that the project was directed towards, and this being available in such format that third parties, stakeholders and assessors would not require to make any additional explorations or assessments other than for validation purposes.

#### Phase 8 – Construct and maintain a sustainable post-project D&V Service

Phase eight is initiated already in connection with the initial parameter and tool/instrument constructing phases, and is incrementally developed and refined to its consolidated stage, which should be reached extensively prior to reaching the end of the project time span.

This phase has its prime attention to assuring that the dissemination and valorisation continues after the completion of the project, and does this for the partnership in a sustainable way, as well as assures that the information materials, products and service are accessible/available to its intended target populations also after the closing of the project, and after the approval of the final report.

The preparations for the post-project continuation of the D&V actions beyond the project time span should also have been accommodated for in the IPR agreements reached among the project partnership, and this document should contain explicit conditions for post-project

usage of project information, know-how, products, outcomes and services in a post-project scenario by both project partners as well as by third parties, who are the IPR representative or the project partnership, as well as what methods for distribution of remunerations across the partnership that should apply by then.

The outcomes of this phase should be a sustainability plan, or post-project operations plan, for the project's products and/or services, prepared for and implemented prior to the conclusion of the project activities, consistent with the initial project specifications and reported on in the interim and final reports, approved by the EU programme as well as committed upon by the project partnership.

The above eight phases should to the extent possible be integrated into the works of the WPs defined for the project, but may also be seen as work of a separate WP, or alternatively as part of the project management/coordination tasks of the project. As the project coordinator will probably be deeply involved in activity and resource management, it may be a strong advantage for the overall project if there is a separate D&V Manager assigned, having the leadership, monitoring and supporting responsibilities for the actions and partner contributions highlighted or implied in above eight phases.

## **D&V Strategy Implementation Plan**

### **Implementation of Phase 1 - Establish a DVM System**

The first D&V Phase is to be implemented in connection with the project initiation and the preparation/implementation of the project 'kick-off' meeting. The initiating DVM decisions and the actions taken are introduced to the partnership outcomes in connection with the kick-off meeting and/or documented/conveyed through the communication channels established for the project partnership. The selected DVM system is integrated into the project web site and assess to its online DVM services are provided for to all relevant project actors / partner representatives.

This phase should be completed within the first two months of the project, and the instructions for access to its services should be available to all relevant parties. The principles for the adopted DVM services is introduced to the project partner representatives in connection with the project's kick-off meeting, documentation on the D&V , documentation on the D&V perspectives and the DVM components are distributed to participants in the kick-off meeting and/or through the project web site.

### **Implementation of Phase 2 – Defining D&V Parameters**

Preliminary agreements on the responsibility distribution is proposed by the project management during the kick-off meeting, The parameters to be included in the D&V services are listed by the project manager in consultation with the partner representatives during the kick-off meeting, and responsibilities for the definitions of respective parameters are assigned by the project manager across the partnership as found optimal for the partnership constellation at hand. After the kick-off meeting each parameter is defined through the leadership of the assigned 'parameter' coordinator.

The parameter listing and responsibility distribution stage for this phase should preferably be completed in connection with the project's kick-off meeting, or immediately after that meeting by the project coordinator. The support for the production of the parameter descriptions is to be provided by the assigned DVM Coordinator through the different communication means made available to the project partnership for remote interactions.

This second phase should be completed by the end of the first project quarter, which means that all parameter description files are populated with descriptive data according to the DVM Guide and supported by the pre-defined forms for respective parameter category.

All partner representatives, as well as all key project actors from respective partner organization should have reviewed, commented and approved the specifications made, the project actor assignments indicated and the resource/support implications that are implied in parameter lists.

### Implementation of Phase 3 – Action Planning

The action planning starts in parallel with the implementation of the Phase 2, and is extensively based on the partnership agreements on the dissemination/valorisation parameters that should apply to the project. The action planning includes two activities which are documented within the DVM environment, and two activities that are essentially performed outside the DVM interactive services, extensively carried out locally and with involvement of relevant project actors and project stakeholders. The first type of activity planning is probably easiest done having 'live' access to the information screens and forms available within VPO/DVM while the second type of action planning are mainly carried out in a collaborative modality either off-line or online with the usage of the interactive tools available to the project as part of the virtual community services.

One action planning task is the production of specific dissemination action plans for each of the identified 'target group' and 'product/outcome' parameters assigned to a particular project actor, followed by a review, improvement proposal and agreements on the produced plans. Such agreements also include commitments from the actors expected to be engaged in the preparation, implementation and evaluation/review of the produced action plans. When completed, these action plans are also uploaded and associated with the dissemination parameter it is related to.

A second action planning task is the completion of the detailed 'Impact' plans to be developed by each national partner organization, as well as for each dissemination/valorisation 'market' in which the project is expected to have an impact. Once drafted those 'impact plans' are processed in similar manner as mentioned for the documentation of the first type of activity planning tasks.

The third activity planning task is to identify and propose proposals on what dissemination tools, facilities and support materials that are needed in order to ensure both an efficient implementation of the action plans, as well as to secure that the expected impact and outcomes from the dissemination efforts are generated. The outputs from this part of Phase 3 are some of the more important inputs to the fourth phase.

The fourth activity task the establishment of the communication channels, contact points and your own response handling of the responses, inquiries, requests and engagement indications from those that will be addressed/approached/engaged in connection with the various dissemination parameters defined during the previous phases and action planning tasks. This will involve setting up contact lists and databases on individuals and organizations that are to be approached, lists of potential users/ participants for the planned events, information subscription mechanism and email/message handling services. Arranging for updating and dynamic maintenance of such records are also included in this task. This task will probably overlap with later phases, even if the thrust should be initiated early.

### Implementation of Phase 4 – Tools Preparation

This production and facilitation-oriented phase involves mainly the acquisition, development, adaptation and testing of the tools and mechanisms that are to be used for the initiation and efficient operation of ongoing dissemination and valorisation activities in line with those outlined for respective dissemination 'parameters'. Such preparatory production tasks involves both print and off-line resource materials, such as posters, brochures, flyers, press info, publications, as well as templates for presentation materials, newsletters, dispatch letters, and advertisements. Electronic tools include both the mechanisms that are carrying/mediating

the dissemination messages/services, as well as the materials made available and mediated through these mechanisms. As examples of the former could be mentioned the tools made available via the EUproject.net's Propagator initiative, and examples on the latter are articles in electronic newsletters, announcements, and notifications.

Part of the tool preparation phase can be initiated as soon as the major structures of the dissemination actions planned on project-, WP- and/or partner levels are reasonable clear. The tool production ought to be timely completed so that the timeframes for the dissemination actions specified on the respective dissemination action plans can be respected.

#### Implementation of Phase 5 – Implementing Actions planned

When the tools and mechanisms needed for the implementation of the various dissemination action plans are in place the implementation of these actions can be intensified. Once the implementation has started it is important that the responsible actors keep the implementation status up-to-date, and report on potential deviations early. The management, on project, WP and partner levels, has on the other hand to monitor, support and recognize timely implementation of the plans, as well as regularly assess the quality and impact of the actions taken.

The implementation of the dissemination and valorisation actions should be a prioritized activity of the project, and should therefore also be a given point on the agenda for all steering and coordinative events. Appropriate resource allocations, timely implementation, as well as partnership-wide engagement and commitment to the project's dissemination and valorisation ambitions.

#### Implementation of Phase 6 – Progress Reporting

The DVM services contains a standard set of reporting forms, separate for each dimension of the dissemination/valorisation efforts to be performed, reported on, monitored and verified. Progress reports can be done either online, using the online reporting forms, or off-line where the reports are provided in pre-defined or free-format Word files and/or as handwritten entries subsequently added into the DVM services by the partner representatives, or by assistants assigned such tasks by the partner representative. If such progress reporting tasks are not distributed in such manner it will be the responsibility of the project office / project administrators to maintain such progress records.

The coordinators for the WPs associated with the dissemination outcomes/concerns to which the dissemination actions are being addressed are responsible for regular monitoring of the dissemination actions related to them, and it is the project coordinator's responsibility to monitor, initiate corrective actions and provide additional support to those actors that do not prepare for and/or implement their dissemination actions to the quality, extent, and timeliness that have previously defined.

#### Implementation of Phase 7 – Impact verification

Preparations for impact verification have to start early if one wants to secure efficient dissemination and valorisation management performances. The starting point is the decision in Phase 1 to make use of an online and collaborative DVM process, and by applying an online VPO solution for enabling openness and a shared responsibility for the coordination and implementation of the project.

Defining evaluation and review actions that will be integrated into the project management's quality management and evaluation responsibilities is facilitated through VPO/DVM and the evaluation management is one integrated part of the VPO reporting facilities. Within the VPO it is possible to establish and document the project's evaluation plans, as well as document the outcomes from those. These evaluation management services can also be applied within DVM for impact verification. The VCP-based virtual community environment used by the project

also includes facilities for polls, surveys, interactive dialogues, as well as blog-oriented feedback-collection mechanisms. These tools are also suggested to be utilized for impact assessment, both within the partnership as well for the broader impact assessment within the markets and among the project's stakeholders and end-users.

#### Implementation of Phase 8 – Sustainable continuation

The preparations for a sustainable continuation of the product/service provision beyond the project time span should be initiated already during the early stages of development, design, testing and tryout of the developed products/services. It is recommended that a staged process for sustainability development is being adopted. An example of such staged sustainability development process has been developed by the Sustain initiative ( ). What is important is that the staged process is not only preparing for the sustainability of the product/service, but also that there is an acceptance of a learning process as part of this sustainability development process, as illustrated in the diagram below:



The

implementation of the project strategy for the project's dissemination and valorisation is a process that can not be delegated or assigned to an individual project actor or partner. In order to become a successful effort the strategy implementation process has to engage every partner organization, all concerned stakeholders, and be a concern addressed throughout the project time span.

Kennet Lindquist, STPKC

# Intellectual Property Rights in EU projects

*Gheorghe SCUTARU*

*Transilvania University of Brasov, Romania*

**Key words:** *intellectual property rights*

**Abstract:**

*The paper presents general issues related to the Intellectual Property Rights in EU projects; an example of IPR consortium agreement and some specific issues concerning Socrates projects.*

## Introduction [1]

Intellectual property laws confer a bundle of exclusive rights in relation to the particular form or manner in which ideas or information are expressed or manifested, and not in relation to the ideas or concepts themselves. The term "intellectual property" denotes the specific legal rights which authors, inventors and other IP holders may hold and exercise, and not the intellectual work itself.

Intellectual property laws are designed to protect different forms of subject matter, although in some cases there is a degree of overlap.

Copyright may subsist in creative and artistic works (e.g. books, movies, music, paintings, photographs, and software) and gives the exclusive right to control reproduction or adaptation of such works for a certain period of time.

A patent may be granted for a new, useful, and non-obvious invention, and gives the patent holder an exclusive right to commercially exploit the invention for a certain period of time (typically 20 years from the filing date of a patent application).

A trademark is a distinctive sign which is used to distinguish the products or services of different businesses.

An industrial design right protects the form of appearance, style or design of an industrial object (e.g. spare parts, furniture, or textiles).

A trade secret (which is sometimes either equated with, or a subset of, "confidential information") is secret, non-public information concerning the commercial practices or proprietary knowledge of a business, public disclosure of which may sometimes be illegal.

Patents, trademarks, and designs rights are sometimes collectively known as industrial property, as they are typically created and used for industrial or commercial purposes.

## Intellectual property rights in the digital era [1]

Intellectual property rights (IPRs) in the digital era have added a new dimension to the traditional regime of IPRs. The complexity and jurisdictional issues relating to the Internet are challenging the IPR regime drastically. Though, the Agreement on Trade Related Aspects of Intellectual Property Rights (TRIPS Agreement) has tried to harmonise the IPRs all over the world yet the digital issues are vexing the IPRs enforcement everywhere. There is no harmonised law vis-à-vis IPRs in the digital era and this gives rise to conflict of laws. At the same time certain technological measures have also been adopted to tackle the violations of IPRs in the digital environment but their efficiency and effectiveness is yet to be examined.

In recent times there has been a general expansion in intellectual property laws. This can be seen in the extension of laws to new types of subject matter such as databases, in the regulation of new categories of activity in respect of subject matter already protected, in the increase of terms of protection, in the removal of restrictions and limitations on exclusive rights, and in an expansion of the definition of "author" to include corporations as the legitimate creators and owners of works. The concept of work for hire has also had the effect of treating a corporation or business owner as the legal author of works created by employees.

Some consider that the expansion of intellectual property laws upsets the balance between encouraging and facilitating creativity and innovation, and the dissemination of new ideas and creations into the public domain for the common good. They consider that as most new ideas are simply derived from other ideas, intellectual property laws tend to reduce the overall level of creative and scientific advancement in society. They argue that innovation and competition is in effect stifled by expanding IP laws, as litigious IP rights holders aggressively or frivolously seek to protect their portfolios. Opposition to expansion of intellectual property laws is strongly supported by the general economic arguments against monopolies.

The electronic age has seen an increase in the attempt to use software-based digital rights management tools to restrict the copying and use of digitally based works. This can have the effect of limiting fair use provisions of copyright law and even make the first-sale doctrine (known in European Union law as "exhaustion of rights") moot. This would allow, in essence, the creation of a book which would disintegrate after one reading. As individuals have proven adept at circumventing such measures in the past, many copyright holders have also successfully lobbied for laws such as the Digital Millennium Copyright Act, which uses criminal law to prevent any circumvention of software used to enforce digital "rights management" systems. Equivalent provisions, to prevent circumvention of copyright protection have existed in EU for some time, and are being expanded in, for example, Article 6 and 7 the Copyright Directive. Other examples are Article 7 of the Software Directive of 1991 (91/250/EEC), and the Conditional Access Directive of 1998 (98/84/EEC). These provisions raise serious free speech issues even beyond those raised by intellectual property law in general.

At the same time, the growth of the Internet, and particularly distributed search engines represents a challenge for exclusive rights policy. The Recording Industry Association of America, in particular, has been on the front lines of the fight against what it terms "piracy". The industry has had victories against some services, including a highly publicized case against the file-sharing company Napster, and some people have been prosecuted for sharing files in violation of copyright. However, the increasingly decentralized nature of such networks makes legal action against distributed search engines more problematic.

The study of intellectual property has grown in to a distinct academic discipline, most notably in law schools from higher education institutions in developed countries such as the UK, Germany, USA and Canada. Postgraduate courses (often referred to as an LLM or Master of Laws) are available for those looking to further their academic exposure and gain internationally recognised qualifications for intellectual property.

## **Consortium agreement example [2]**

### **Section X: Intellectual Property Rights**

#### **X.1 General Provisions**

The *Parties* agree to respect their individual *Intellectual Property Rights*.

#### **X.2 Protection of Knowledge**

##### **X.2.1 Joint Invention**

If, in the course of carrying out work on the *Project*, a joint invention, design or work is made - and more than one *Party* is contributor to it - and if the features of such joint invention design or work are such that it is not possible to separate them for the purpose of applying for, obtaining and/or maintaining the relevant patent protection or any other *Intellectual Property Right*, the *Parties* concerned agree that they may jointly apply to obtain and/or maintain the relevant right together with any other *Parties*.

The *Parties* concerned shall seek to agree amongst themselves arrangements for applying for, obtaining and/or maintaining such right on a case-by-case basis. As long as any such right is in force, each *Party* concerned shall be entitled to use and to license such right without the consent of the other *Parties*, provided that the *Party* concerned shall be informed in advance of any licensing to third parties. In case of licensing to third parties, appropriate financial compensation shall be given to the other *Parties* concerned.

##### **X.2.2 Application for a Patent**

In respect of a country either specified by the *Commission* or agreed upon by the *Parties*, a *Party* shall notify the other *Parties* (via the *Co-ordinator*, if this is practical) if it does not intend to seek adequate and effective protection (as required by the *Contract*) of certain of its *Knowledge* from the *Project* or if that *Party* intends to waive such protection.

If another *Party* (or *Parties*) informs the notifying *Party* in writing within one calendar month of such notice that it wishes to obtain or maintain such protection, the notifying *Party* shall assign to such other *Party(ies)* all necessary rights which it owns.

Such assignment shall ensure that the *Access-rights* of all *Parties* will be unaffected. For the avoidance of doubt, the *Party* which assigned its rights shall have at least the same *Access-rights* as the non-involved *Parties*.

#### **X.3 Exclusion of Access-rights to Pre-existing Know-How**

In accordance with the *Contract*, (...), each *Party* has the right to exclude specific *Pre-existing Know-how* from the other *Parties'* access, as far as the restrictions are announced as described hereinafter before the signature of the *Contract* or before the effective joining of a new party or if acquired parallel with the *Project*..

The procedure comprises the following steps:

- The *Co-ordinator* shall first be informed by the owning *Party* in writing about the type and scope of *Pre-existing Know-how* for which exclusion from access is requested or announced.
- The *Co-ordinator* will inform the other *Parties* about such requests or announcements.
- The exclusion from access to *Pre-existing Know-how* will become effective in accordance with the *Contract*, (...), subject to the written contradiction of the other *Parties* to be substantiated in accordance with the *Contract*, (...).
- In the event that a new *Party* is admitted to the *Project*, any other *Party* may exclude access to *Pre Existing Know-how* only to the newly admitted *Party*.
- the *Pre-existing Know-how* originally excluded from access or excluded at any later moment or any modification thereof will be listed in Annex D and become part of this *Consortium Agreement*.

#### **X.4 Access-rights**

##### **X.4.1 General Principles**

All *Access-rights* granted in accordance with this Section are granted on a non-exclusive basis, expressly exclude any rights to sub-license and shall be made free of any transfer costs.

*Access-rights* shall be granted in accordance with and subject to the *Contract*, (...). *Knowledge* and *Pre-existing Know-how* shall be used only for the purposes for which *Access-rights* to it have been granted and only for so long as is necessary for those purposes.

In relation to the granting of *Access-rights* "needed" or "need" shall mean that, without the grant of such *Access-rights*:

- In the case of *Access-rights* granted for the execution of the *Project*, carrying out the tasks assigned to the recipient *Party* under the Work Plan (as amended from time to time) would be impossible, significantly delayed, or require significant additional financial or human resources.
- In the case of *Access-rights* granted for use, the use of a defined and material element of the recipient *Party's* own *Knowledge* would be technically or legally impossible.

The burden of proof in relation to a claimed need for *Access-rights* shall be on the requesting *Party*. This *Party* shall provide such proof to the owning *Party* on a written request.

According to the *Contract*, (...) the *Parties* shall conclude a specific agreement for granting *Access-rights*.

The parties shall endeavour to reconcile any dispute concerning the *need* for *Access-rights* through the *Project Co-ordination Committee*

Any grant of *Access-rights* not covered by this Section shall be at the absolute discretion of the owning *Party* and subject to such terms and conditions as may be agreed between the owning and receiving *Parties*.

#### X.4.2 *Access-rights* for carrying out the *Project*

##### X.4.2.1 Conditions for Access

*Access-rights* to *Knowledge* and *Pre-existing Know-how* needed for the performance of the *Project* shall be granted on a royalty-free basis only upon written request specifying the scope and duration of their application particularly with respect to *Pre-existing Know-how*.

##### X.4.2.2 Entitlement for execution of the *Project*

After conclusion of an agreement in accordance with *Contract*, (...), the receiving *Party* is entitled to Use the *Pre-existing Know-how*, *Knowledge* or Software for performing the *Project* work.

If a *Party* applies *Pre-existing Know-how* of another *Party* without the grant of access, a penalty will be decided by the IPR-Council on a case by case basis depending on the value of the infringed rights.

#### X.4.3 *Access-rights* for *Use*

Subject to Section X.4.1, *Access-rights* to *Knowledge* and *Pre-existing Know-how* both needed for *Use* shall be granted upon bilateral agreement between the *Parties* concerned.

*Access-rights* to *Knowledge* shall be granted on preferential conditions, *Access-rights* to *Pre-existing Know-how* shall be granted on Fair and Non-discriminatory Conditions. The granting of *Access-rights* shall be made conditional on to the following principles:

- (i) the access to *Pre-existing Know-how* is limited to the field of application being identified as pertaining to the objectives, content and goals of the *Project* and necessary for the *Use* of own *Knowledge* of the recipient *Party*.
- (ii) the access to *Knowledge* is limited to the field of application being identified as the objectives and goals of the *Project*.
- (iii) subject to (i) and (ii) access has to be granted within 6 months after written request by the potential user to the owning *Party*.

#### X.4.4 *Access-rights* for using *Knowledge* in subsequent Research Activities

Recognising the *Parties'* obligations to act in good faith and in accordance with the contract, the *Parties* agree that the *Access-rights* for using *Knowledge* in subsequent research activities are to be as follows:

As of the date set out in the *Contract*, (...), *Parties* are deemed to be granted, a right to use free of charge *Knowledge* from the *Project* for:

- (a) internal research;
- (b) third-party research, provided the third party does not have direct access to confidential *Knowledge* from the *Project* generated by other *Parties* (as examples)
  - producing research results which are available to the third party but which contain hermetically sealed *Knowledge* from the *Project*;
  - using *Knowledge* from the *Project* for in-house testing or diagnosis purposes in doing research,
  - joint publications.

#### X.4.5 *Access-rights* for Affiliates

Each *Party* hereby grants *Access-rights* to all Affiliates of any other *Party* as if such Affiliates were *Parties* provided all such Affiliates grant *Access-rights* to all *Parties* (and their Affiliates) and (without prejudice to the *Parties'* obligations to carry out the *Project* and to provide Project Deliverables) fulfil all confidentiality and other obligations accepted by the *Parties* under the *Contract* or this *Consortium Agreement* as if such Affiliates were *Parties*.

Upon cessation of the control of an Affiliate, any *Access-rights* granted to such Affiliate in respect of *Knowledge* or *Pre-existing Know-how* shall lapse, provided however that information that is *Knowledge* which has been incorporated into the products, processes, software or services of such Affiliate or which has been amalgamated with such Affiliate's own information may continue to be used (in the manner it was then being used) by such Affiliate, if it is not practical to do otherwise. In such an event, at the request of such Affiliate, each requested *Party* shall grant to such Affiliate non-exclusive licences under that *Party's* intellectual property rights which are *Knowledge* against terms and conditions to be agreed, provided that no Legitimate Interests of such *Party* oppose the grant of such licences. Upon such cessation of control, *Access-rights* granted by such Affiliate shall continue in full force and effect.

#### X.4.6 *Access-rights* for *Parties* joining or leaving the *Project*

*Parties* joining the *Project* after the date of the *Contract* will be granted the *Access-rights* as from the date of their signature of the Declaration of Accession.

For *Parties* leaving the *Project* in accordance with the provisions of (...) hereof, the following will apply:

*Defaulting Parties* are obliged to continue to grant *Access-rights* pursuant to the *Contract* and this *Consortium Agreement*, but the *Access-rights* granted to the *Defaulting Party* pursuant to this *Consortium Agreement* shall cease immediately upon termination of the participation of the *Defaulting Party* in the *Contract*.

Termination of the *Contract* or this *Consortium Agreement* and/or cessation of licenses granted to the *Defaulting Party* in accordance with (...) shall not terminate any sublicenses granted or agreed upon to be granted or offered by the *Defaulting Party* in accordance with Sections X.4.3 and X.4.8.3 prior to the date on which such termination of this *Consortium Agreement* and/or cessation of licenses becomes effective, provided that the *Party* or *Parties* which generated the *Knowledge* or *Pre-existing Know-how* so sublicensed shall have the right to have an assignment of the *Defaulting Party's* rights under such sublicenses.

Any *Party* leaving voluntarily from the *Project* has access to *Knowledge* as this exists at the date of the membership expiration of the *Consortium*.

Any *Party* eliminated by decision of the *Project Co-ordination Committee* does not have any access to *Knowledge*.

#### X.4.7 *Access-rights* for Third Parties

Notwithstanding the provisions of this Section the provisions as set out in *Contract* (...), each *Party* may enter into a technical co-operation or licensing arrangement with a third party in respect of its own *Knowledge*, including, but not limited to, the carrying out of research on behalf of a third party, even if there are minor amounts of *Pre-existing Know-how* and *Knowledge* owned by another *Party*, unavoidably incorporated into or

amalgamated with such own *Knowledge*. In such circumstances and upon request of the party entering into the co-operation or arrangement, the other *Party* shall grant non-exclusive rights to permit such co-operation or arrangement against terms and conditions to be agreed upon, provided that no *Legitimate Interest* of the other *Party* opposes the grant of such rights.

#### X.4.8 Specific Provisions for *Access-rights* to Software

##### X.4.8.1 General principles

For the avoidance of doubt, the general provisions for *Access-rights* provided for in Sections X.4.1 herein are applicable also to software.

*Access-rights* to Software do not comprise access to Source Code but only Limited Source Code *Access* as defined below. Access to Source Code will be granted subject to separate agreements only, to be concluded between the *Parties* concerned.

*Access-rights* to software do not include any right to receive Source Code or Object Code ported to a certain hardware platform or any right to receive respective Software Documentation in any particular form or detail, but only as available from the *Party* granting the *Access-rights*.

##### X.4.8.2 *Access-rights* to Software for carrying out the *Project*

*Access-rights* to Software which is *Knowledge* or *Pre-existing Know-how*, needed for the execution of the *Project* shall be granted on the basis of royalty free Limited Source Code Access upon written request, specifying the scope and duration of their application particularly with respect to Software which is *Pre-existing Know-how*,

##### X.4.8.3 *Access-rights* to Software for Use

Software, which is *Knowledge* or *Pre-existing Know-how* needed for Use shall be granted on the basis of Limited Source Code Access upon a bilateral agreement between the *Parties* concerned.

Access to Software which is *Knowledge* shall be granted on a royalty free basis. Access to Software which is *Pre-existing Know-how* shall be granted on *Fair and Non-Discriminatory Conditions*. The granting of *Access-rights* shall be made conditional on the same principles as stated in Sections X.4.1 and X.4.5. through X.4.7 and shall be applied accordingly.

##### X.4.8.4 Software license and sub-licensing rights

(a) *Access-rights* to *Object Code* and/or Limited Source Code Access all granted in accordance with Sections X.4.1 and X.4.8.1 shall comprise the right:

- (i) to use *Object Code* and Limited Source Code Access in research, or to create and market a product or process, or to create and provide a service; and
- (ii) to make and have made an unlimited number of copies of *Object Code* and Limited Source Code Access; and
- (iii) to distribute, make available, market, sell and offer for sale; even by using services of a third party, such *Object Code* and Limited Source Code Access in connection with products or services of the *Party* having the *Access-rights*.  
provided however that,

- (1) any product, process or service has been developed by the *Party* having the *Access-rights* in accordance with its rights to use *Object Code* and Limited Source Code Access for its own *Knowledge*; and
- (2) *Object Code* and Limited Source Code Access represent only a minor part of the overall product, process or service; and
- (3) *Object Code* and Limited Source Code Access cannot be separated from and/or have been amalgamated with such product, process or service.

In addition, *Access-rights* to *Object Code* shall comprise the worldwide right to grant in the normal course of the relevant trade to end-user customers buying/using the product/services a perpetual, irrevocable, worldwide license

- to Use of *Object Code* in connection with or integrated into, products and services of the *Party* having the *Access-rights* and, as technically essential,
  - to maintain such product/service, and
  - to create for its own end-use interacting interoperable software in accordance with the Council Directive of 14 May 1991 on the legal protection of computer programs (91/250/EEC).
- (b) Where a *Party* has been granted access to Source Code to *Knowledge* according to Section X.4.1 herein, the Parties concerned may further agree that the *Access-rights* to such Source Code can comprise a worldwide license to use, to make and have made copies, to modify and have modified, develop and have developed, to adapt and have adapted Source Code for research, or to create and market a product or process, or to create and provide a service. In addition, *Access-rights* can comprise the worldwide right to sub-license such Source Code, but solely for purpose of adaptation, error correction, maintenance and/or support of the software.
- (c) Each sublicense granted according to the provisions of Section X.4.2 shall, when reasonably possible, be made by a traceable agreement specifying and protecting the proprietary rights of the *Party* or *Parties* concerned unless otherwise agreed upon in a separate agreement.

#### X.4.8.5 Modifications of Software

Unless otherwise agreed, any change or modification on the software made by the receiving *Party* must be reported with a detailed description immediately to the owning *Party*. In the event a *Party* will not comply with this obligation, which is valid for *Pre-existing Know-how* as well as for *Knowledge*, Section X.4.2.2 will be applied.

### IPR in SOCTARES/Leonardo da Vinci [3]

→ *Copyright or industrial property ?*

Most of Leonardo da Vinci projects produce training materials or studies. Generally speaking, results are protected by copyright.

Copyright includes property rights (reproduction, adaptation, distribution and publication) as well as moral rights (authorship and integrity).

Copyright is automatic. It does not require any registration. It takes effect as from the creation of the work and runs for the author's life plus 70 years after his or her death.

Under certain circumstances, promoters might deem it necessary to take steps to protect their results by a patent or a trademark.

→ *Transnational partnership as a joint author ?*

Unless specified, the partnership is regarded as joint author of the results. However, it appears that partners' contributions in a project may substantially vary. Distribution of copyright among partners can reflect such variation and be, for instance, commensurate to the contributions to the project, or distinguish architecture and content or various language versions.

Similarly, the partnership can choose one organisation as exclusive holder of the rights. Any distribution must be governed by an intellectual property agreement.

*The European Commission's rights*

The Commission does not hold any copyright on products developed under the Leonardo da Vinci programme. It nevertheless reserves the right to use the results for demonstration purposes (publication of compendia, display at fairs and exhibitions etc).

Partnerships have to provide for this in their intellectual property agreements.

→ *Intellectual property agreements, why make them ?*

Intellectual property agreements clarify the rights:

- of the partners
- of the partnership with respect to third parties
- of subcontractors

on pre-existing or new material.

Intellectual property agreements are private contracts between partners. Intellectual property provisions can be an integral part of the partnership agreement planned for the project or be subject to a separate agreement.

→ *Intellectual property and commercialisation?*

Copyright includes an economic dimension (reproduction, adaptation, distribution and publication rights). It is of paramount importance to clarify copyright issues when project results are to be commercialised. The commercialisation of Leonardo da Vinci results is subject to a specific procedure. Promoters who wish to market their results shall seek prior authorisation from the Commission. The quality of products and the existence of intellectual property agreements will then be checked.

Requests shall include the following:

- Request for commercialisation containing information to be provided by promoters;
- Intellectual property agreements signed by all partners;
- Two copies (or prototypes or Internet addresses) of products to be marketed.

All marketed products shall bear:

- The European emblem: the technical details can be downloaded from the Commission site at [http://www.ipr-helpdesk.org/t\\_en/home.asp](http://www.ipr-helpdesk.org/t_en/home.asp)
- The following disclaimer: *-This project (or handbook, publication, etc) was carried out with the support of the European Commission under the Leonardo da Vinci programme. Its content does not necessarily reflect the Commission's position on this subject.*

All incomes received during the project contract period shall be recorded in the financial tables in accordance with the provisions of the Administrative and financial handbook.

### **References:**

- [4] [http://en.wikipedia.org/wiki/Intellectual\\_property](http://en.wikipedia.org/wiki/Intellectual_property)
- [5] [CONSORTIUM AGREEMENT FOR SPECIFIC TARGETED RESEARCH PROJECTS IN THE FP 6; [www.uni-kassel.de/owwz/owwz/Downloads](http://www.uni-kassel.de/owwz/owwz/Downloads) ]
- [6] <http://www.ipr-helpdesk.org/controlador/principal?seccion=principal&len=en>

### **Author(s):**

Gheorghe Scutaru, eng. PhD, professor;  
Faculty of Electrical Engineering and Computer Science  
Transilvania University of Brasov,  
Str POLITEHNICII Nr. 1  
500039 BRASOV  
ROMANIA  
Email: [scutaru@unitbv.ro](mailto:scutaru@unitbv.ro)

## Metadata for Online Experiments

*Anna Marina Scapolla, Andrea Bagnasco*

Biophysical and Electronic Engineering Department - DIBE - University of Genoa

### Introduction

This document aims at promoting the discussion on the online experiments metadata schema that will be adopted by the IDENTITY project. We need a format to describe simulated and remote experiments for learning purposes with the objective to ease the integration of experiments in the offer of standard e-learning platforms.

The VR-LRC will consist of a structured, compliant and expandable learning resources repository and will give support to the students mostly for performing VR applications (multimedia products) and executing real experiments remotely.

The IDENTITY project proposes a VR-LRC that covers the domain of electrical engineering on the following topics: Electric Circuits, Analogue and Digital Electronics, Electrical Machines and Drives, Measurement & Automated Test Systems, Home appliance systems and Industrial Process Control..

The integration of simulated and remote experiments with traditional learning material in electronic format, which will be provided by the project partnership, in EILE and other e-learning platforms, will improve the student practical skills required by the current lab activity, as requested by curricula in technical disciplines. Moreover, it will be a contribution to future standardization of e-Learning platforms, regarding mainly the integration of virtual & remote experiments and the insertion of educational capabilities in the offer of standard service providers.

This document describes the metadata defined by DIBE for the management of the experiments of the remote laboratory on electronics ISILab (<http://isilab-esng.dibe.unige.it>) [1] and reports the approach followed in the PROLEARN Network of Excellence (EC VI FP IST-507310) – Work Package “Online experiments”.

The last section contains some considerations about the two solutions presented and proposes a metadata schema as starting point for the IDENTITY activities.

### ISILab and Online Experiments Metadata

Metadata, which have been adopted by ISILab, have two objectives: to catalogue online experiments as learning resources and to facilitate the management of the remote laboratory. Online experiments are described as learning objects on the base of a subset of the IEEE LOM conceptual schema i, nevertheless some extensions have been done to deal with the specificity of these learning objects, and to store all the information that allow the ISILab engine to work properly. These extensions cover the declaration of the instruments, the virtual interfaces used to run the experiments and the assignments that are associated to each experiment.

In ISILab, the Real Laboratory Server engine, which is in charge to manage a multi-user concurrent access to the online experiments and to control the real instruments and the connections between instruments and circuit under test, acts as a scheduler and operates according to the metadata associated to the experiments themselves.

Figure 1 maps the schema of the experiment data structure.

The green line groups round the metadata matching the LOM standard, the blue line collects the data that are specific to ISILab. The schema file (ISILab.xsd) is provided together with this document.

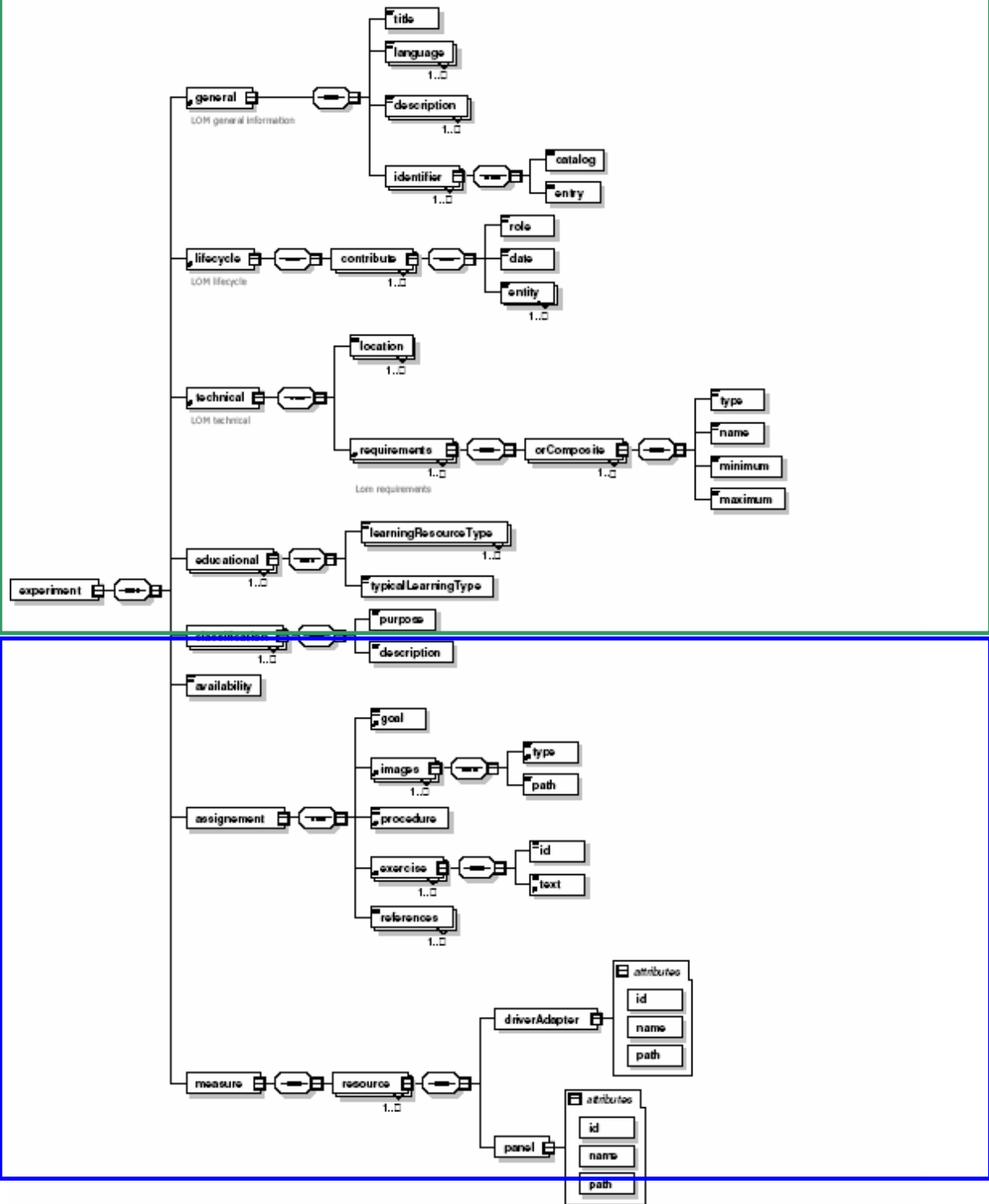


Fig1: ISILab Experiment Schema

The following table lists the schema elements and their descriptions,

<b>Element</b>	<b>Description</b>
<b>1 General</b>	This category groups the general information that describes this learning object as a whole.
General.catalog	The name or designator of the identification or cataloguing scheme for this entry.
General.entry	A global unique label that identifies this learning object.
General.title	Name given to this experiment/learning object.
General.language	The primary human language used within this learning object to communicate to the intended user.
General.description	A textual description of the content of this learning object.
<b>2 Life Cycle</b>	This category describes the history and current state of this learning object and those entities that have affected this learning object during its evolution.
Lifecycle.contribute.role	Kind of contribution (minimally the author(s) of the learning object) of people or organizations that have contributed to the state of this learning object during its life cycle.
Lifecycle.contribute.entity	The identification of and information about entities (i.e., people, organizations) contributing to this learning object.
Lifecycle.contribute.date	The date of the contribution.
<b>4 Technical</b>	This category describes the technical requirements and characteristics of this learning object
Technical.location	A string that is used to access this learning object. It may be a location (e.g., Universal Resource Locator), or a method that resolves to a location (e.g., Universal Resource Identifier).
<i>Technical.requirements</i>	The technical capabilities necessary for using this learning object. If there are multiple requirements, then all are required, i.e., the logical connector is AND.
Technical.requirements.OrComposite	Grouping of multiple requirements. The composite requirement is satisfied when one of the component requirements is satisfied, i.e., the logical connector is OR.
Technical.requirements.type	The technology required to use this learning object, e.g., hardware, software, network, etc
Technical.requirements.name	Name of the required technology to use this learning object.
Technical.requirements.minimumVersion	Lowest possible version of the required technology to use this learning object.
<b>5 Educational</b>	This category describes the key educational or pedagogic characteristics of this learning object
Educational.learningResourceType	Specific kind of learning object. The most dominant kind shall be first.(i.e. experiment, simulation)
Educational.typicalLearningTime	Approximate or typical time it takes to work with or through this learning object for the typical intended target audience.
<b>9 Classification</b>	This category describes where this learning object falls within a particular classification system.

Classification.purpose	The purpose of classifying this learning object (discipline,idea, prerequisite, educational objective, .....
Classification.description	Description of the learning object relative to the stated 9.1:Classification.Purpose of this specific classification, such as discipline, idea, skill level, educational objective, etc.
<b>ISILAB specific data</b>	
Availability	
Assignment	
Assignment.goal	Target of the experiment
Assignment.images.type	Type of image(electric diagram, connections synoptic)
Assignment.images.path	Path of the image
Assignment.procedure	Procedure used to set up the experiment,
Assignment.exercise.id	Exercise identifier
Assignment.exercise.text	Exercise text
Assignment.reference	References
Measure.resources	List of all the measure resources (instruments and devices that are involved in the experiment)
Measure.resource.driverAdapter[id]	Identifier of the driver adapter used by this measure resource.
Measure.resource.driverAdapter[name]	Driver adapter. name.
Measure.resource.driverAdapter[path]	Path of the driver adapter
Measure.resource.panel[id]	Identifier of the measure resource virtual panel.
Measure.resource.panel[name]	Name of the measure resource as presented in the virtual panel. i.e. oscilloscope, main control panel
Measure.resource.panel[path]	Path of the panel description file

The following table contains an example of an experiment description. Starting from the left, the first column contains the schema field name, the second one contains the field content, and the third one matches the field to the IEEE LOM standard.

<b>ISILab experiment schema</b>	<b>An experiment</b>	<b>IEEE LOM</b>
General.catalog	ISILab	✓
General.entry	15	✓
General.title	Integrator circuit	✓
General.language	en	✓
General.description	The experiment shows the behaviour of an integrator circuit.	✓
Lifecycle.contribute.role	creator	✓
Lifecycle.contribute.entity	Andrea Bagnasco	✓
Lifecycle.contribute.date	14-1-2004	✓
Technical.location	http://130.251.89.105	✓
Technical.requirements.type	browser	✓
Technical.requirements.name	Internet Explorer	✓
Technical.requirements.minimum	5.0	✓
Technical.requirements.type	Java Virtual Machine	✓

Technical.requirements.name	Java Plug-in	✓
Technical.requirements.minimum	1.4.2	✓
Educational.learningResourceType	Online experiment	✓
Educational.typicalLearningTime	15 min	✓
Classification.purpose	discipline	✓
Classification.description	Electronics	✓
Classification.purpose	educational objective	✓
Classification.description	To practice an integrator circuit.	✓
Availability	Running	
Assignment.goal	You are required to verify if the circuit works as an integrator	
Assignment.images.type	Electric diagram	
Assignment.images.path	<a href="http://isilab-esng.dibe.unige.it/database/images/exp14-1.gif">http://isilab-esng.dibe.unige.it/database/images/exp14-1.gif</a>	
Assignment.images.type	Synoptic diagram	
Assignment.images.path	<a href="http://isilab-esng.dibe.unige.it/database/images/exp15-2.gif">http://isilab-esng.dibe.unige.it/database/images/exp15-2.gif</a>	
Assignment.procedure	Circuit set-up: the waveform generator is connected to the input N1, the channel 1 of the oscilloscope ...	
Assignment.exercise.id	1	
Assignment.exercise.text	Use the three standard waveforms (sine, square, and triangle) to test the behavior of the circuit.	
Assignment.exercise.id	2	
Assignment.exercise.text	Find the cut-off frequency and the gain of the circuit.	
Assignment.exercise.id	3	
Assignment.exercise.text	Compare your results with the PSPICE simulation.	
Assignment.reference	<a href="http://isilab-esng.dibe.unige.it/database/references/integrator.pdf">http://isilab-esng.dibe.unige.it/database/references/integrator.pdf</a>	
Measure.resource.driverAdapter[id]	14	
Measure.resource.driverAdapter[name]	Switch matrix	
Measure.resource.driverAdapter[path]	Driver/driver1.llb	
Measure.resource.panel[id]	10	
Measure.resource.panel[name]	RF-Filter	
Measure.resource.panel[path]	instr10.xml	
Measure.resource.driverAdapter[id]	1	
Measure.resource.driverAdapter[name]	Waveform generator	
Measure.resource.driverAdapter[path]	instr10.llb\instr10.vi	
Measure.resource.panel[id]	2	
Measure.resource.panel[name]	Clock generator	
Measure.resource.panel[path]	Instr2.xml	

Table 1

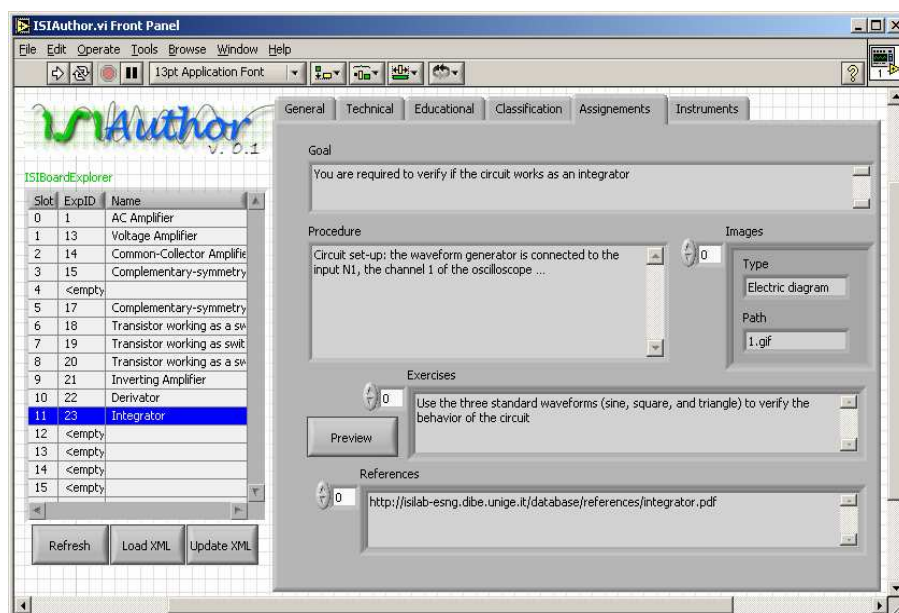
The process of creating the XML files, describing the experiments to be put on line in ISILab, is supported by a tool, named ISIAuthor. It offers a user friendly way to describe the laboratory experiments according to the schema presented in the previous section.

ISIAuthor collects information via diverse panels, which correspond to the groups of metadata listed above. A snapshot of the application graphical user interface is reported in Figure 2.

This application is strictly linked to the ISILab environment. Data input is saved as an XML configuration file that will be used to dynamically generate the online experiment web pages and allows the core engine of the laboratory to manage the communication between virtual instrument interfaces and real workbench.

It is worth noting that this application collects both the metadata related to the experiment as a learning object, and data for the ISILab engine. It would be easy to extract the metadata part for indexing purposes

Furthermore, the definition of the exercises as a whole with the experiment could be revised. Exercises can be treated as stand-alone learning objects and combined with online experiments at the level of the LMS.



**Figure 2: a snapshot of the ISIAuthor tool**

## The PROLEARN approach

PROLEARN, a Network of Excellence in Professional Learning in the area of IST/Technology Enhanced Learning within the European Union 6th research framework, has a specific work package on the subject “Online experiments”.

One of the objectives of this work package is to define a common description for online experiments and to develop an online repository of experiment descriptions, which will allow educators, experiment developers and educational researchers to locate online experiments of interest.

The PROLEARN community has chosen a metadata schema, which deals with experiments as a special kind of learning objects. The schema is an extension of the metadata schema for learning objects that has been adopted by EducaNext ([www.educanext.org](http://www.educanext.org)), a European brokerage platform for the exchange of educational content and the creation and sharing of

knowledge. The schema and the additional attributes, which have been specified for online experiments, are described in ii iii.

The list of experiment descriptions provided by the partners of PROLEARN is available on the EducaNext portal (<http://www.educanext.org/>) by the “advanced search” utility. Select the “learning resource type” equal to “Experiment, Experiment (Offline), Experiment (Online)”.

At the moment, there are 57 resources and most of them are descriptions of remote laboratories or practice tool more than descriptions of single experiments.

The fields that are required to insert a new resource are:

#### *General*

- Description Language: (Mandatory)
- Title: (Mandatory)
- Learning Resource Language: (Mandatory)
- Description: (Mandatory)
- Classification system, discipline, subdiscipline: (Mandatory)
- Learning Resource Category: (Mandatory)
  
- Educational Material Type: (Mandatory)
- Typical Learning Time: (Optional)
- Contributors: (Mandatory)
- Author: (Mandatory)
- Location: (Mandatory)

#### *Technical*

- Version: (Optional)
- Format: (Optional)
- Size: (Optional) (bytes)
- Technical Requirements (Optional)

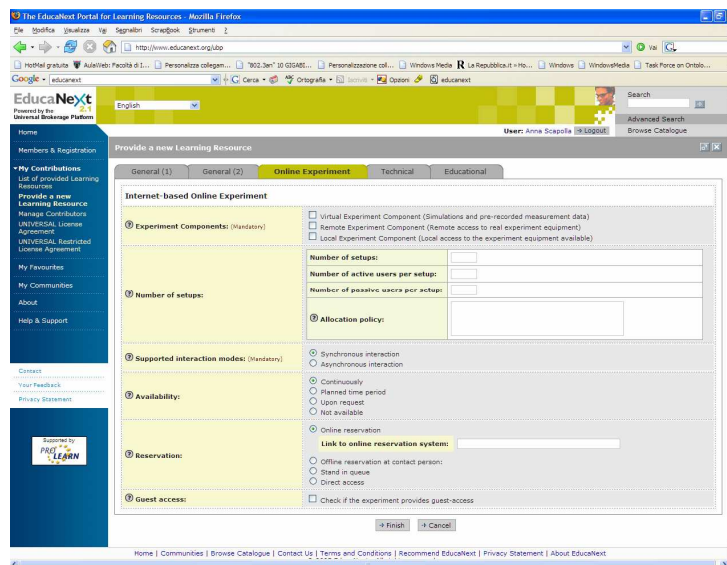
#### *Educational*

- Educational Objectives: (Optional)
- Method of Instruction: (Optional)
- Location of Additional Information: (Optional)
- Curriculum: (Optional)
- Prerequisites: (Optional)
- ECTS Credits: (Optional)

If Educational Material Type is equal to “online experiment” the following additional information are requested:

- Experiment Components:
- Number of setups: (Number of active users per setup, Number of passive users per setup, Allocation policy)
- Supported interaction modes: (Mandatory) (Synchronous interaction, Asynchronous interaction)
- Availability: (Continuously, Planned time period, Upon request, Not available)
- Reservation (Online reservation, Link to online reservation system, Offline reservation at contact person, Stand in queue, Direct access)
- Guest access:

Figure 3 shows a snapshot from the EducaNext site.



**Fig. 3 EducaNext portal: panel specific to online experiments**

The information, which is requested for online experiments, surely helps in specifying the characteristics of this special kind of learning objects. Some doubts can arise on the reliability of such information, as online experiment are not contents in digital format, stored in a repository, but resources that are made available by network servers that manage complex hardware and software systems.

## Conclusions

In our opinion, the experience acquired in ISILab and PROLEARN is a good starting point to choose the metadata that will be adopted by the IDENTITY project.

Looking at the work done in ISILab, experiment description files have been conceived with the aim to be as much as possible LOM compliant, but they still contain ISILab specific data. The ISILab engine was the unique consumer of such files.

In the IDENTITY context we have to separate metadata targeted to describe the learning object resource from the information used by the remote laboratory for configuring and running the experiment.

The main contribution from the PROLEARN community is from the section specifically created for online experiments.

We should consider which elements are of interest and which might be added.

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2. <http://130.75.137.13/pub/OE/Task32Catalog/PROLEARNdeliverableD321reportRev2.doc>
3. [http://130.75.137.13/pub/OE/D3\\_6Catalogue/PROLEARNdeliverableD3\\_6Areport.doc](http://130.75.137.13/pub/OE/D3_6Catalogue/PROLEARNdeliverableD3_6Areport.doc)

## Author(s):

Anna Marina Scapolla, Professor; Andrea Bagnasco, PhD  
University of Genoa, Biophysical and Electronic Engineering Department  
Via Opera Pia, 11a, Genoa, Italy  
{scapolla, pont, gian, bagnasco }@dibe.unige.it

## Metadata for Online Experiments: Laboratorio delle Idee's point of view

*Massimo Mustica*<sup>1</sup>

Laboratorio delle Idee Srl

**Key words:** *SOA, SCORM2004, Virtual laboratory LMS, LCMS*

### **Abstract:**

*Using the SCORM 2004 standard as consolidated Pattern in building the integration of Enhanced Individualized Learning Environment ((EIDE) and VR-Learning Resources Centre (VR-LRC)*

## **1 Making focus on project deliverables: EILE and VR-LRC**

### **1.1 EILE**

EILE will be dedicated to endorse the asynchronous learning part, without time-constraints, also untied to space or mobility restrictions – distance-learning and ubiquitous (mobile) m-learning, respectively. EILE provides each student and tutor with a “tailored panel” to identify the student’s learning needs and the adequate adjustments and to assure an efficient progress of each student. EILE also provides each student with access to the VR-LRC needed to learn to the fullness of their individual ability. “Tutor panel” main menu includes the following major functions: module-course information; student assistance; student progress reports, best practice guide “Student panel” main menu includes the following major functions: learning information, progress information; resources (VR-LRC) access; contacts (tutor, students, administrative desk).

### **1.2 VR-LRC**

VR-LRC consists of a structured, compliant and expandable learning resource repository aimed to give support to the students mostly for performing remote experiments by using VR applications (multimedia products), in order to improve the student practical skills before and after executing real experiments. VR-LRC can be accessed by EILE but it could be used separately as an independent product to be included in various e-learning platforms. IDENTITY project proposes a VR-LRC that covers a specific domain: electrical engineering. As a result, the VR applications to be included in VR-LRC will be related to the following topics: Electric Circuits, Analog and Digital Electronics, Electrical Machines and Drives, Measurement & Automated Test Systems, Home appliance systems and Industrial Process Control. VR-LRC will include not only VR applications but also traditional learning material in electronic format. VR-LRC is to integrate already available appropriate e-learning products provided by the project partnership (based on an intellectual property rights agreement)

### 1.3 Actors

The main human actors of our building system are: administrators, students, teachers; of course non human actors are: the systems itself (the different Vlab's<sup>1</sup> and LMS's<sup>2</sup> involved in the project ).

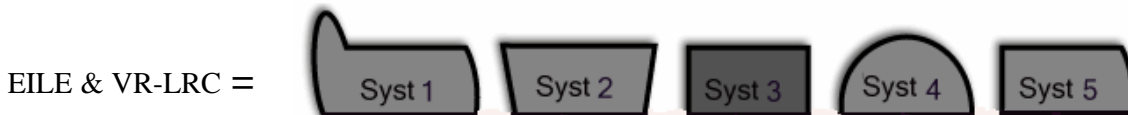
These actors will participate to the following use cases:

- ✓ The Administrator imports the resources of the remote system experiments on EILE
- ✓ The Teacher will look for experiments on VR-Learning Resources Centre
- ✓ The Teacher will link one or more experiments to a course
- ✓ The Student will ask to be enrolled on course
- ✓ EILE accepts/discards the request (in an automatic or mediated way)
- ✓ The system enrolls the student and give him/her the access to the course
- ✓ The Student accesses the experiments and receives the results (on-line or via asynchronous messaging system [file attach]
- ✓ .....
- ✓ .....
- ✓ .....
- ✓ .....

## 2 Scenario

### 2.1 EILE and VR-LRC

Generally speaking EILE is not a monolithic system but is made up of a collection of different systems



Systems can be one of three types: LMS, Vlab and VR-LRC.

In the simplest project scenario we will have 1 LMS, 1 VR-LRM and more than one Vlabs.

To build **EILE & VR-LRC** means to perform an integration task

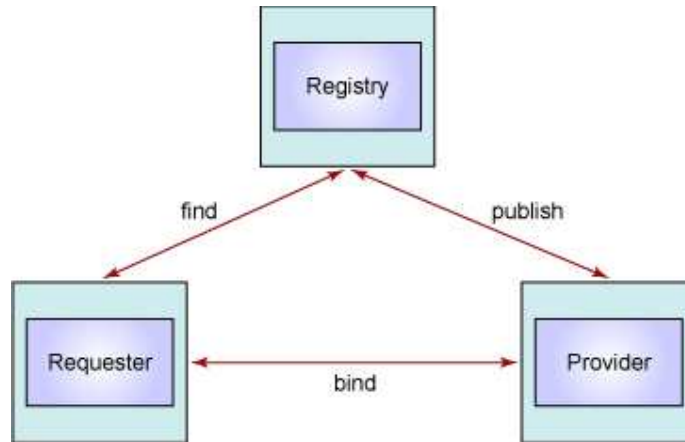
### 2.2 Possible technical solutions

#### 2.2.1 Web services technologies

A Web service is an application that accepts XML-formatted requests from other systems across a network (Internet or intranet) via lightweight, vendor-neutral communications protocols. Web services-based systems are loosely-coupled distributed systems. The simplest Web service system has two participants, a service provider and a service requester. The provider presents the interface and implementation of the service, and the requester (sometimes called consumer or client) uses the Web service. This simple architecture looks like this:

<sup>1</sup> Virtual laboratory.

<sup>2</sup> Learning management system



Registry=UDDI Universal Description Discovery and Integration

<http://jcp.org/en/jsr/all>

### 2.2.2 OKI Standard

The Open Knowledge Initiative (O.K.I) develops and promotes specifications that describe how the components of a software environment communicate with each other and with other enterprise systems. O.K.I. specifications enable sustainable interoperability and integration by defining standards for Service Oriented Architecture (SOA). Through this work O.K.I. seeks to open new market opportunities across a wide range of software application domains.



To this end, O.K.I. has developed and published the Open Service Interface Definitions (OSIDs), whose design has been informed by a broad architectural view. The OSIDs define important components of a SOA<sup>3</sup> as they provide general software contracts between service consumers and service providers. This enables applications to be constructed independently of any particular service environment, and eases integration. The OSIDs enable choice of end-user tools by providing plugin interoperability.

<http://www.okiproject.org/>

<sup>3</sup> Service Oriented Architecture

### 2.2.3 Apply a consolidated Pattern

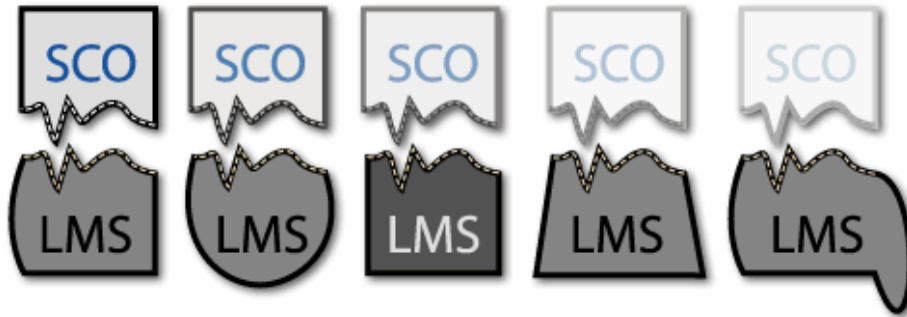
In software engineering, a design pattern is a general repeatable solution to a commonly occurring problem in software design. A design pattern is not a finished design that can be transformed directly into code. It is a description or template for how to solve a problem that can be used in many different situations.

....

## 3 SCORM2004 as a pattern

### 3.1 *SCORM what it does at Run-time Environment:*

- ✓ A common way to start learning resources [Launch mechanism]
- ✓ A common mechanism for communication with an LMS [API (Application Program Interface)]
- ✓ A common vocabulary for communication with an LMS [Run-Time Environment Data Model]



SCO is particular type of learning object

### 3.2 *SCORM what it does at meta-data level*

- ✓ Describes and identifies the resource
- ✓ Gives the history of the resource and documents who created or altered it
- ✓ Provides technical information about the resource
- ✓ Describes the pedagogical characteristics of the resource
- ✓ Provides intellectual property rights and usage information
- ✓ Tells how a resource works together with other resources

### 3.3 *SCORM what it does at Content Packaging*

- ✓ IMS Content Package – A package is a unit of usable (and reusable) content. A package must be able to stand alone, and therefore must contain all the information and components needed to use the contents for learning when it is unpacked.

- ✓ Content Packaging Information Model – The information model defines the data elements available for the building of SCORM conformant packages.
- ✓ Content Packaging XML Binding – The XML binding is a template (called a schema) for representing a SCORM content package using an XML file. An XML file is a structured text file contains information for learning management systems on how to present the content and instructions for reconstructing it at run time.

## 4 Why use SCORM2004 as a pattern?

### 4.1 *Our Project needs:*

#### 4.1.1 Run-time Environment:

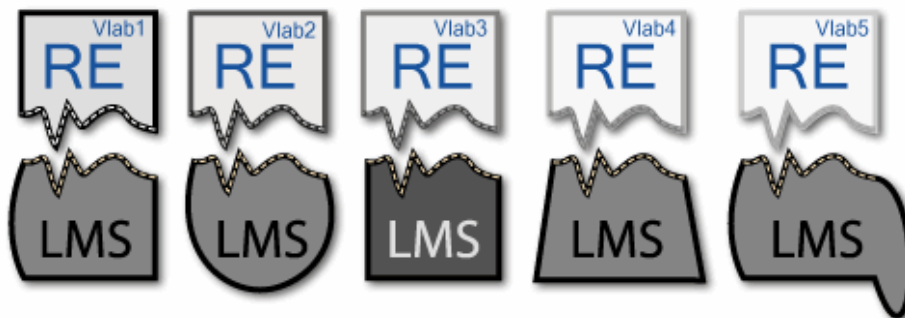
- ✓ A common way to start **remote experiment** [Launch mechanism]
- ✓ A common mechanism for communication with an **LMS and Vlab at experiment Level** [API (Application Program Interface)]
- ✓ A common vocabulary for communication with an **LMS and Vlab at experiment Level** [Run-Time Environment Data Model]

#### 4.1.2 Meta-Data Level

- ✓ Describes and identifies the resource
- ✓ Gives the history of the resource and documents who created or altered it
- ✓ Provides technical information about the resource
- ✓ Describes the pedagogical characteristics of the resource
- ✓ Provides intellectual property rights and usage information
- ✓ Tells how a resource works together with other resources

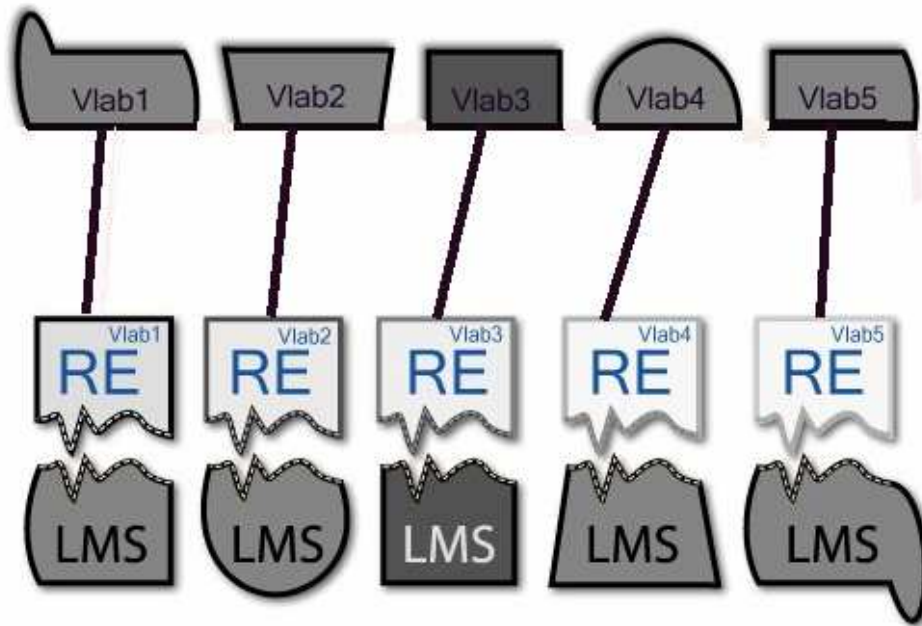
### 4.2 *Applying Run-time Environment and Meta-Data Level*

LMS will manage a particular type of learning resources : **Remote Experiment**

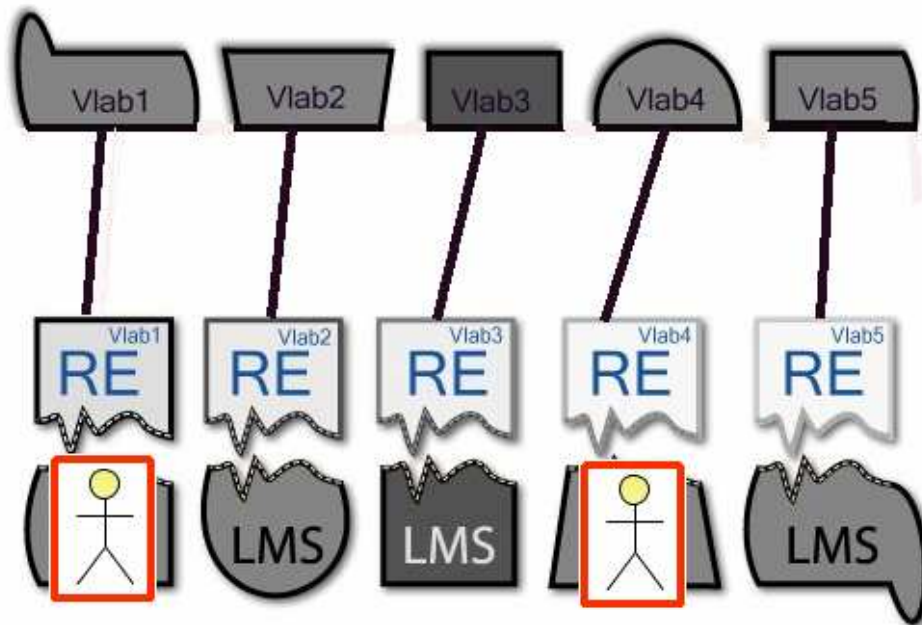


#### **RE Remote Experiment:**

- It must be available on Internet
- Client requirement must only be Internet Browser and selected plug-in
- Protocol must be http on 80 port or https on port 443
- It has be described by metadata



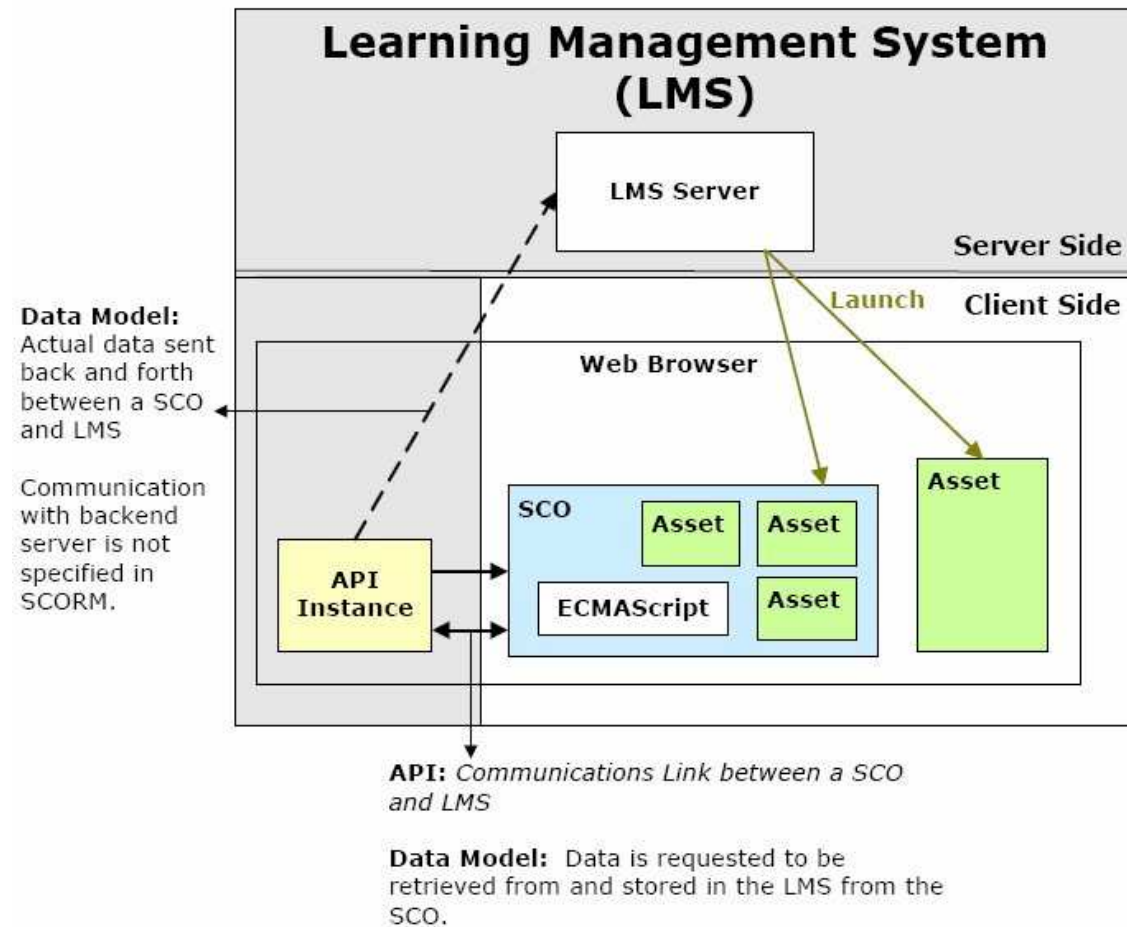
Meta data regarding the Remote Experiment will be the LINK through Vlab's and LMS's



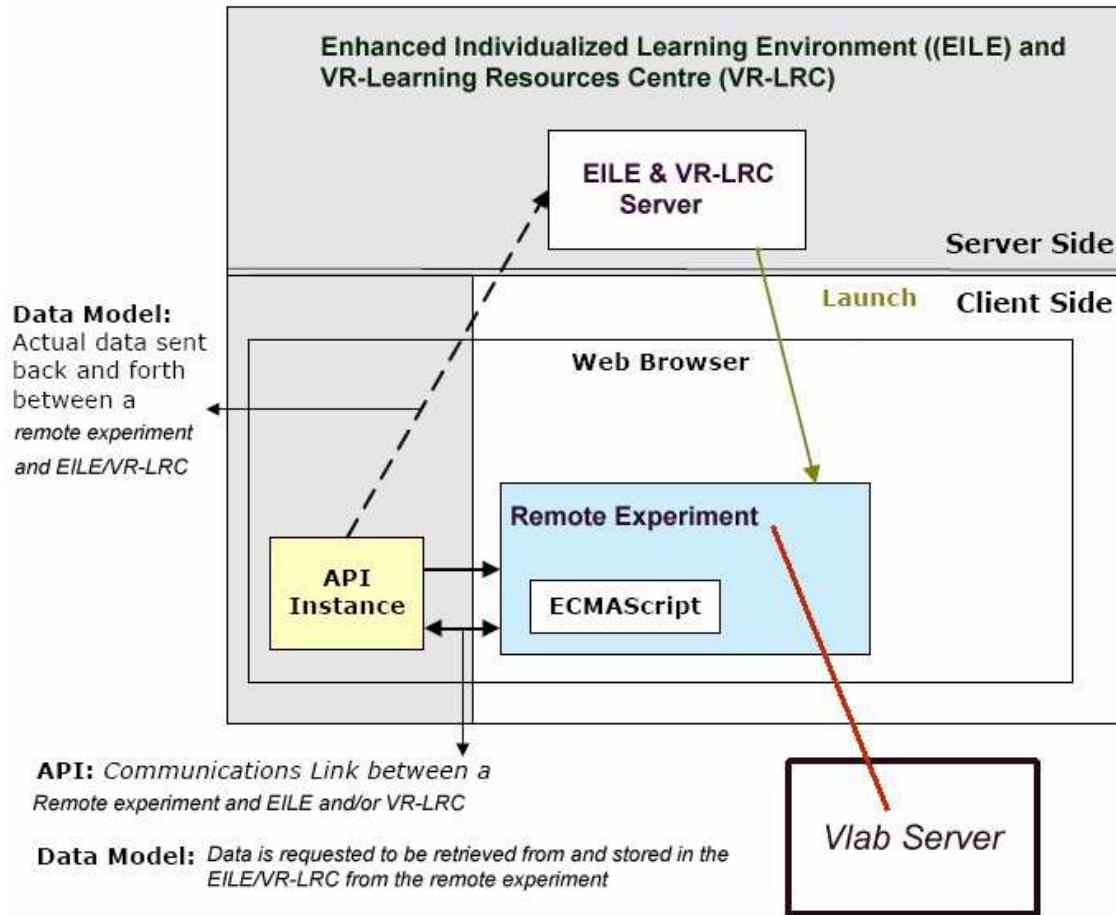
Project API will deliver all required information to cover all the cases of use of our project. (an example is login phases where the API provides user information to the Vlab system)

### 4.3 API Pattern

The following image shows the architecture of SCORM 2004



The following image shows the architecture of Identity Project



## 5 Activities to be done

- To agree upon the use cases and add more in our discussion during our meeting
- To agree upon the project's scenario (LMS and Vlab types)
- To define the information needs of Vlab's systems to :
  - allow access to remote experiments
  - give back the results in a synchronous and asynchronous way
- To extend metadata for online experiments of DIBE - University of Genoa putting the focus on:
  - not re-doing but re-using existing standards
  - information regarding VR-LRC (addressing the search facilities)
  - information addressing the Launch mechanism of remote experiments
  - information addressing the new way of using the project's resources proposed in Identity project (time zones; authorization and so on ....)
- To implement all use cases

Regarding the outcomes of the requirements from points a,b and c we propose to evaluate it in compliance with the ISO 9126.<sup>4</sup>

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## Author(s):

Massimo, Mustica, dott. Ing.  
Laboratorio delle Idee, ICT director  
Via G. B. Miliani 36 60044 Fabriano (AN) Italy  
[massimo.mustica@labidee.com](mailto:massimo.mustica@labidee.com)

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<sup>4</sup> ISO 9126 is an international standard for the evaluation of software. It will be overseen by the project SQuaRE, ISO 25000:2005, which follows the same general concepts

## A Remote Learning System (RLS) – from portal to semantic web

Sorin-Aurel Moraru, Paul Nicolae Borza<sup>1</sup>,  
Massimo Mustica<sup>2</sup>, Ionut Ilarie Diaconu<sup>3</sup>

Transilvania University of Brasov<sup>1</sup>, Laboratorio delle Idee srl<sup>2</sup>, Vision Systems srl<sup>3</sup>

**Key words:** *portal, remote learning system, semantic web*

### Abstract:

The paper presents a solution for a remote learning system that makes up the unification of the resources through a homogeneous structure, allowing the unified management of the users at a superior level (near user) and the resource interfacing in a uniform and manageable way at an inferior level (near resources). There are presented advantages of the new system, and the features, architecture and technologies. The solution is introduced after an analysis of portals, portlet technology and corresponding Java Specification Request. The Course Management System is contextualized using the Moodle solution and metadata concept. For the same of common formats for integration and combination of data drawn from diverse sources, and the language for recording how the data relates to real world objects is proposed a semantic web solution.

## 1 Portals

### 1.1 Introduction

Modern software is complex and expensive, which has motivated many organizations to invest in enterprise portals as a mechanism by which they can manage information in a cohesive and structured fashion.

Portals offer many advantages over other software applications. First, they provide a single point of entry for employees, partners, and customers. Second, portals can access Web services transparently from any device in virtually any location. Third, portals are highly flexible; they can exist in the form of B2E intra-nets, B2B extra-nets, or B2C inter-nets. Fourth, portals can be combined to form a portal network that can span a company entire enterprise system, allowing for access both inside and outside the firewall.

A personal portal is a site on the World Wide Web that typically provides personalized capabilities to its visitors, providing a pathway to other content. It is designed to use distributed applications, different numbers and types of middleware and hardware to provide services from a number of different sources.

In addition, business portals are designed to share collaboration in workplaces. A further business-driven requirement of portals is that the content be able to work on multiple platforms such as personal computers, personal digital assistants (PDAs), and cell phones.

Portals have many advantages, which is why they have become the de facto standard for Web application delivery. In fact, analysts have predicted that portals will become the next generation for the desktop environment.

Portals distinguish themselves from other software systems because they provide the ability to integrate disparate systems and leverage the functionality provided by those systems. As such,

they are not mutually exclusive, and do not force you into an either-or decision vis-a-vis existing software systems. This point is of paramount importance, particularly when you consider the fact that Web services are destined to fuel the explosion of Web applications. Since portals can access any Web services, the conclusion is inescapable: portals provide a unique opportunity to leverage the functionality of nascent technologies as well as mature, well-established software systems.

## **1.2 What portals do we have?**

The most powerful portals that exist these days are:

### **uPortal**

uPortal is an open-standard effort using Java, XML, JSP and J2EE. It is a collaborative development project with the effort shared among several of the JA-SIG member institutions.

uPortal is a Java-based framework for creating web portals for educational institutions.

uPortal is open source under a BSD-style license.

uPortal has integrated Apache Software Foundation's Pluto software to become JSR 168 compliant allowing it to host Portlets.

uPortal is a free, sharable portal under development by institutions of higher-education. This group sees an institutional portal as an abridged and customized version of the institutional Web presence... a "pocket-sized" version of the campus Web. Portal technology adds "customization" and "community" to the campus Web presence. Customization allows each user to define a unique and personal view of the campus Web. Community tools, such as chat, forums, survey, and so on, build relationships among campus constituencies.

### **Jetspeed-1**

Jetspeed-1 is an Open Source implementation of an Enterprise Information Portal, using Java and XML. Jetspeed-1 is a user-customizable portal system, supporting a rich feature set and mature user base.

### **Jetspeed-2**

Jetspeed-2 is the next-generation enterprise portal at Apache. Jetspeed-2 offers several architectural enhancements and improvements over Jetspeed 1.0. First, Jetspeed-2 is conformant to the Java Portlet Standard and will provide a standard mechanism for the deployment of portlets. Second, Jetspeed-2 has matured to a more scalable architecture featuring multi-threaded functionality. Third, Jetspeed-2 is decoupled from several legacy open source projects. Fourth, Jetspeed-2 is based on a component architecture.

### **Pluto**

Pluto is the Reference Implementation of the Java Portlet Specification. The current version of this Portlet specification is JSR 168 1.0. Portlets are designed to run in the context of a portal. They are written to the Portlet API. Pluto implements the contract, the Portlet API, between portlets and portals. Pluto is a portlet container.

## **1.3 Portlet technology**

Portlets are pluggable user interface components that are managed and displayed in a web portal. Portlets produce fragments of markup code that are aggregated into a portal page. Typically, following the desktop metaphor, a portal page is displayed as a collection of non-overlapping portlet windows, where each portlet window displays a portlet. Hence a portlet (or collection of portlets) resembles a web-based application that is hosted in a portal. Portlet applications include email, weather reports, discussion forums, and news.

Portlet standards are intended to enable software developers to create portlets that can be plugged in any portal supporting the standards.

The purpose of the Web Services for Remote Portlets protocol is to provide a web services standard that allows for the "plug-n-play" of remote running portlets from disparate sources. Many sites allow registered users to personalize their view of the website by turning on or off portions of the webpage, or by adding or deleting features. This is usually accomplished by a set of portlets that together form the portal.

The Java Portlet Specification (JSR168) enables interoperability for portlets between different web portals. This specification defines a set of APIs for interaction between the portlet container and the portlet addressing the areas of personalization, presentation and security.

Apache Pluto is a reference implementation of JSR168. Other than the reference implementation, a number of vendors provide commercial implementations of the portlet container. Some of the leading vendors are IBM, Oracle, BEA Systems and Vignette Corporation. These vendors provide standards based implementations as well as extensions not yet approved by the standards body.

### **1.4 What is JSR (Java Specification Request) 168 ?**

The variety of incompatible portlet interfaces generates problems for application providers, portal customers, and portal server vendors. To overcome these problems, JSR (Java Specification Request) 168, the Portlet Specification, was started to provide interoperability between portlets and portals.

JSR 168 defines portlets as Java-based Web components, managed by a portlet container, that process requests and generate dynamic content. Portals use portlets as pluggable user interface components that provide a presentation layer to information systems.

JSR 168's goals are the following:

- Define the runtime environment, or the portlet container, for portlets
- Define the API between portlet container and portlets
- Provide mechanisms to store transient and persistent data for portlets
- Provide a mechanism that allows portlets to include servlets and JSP (JavaServer Pages)
- Define a packaging of portlets to allow easy deployment
- Allow binary portlet portability among JSR 168 portals
- Run JSR 168 portlets as remote portlets using the Web Services for Remote Portlets (WSRP) protocol

The IT industry has broadly accepted JSR 168. All major companies in the portal space are part of the JSR 168 expert group: Apache, ATG, BEA, Boeing, Borland, Broadvision, Citrix, EDS, Fujitsu, Hitachi, IBM, Novell, Oracle, SAP, SAS Institute, Sun Microsystems, Sybase, TIBCO, and Vignette.

## **2 Course Management System**

The course management are designed to support academic classroom courses.

Course management systems (CMSs) are online systems that were originally designed to support classroom learning in academic settings, such as universities and high schools. CMSs provide instructors with the ability to perform the following tasks:

- Place course materials online. Most CMSs provide pre-programmed buttons for the course syllabus, course schedule, and course materials linked to specific lessons, such as copies of readings and PowerPoint slides from lectures.
- Track student progress through assessment features, which enable instructors to give quizzes and tests online, and an online gradebook, where instructors can post student grades.

- Discussion board, where instructors and students can discuss readings and continue class discussions between formal class sessions.
- Other communications tools, which let instructors send announcements to classes and communicate individually with students
- Lock box for students, where students can store class materials in a safe place—either a presentation to give later in class or backing up class assignments in a safe place.
- Course statistics, which provide information on the use of the course site, including who used the course site and when.

Examples of CMSs include the commercial products Blackboard and WebCT, and the open source system, Moodle.

Because CMSs enable instructors to easily create a course website by following a template and uploading existing documents in PowerPoint, Word, Excel, Acrobat and other popular formats without converting them to a web format (like HTML), they require few specialized skills. As a result, CMSs are easy to learn and were quickly adopted by instructors, even those who might claim to be luddites. Indeed, some universities report that well over 70 percent of their instructors have created course websites using CMSs.

CMSs also have proven popular in managing asynchronous academic distance courses, too, because of their ability to manage discussions. In addition, given that CMSs were already installed and in wide use only adds to their popularity. When using a CMS to manage a distance course, instructors post a core lesson - a master script, of sorts, that guides students through readings, discussions, and learning activities - instead of merely posting readings and PowerPoint slides for each lesson,. Instructors then use the discussion board to manage the course discussions, which are usually more extensive than those used in classroom courses.

### **2.1. Moodle (*Modular Object-Oriented Dynamic Learning Environment*)**

Moodle is a free and open source software e-learning platform (also known as a Course Management System (CMS), or Learning Management Systems (LMS), or Virtual Learning Environment (VLE))

Moodle is designed to help educators create online courses with opportunities for rich interaction. Its open source license and modular design means that many people can develop additional functionality.

Moodle runs without modification on Unix, Linux, FreeBSD, Windows, Mac OS X, NetWare and any other systems that support PHP, including most webhost providers.

Data is stored in a single database: MySQL and PostgreSQL were the only feasible options in Moodle.

Moodle has many features expected from an e-learning platform including:

- Forums
- Content managing (resources)
- Quizzes with different kinds of questions
- Blogs
- Wikis
- Database activities
- Surveys
- Chat
- Glossaries
- Peer assessment
- Multi-language support (over 60 languages are supported for the interface [2])

Moodle is modular in construction and can readily be extended by creating plugins for specific new functionality. Moodle's infrastructure supports many types of plugin:

- Activities

- Resource types
- Question types
- Data field types (for the database activity)
- Graphical themes
- Authentication methods
- Enrolment methods
- Content Filters

PHP can be used to author and contribute new modules. Moodle's development has been assisted by the work of open source programmers. This has contributed towards its rapid development and rapid bug fixes.

Moodle contains a wide range of activity modules that can be used to build up any type of course.

*a) Assignments*

Assignments allow the teacher to specify a task that requires students to prepare digital content (any format) and submit it by uploading it to the server. Typical assignments include essays, projects, reports and so on. This module includes grading facilities.

*b) Chats*

The Chat module allows participants to have a real-time synchronous discussion via the web. This is a useful way to get a different understanding of each other and the topic being discussed - the mode of using a chat room is quite different from the asynchronous forums. The Chat module contains a number of features for managing and reviewing chat discussions.

*c) Choices*

A choice activity is very simple - the teacher asks a question and specifies a choice of multiple responses. It can be useful as a quick poll to stimulate thinking about a topic; to allow the class to vote on a direction for the course; or to gather research consent.

*d) Forums*

This activity can be the most important - it is here that most discussion takes place. Forums can be structured in different ways, and can include peer rating of each posting. The postings can be viewed in a variety of formats, and can include attachments. By subscribing to a forum, participants will receive copies of each new posting in their email. A teacher can impose subscription on everyone if they want to.

*e) Glossary*

This activity allows participants to create and maintain a list of definitions, like a dictionary.

The entries can be searched or browsed in many different formats.

The glossary also allows teachers to export entries from one glossary to another (the main one) within the same course.

*f) Labels*

This is a dummy activity - it is a "dummy" activity that allows you to insert text and graphics among the other activities on the course page.

*g) Lesson*

A lesson delivers content in an interesting and flexible way. It consists of a number of pages. Each page normally ends with a question and a number of possible answers. Depending on the student's choice of answer they either progress to the next page or are taken back to a previous page. Navigation through the lesson can be straight forward or complex, depending largely on the structure of the material being presented.

*h) Quizzes*

This module allows the teacher to design and set quiz tests, consisting of multiple choice, true-false, and short answer questions. These questions are kept in a categorised database, and can be re-used within courses and even between courses. Quizzes can allow multiple attempts. Each attempt is automatically marked, and the teacher can choose whether to give feedback or to show correct answers. This module includes grading facilities.

*i) Resources*

Resources are content: information the teacher wants to bring into the course. These can be prepared files uploaded to the course server; pages edited directly in Moodle; or external web pages made to appear part of this course.

*j) SCORM/AICC Packages*

A package is a bundle of web content packaged in a way that follows the SCORM or the AICC standard for learning objects. These packages can include web pages, graphics, Javascript programs, Flash presentations and anything else that works in web browsers. The Package module allows you to easily upload any standard SCORM or AICC package and make it part of your course.

*k) Surveys*

The Survey module provides a number of verified survey instruments that have been found useful in assessing and stimulating learning in online environments. Teachers can use these to gather data from their students that will help them learn about their class and reflect on their own teaching.

*l) Wikis*

A Wiki enables documents to be authored collectively in a simple markup language using a web browser.

"Wiki wiki" means "super fast" in the Hawaiian language, and it is the speed of creating and updating pages that is one of the defining aspects of wiki technology. Generally, there is no prior review before modifications are accepted, and most wikis are open to the general public or at least to all persons who also have access to the wiki server.

The Moodle Wiki module enables participants to work together on web pages to add, expand and change the content. Old versions are never deleted and can be restored.

*m) Workshop*

A Workshop is a peer assessment activity with a huge array of options. It allows participants to assess each other's projects, as well as exemplar projects, in a number of ways. It also coordinates the collection and distribution of these assessments in a variety of ways.

**2.2 Metadata**

Metadata has multiple definitions, the briefest of which is "data about data." It can generally be thought of as information that describes, or supplements, the central data. For example, metadata produced by digital cameras describe the settings used for the picture, such as exposure value or flash intensity. In such cases, the metadata can be considered as extra data, which merely add information, and is not critical to the functions of the main data.

Even when it is not essential to the proper functioning of a product, metadata is valuable because of the context that it provides, and the ways that contextual information can be used. When data is made available to a potential user, the user (human or computer) must put the data into an existing model of knowledge, and may ask questions to do so. For example, in the case of an image, typical questions include "When was this taken?" and "Who and what are in this image?" Metadata provides context to answer many of these questions. In sophisticated data systems, the metadata - the contextual information surrounding the data - will also be very sophisticated, capable of answering many questions that help understand the data.

In a unified content strategy, metadata enables content to be retrieved, tracked, and assembled automatically. Metadata enables:

- Effective retrieval
- Systematic reuse
- Automatic routing based on workflow status
- Tracking of status
- Reporting

Metadata is used by CMS for managing courses.

For example, the SCORM courses metadata are organized into nine broad categories, some of which are optional for one or more types of resources.

- General – information about the resource or content aggregation as a whole
- Lifecycle – history and current state of the resource and those who have contributed to its development (optional for assets)
- Meta-Metadata – specific information about the metadata record itself, as opposed to the resource described by the metadata
- Technical – technical requirements and characteristics of the resource
- Educational – key educational or pedagogical characteristics of the resource (optional for all resource types)
- Rights – intellectual property rights and conditions for use
- Relation – relationship between the resource and other resources (optional for all resource types)
- Annotation – comments on the educational use of the resource, generally by parties other than the original author (optional for all resource types)
- Classification – where the resource is placed in relation to a specific taxonomy or classification scheme (optional for assets)

### **3 Proposal for developing the Remote Learning System - RLS**

#### **3.1 Present situation**

Now there exist many resources (courses, laboratories, libraries, etc.) that can be accessed by users, locally or over Internet.

The resources structure is not homogeneous.

Users authentication (through username and password) is done for each resource or it is not done at all.

#### **3.2. Unification of the resources**

The unification of the resources can be done through a homogeneous structure at a superior level of resources, named from now on: *Framework*, see the figure 1 (between resources and users).

The *Framework* will permit at a superior level (near user) the unified management of the users:

- a single authentication, at the entrance of the system. After login the user will get access to all required resources. The user will see in a single window the list of available resources, right after the authentication process;
- add/modify/delete users;
- creation of user roles;
- user to role association;
- levels of rights for users (student, teacher, administrator, etc)

The *Framework* will permit at an inferior level (near resources) the resource interfacing in a uniform and manageable way.

Through their essence, the resources are very diverse as functionalities:

- LMS (Learning Management System)
- Remote laboratories
- Libraries
- etc

as well as products/technologies used for functionalities implementation (Java, Ajax, Asp, .Net, Moodle).

In order to create/implement the *framework* it is possible to use one of the following choices:

- OKI (Open Knowledge Interface) – standard created by MIT University SUA – very good, but not easy to implement;
- UPortal – it is easier to use in software developing;
- etc.

**We recommend the use of UPortal.**

The uPortal will include the Moodle CMS through the use of Portlet. Moodle will be contained into a portlet (the portlet can play the role of container).

Uportal as well as Moodle have their own access/login mechanism based on username and password.

Moodle will be placed inside uPortal.

The SSO (Single Sign On) feature is accomplished through an portlet (autologinPortlet) that retrieves the username and password from the uPortal (the login servlet will put the necessary credentials into the session), and then performs autologin into Moodle system by calling a modified instance of login page that expects the username and password as parameters.

This way the user has to login only once, in portal.

The management of users will be done in one place – in uPortal. A VB Script will perform synchronization of the user tables, between uPortal database and Moodle database.

The resources that are used by Moodle as well as uPortal can be easily modified /updated through FTP, because resources can be stored and liked from there.

Students can register for an account in uPortal. Then they are able to login. For the first login time, they are able to browse the lists of available courses, visualize their metadata and ask to enroll.

The user with teacher role will see the enroll requests and he can grant or deny their request.

If the student is allowed to join the requested course, at the next login he will be able to see and attend the course.

Inside portal he could access courses (in standard format or SCORM/AICC), class chat, class forums, public chats and forums, webmail, wiki, calendar etc. All these features are hosted by portlets (portlet that can perform SSO – single sign on) where necessary (for example: forum, wiki).

The idea of interfacing the *framework* with the resources is a good strategic option, because (beyond uniformity and the possibility to keep the control of the entire system) it permits developing/modifying/attaching of the resources to the system

- independently
- with minimum of effort for creating/modifying the software(named interface) necessary for the functioning of these resources in the system.

### **3.3 Use of a Control Versioning System CVS**

This system permits:

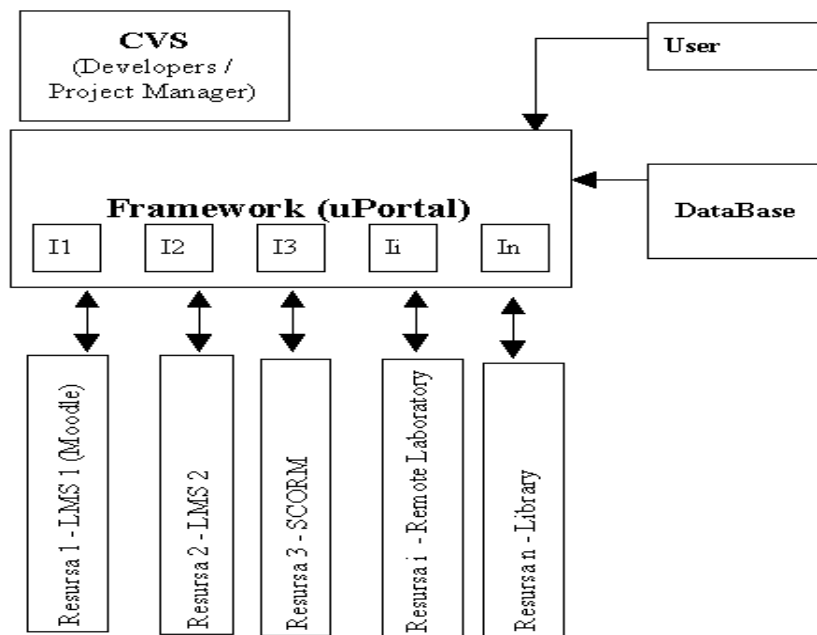
- General control of the project evolution.
- Exact knowledge by developer/manager of the answers to questions like: who is working, what is working, which was the software development time evolution, etc.
- Concurrent developing (many users at the same time) of the software code created in university for the system functioning, which reduce the time for developing.
- Detect and help in correction of the conflicts that occur during software developing.

The CVSs exist both in free and commercial versions.

We propose a study of the needs for the system and decide for the best suited CVS version to be used.

### 3.4 Some advantages of the new solution

- **Scalability**; The proposed architecture for the RLS system includes Cluster advantages (RLS runs on many computers), permitting resources distribution over many computers, according to the system load (resources number, users number, concurrent using load, etc).
- **Modularized** developing of the required components of the RLS system, though dividing of the whole problem in small problems, easier to develop, and as assembling of these “bricks” in a coherent and controlled way, with the implication of a team of specialists formed for the specific project.



I1, I2, In, Ii – Interfaces

Fig 1. Proposed architecture for LRS

## 4 About Semantic Web, specific languages description and tools

Semantic Web offer for users information a "well defined meaning, better enabling computers and people to work in cooperation"[4]. The semantic Web sue a specific tools and languages in order to offer a comprehensive image of the generic reality for computers and in the same time for users.

The Semantic Web is about two things. It is about common formats for integration and combination of data drawn from diverse sources, where on the original Web mainly

concentrated on the interchange of documents. It is also about language for recording how the data relates to real world objects. That allows a person, or a machine, to start off in one database, and then move through an unending set of databases which are connected not by wires but by being about the same thing.

In February 2004, The World Wide Web Consortium released the Resource Description Framework (RDF) and the OWL Web Ontology Language (OWL) as W3C Recommendations. RDF is used to represent information and to exchange knowledge in the Web. OWL is used to publish and share sets of terms called ontologies, supporting advanced Web search, software agents and knowledge management.

The Semantic Web is an evolving extension www ( World Wide Web) offering a form that can be understood, interpreted and used by software agents. It is so possible to find, share and integrate information more easily [5]. Thus Web becomes a universal medium for data, information, experiences and knowledge exchange.

RDF is a language for representation of information, in general of metadata, using syntax XML (extended markup language) organized in a form of triplets (subject, predicate, and object). RDF is intended to provide a simple way to make statements about Web resources. Three elements are important in order to well describe the meaning of data (figure 2), these are:

- subject, that indicate the thing that is specified;
- predicate that specify a property of the subject;
- object that define the specific value of predicate.



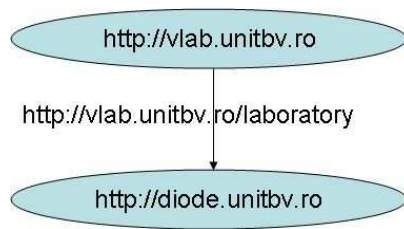
Fig. 2. Elements describing the meaning of data and their relation

Thus, the RDF made a machine - processable statements assuring:

- a system of machine-processable identifiers for identifying a subject, predicate, or object in a statement without any possibility of confusion with a similar-looking identifier that might be used by someone else on the Web.
- a machine-processable language for representing these statements and exchanging them between machines.

URI (Uniform Resource Identifier) is anything that indicates *unequivocally* a resource represented as a compact string of characters. Using URI we can identify for example the subjects and predicates.

A subset of URI is used to locating or find a resource it is named URL (Uniform Resource Locator). A URL indicates the access to a resource. URN (Uniform resource Name) refers to a subset of URI and indicates names that must remain unique even when the resource ceases to be available. URNS intended to serve as persistent, location-independent resource identifiers and are designed to make it easy to map other namespaces.



Using for example a RDF scheme we can represent a simple statement between the learning object, and also we can locate them. In figure 3 we illustrate in graph form such statement (simple RDF scheme) for a laboratory of the VirtualElectroLab system. In order to easier the buildup of RDF schemes and the ontology also lot of tools and environment was developed.

Fig. 3. RDF for VirtualElectroLab

#### 4.1. Tools useful for easier the work at the definition and automated reasoning

Some useful tools are:

- **EULER** is graph oriented is view not as a graph structure with oriented links but as a collection of triplets.

- **PROTÉGÉ**, is environment developed at Stanford university and offer a editor having a user friendly interface and a knowledge server to support users in constructing and storing frame-based domain ontologies, customizing data entry forms, and entering instance data. Protégé-Frames implement a knowledge model which is compatible with the Open Knowledge Base Connectivity protocol (OKBC). In this model, an ontology consists of a set of classes organized in a subsumption hierarchy to represent a domain's salient concepts, a set of slots associated to classes to describe their properties and relationships, and a set of instances of those classes - individual exemplars of the concepts that hold specific values for their properties. Between the features of Protégé we mentioned: a wide set of user interface elements that can be customized to enable users to model knowledge and enter data in domain-friendly forms; a „plug-in architecture“ that can be extended with custom-designed elements, such as graphical components, media, various storage formats (RDF XML HTML and database back-ends), and additional support tools (e.g., for ontology management, ontology visualization, inference and reasoning, etc.); a Java-based Application Programming Interface (API) that makes it possible for plug-ins and other applications to access, use, and display ontologies created with Protégé-Frames.

- **JENA** - developed by HP Labs Semantic Web programme. It is an Open Source Java framework for building *Semantic Web* applications.

Jena provides a programmatic environment for RDF, RDFS and OWL, SPARQL and includes a rule-based inference engine.

RDFS stands for RDF Schema and it is a standard which describes how to use RDF to describe RDF vocabularies on the Web.

The **SPARQL** query language consists of the syntax and semantics for asking and answering queries against RDF graphs. SPARQL contains capabilities for querying by triple patterns, conjunctions, disjunctions, and optional patterns.

A few IT applications of Jena are: enterprise-scale data integration, knowledge discovery, knowledge management and service-oriented architectures.

The features of Jena Framework are:

##### a) An RDF API

- statement centric methods for manipulating an RDF model as a set of RDF triples
- resource centric methods for manipulating an RDF model as a set of resources with properties
- cascading method calls for more convenient programming
- built in support for RDF containers - bag, alt and seq
- enhanced resources - the application can extend the behavior of resources
- integrated parsers and writers for RDF/XML (ARP), N3 and N-TRIPLES
- support for typed literals

##### b) ARP - Jena's RDF/XML Parser

ARP aims to be fully compliant with the latest decisions of the RDF Core WG. The Jena2 version is compliant with the RDF Core recommendations. ARP is typically invoked using Jena's read operations, but can also be used standalone.

##### c) Persistence

The Jena2 persistence subsystem implements an extension to the Jena Model class that provides persistence for models through use of a back-end database engine. Jena2 also supports a Fastpath capability for SPARQL and RDQL queries that dynamically generates SQL queries to perform as much of the SPARQL or RDQL query as possible within an SQL database engine.

*d) Reasoning Subsystem*

The Jena2 reasoner subsystem includes a generic rule based inference engine together with configured rule sets for RDFS and for the OWL/Lite subset of OWL Full. These reasoners can be used to construct *inference models* which show the RDF statements entailed by the data being reasoned over.

*e) Ontology Subsystem*

The Jena2 ontology API is intended to support programmers working with ontology data based on RDF. Specifically, this means support for OWL, DAML+OIL and RDFS. A set of Java abstractions extend the generic RDF Resource and Property classes to model more directly the class and property expressions found in ontologies using these languages, and the relationships between these classes and properties, and the individuals created from them. The ontology API works closely with the reasoning subsystem to derive additional information that can be inferred from a particular ontology source. Given that ontologists typically modularise ontologies into individual, re-usable components, and publish these on the web, the Jena2 ontology subsystem also includes a document manager that assists with process of managing imported ontology documents.

*f) SPARQL query language*

Jena provides the ARQ query engine which implements both the SPARQL query language and RDQL. The implementation in Jena is coupled to relational database storage so that optimized query is performed over data held in a Jena relational persistence store.

**4.2. Some other general development environments,** editors and content management systems that support Semantic Web Development are:

- Adobe's XMP
- Altova's SemanticWorks
- GrOWL
- IBM's Web Ontology Manager
- OWL verbalizer
- SWOOP
- VisualKii
- Corese
- JRDF
- RDFSuite
- SemWeb
- Jibbering
- ARC
- RAP

Some on-line Validators are:

- BBN OWL Validator
- OWL Consistency checker
- WonderWeb OWL-DL Validator
- W3C's RDF Validator
- RDF/XML and N3 Validator
- VISTology's ConsVISor OWL Consistency checker

## 5. Conclusions

- Unification of the learning resources through a homogeneous structure, allowing the unified management of the users at a superior level (near user) and the resource interfacing in a uniform and manageable way at an inferior level (near resources) can be realized by the system proposed.

- The advantages of the new system, the features, architecture and technologies are presented..
- An analysis of portals, portlet technology and corresponding Java Specification Request is was made up.
- The Course Management System is contextualized using the Moodle solution and metadata concept.
- a semantic web solution is proposed for the same of common formats for integration and combination of data drawn from diverse sources, and the language for recording how the data relates to real world objects is proposed.

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## Authors:

Moraru, Sorin-Aurel, Assoc.Prof.Dr.eng.  
*Transilvania* University of Brasov, Department of Automatica  
 Str. Mihai Viteazu 5, et. 3, Brasov, Romania  
 smoraru@marconi.unitbv.ro

Borza, Paul Nicolae, Prof.Dr.eng.  
*Transilvania* University of Brasov, Department of Electronics and Computers  
 Str. Politehnicii nr. 1, et. 2, Brasov, Romania  
 paul.borza@siemens.com

Mustica, Massimo, MSc.Eng.  
 Laboratorio delle Idee srl  
 Via G. B. Miliani, 36 – Fabriano – AN – 60044, ITALY  
 mustica-massimo@labidee.com

Diaconu, Ionut Ilarie, MSc.Eng.  
 Vision Systems srl  
 B-dul M. Kogalniceanu 21, Brasov, Romania  
 idiaconu@vision-systems.ro

# Real and Emulated Experiments for e-Learning and m-Learning Implemented by Virtual Instrumentation

Florin SANDU, Paul Nicolae BORZA

"Transilvania" University of Brasov – Romania

**Key words:** *remote laboratories, virtual instrumentation, emulation, m-Learning*

## Abstract:

*For the remote (and mobile) access to laboratory work-benches (WB) for e-Learning in engineering they were implemented session-based step-by-step- / automated- (synchronous / asynchronous) test & measurement (T&M) sequences with remote access -fixed (to rich content) / -mobile (with content-to-terminal adaptation), oriented -on equipment/ -on application (the case-studies are in electronics) with wyswyg visualization (from web-cam monitoring to "hyper-schematics"). The hardware (HW), network (NW) and software (SW) developed in "co-design" is ranging from proprietary solutions to standard interfacing (mainly GPIB), control (Standard Commands for Programmable Instruments) and dedicated drivers or Interchangeable Virtual Instruments (VI) in "Measurement Studios" SW – mainly National Instruments (NI) LabView (LV).*

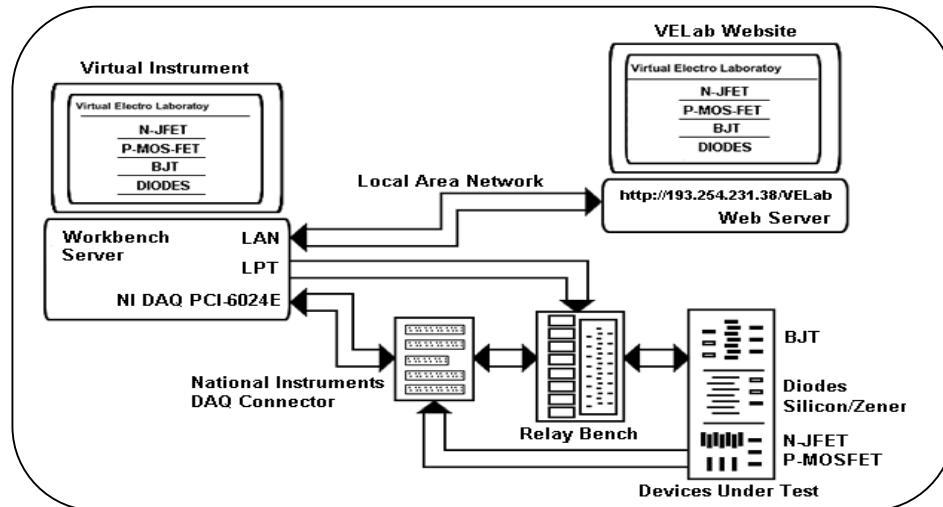
## 1 Introduction

Modern education is more and more distributed and less dependent on time and spatial (even on mobility) restrictions. Because of the large number of hours that have to be spent in the lab, studies in engineering are not so easy to be integrated in the on-line and distance learning. To address this challenge, our Virtual Laboratory ("VL") should be able to "publish" its experimental resources (capabilities), offering services over an access NW (Intranet and/or Internet). Access to the modern lab-equipment can be offered to industrial partners (e.g. small or medium enterprises) or colleges, using a pre-defined schedule or based on a waiting queue. The VL can be integrated to future distributed T&M systems (instrumentation "colonies") with very few „ubiquitous” restrictions: drives / sensors (up to intelligent transducers that can build "the smart dust") have to be almost all the time near the units under test („UUT”).

## 2 The multi-tier VL architecture

1) Each of the WB-s for automated T&M equipment consists of a Hameg HM8142 Power Supply, a HM8131 Function Generator, a HM8133 RF Synthesized Generator, a HM1007 Digital (and Analog) Oscilloscope, a HP Digital Multi-Meter ("DMM"), a Relay Bench (RB) implementing the IviSwch function (for automated signal routing and sub-systems reconfiguration, test point multiplexing and load adjustment) and UUT-s (see fig.1 for a detailed layout for experiments on electronic devices and circuits).

2) The WB Servers (WBS) are controlling WB operation and interleaved multi-user access (based on self-contained "telegrams"). WBS host Data Acquisition & Distribution (DAQ&D) cards (NI PCI 6024E or AT-MIO16E10) and are connected to their WB-s (via local IEEE488.2 NW, by NI PCI-GPIB+ cards) to the automated T&M instrumentation and, to RB, via parallel (Centronics – "LPT" port) interfacing (with the advantage to be "non-invasive" and latched).



**Fig.1** – The WS/WBS/WB layout for real and emulated remote experiments in electronics

The WBS PC SW is, besides the OS (MS Windows XP) and Visual Studio (it was used mainly Visual Basic, VB) – *special instrumentation-dedicated*, NI LV and Component Works (CW) elements that control the WB-s. These "experiments servers" are, this way, much more than simple "information servers" that correspond with the majority of internet nodes. The WB can be *multidisciplinary* extended/adapted by appropriate sensors and transducers at one edge and by drive elements that interface with external equipment, at the other edge.

3) The Web-Server (WS) is connected to WBS-s in the Intranet LAN. The WS includes an Application Server SW, such as the MS Internet Information Server (IIS) or Apache.

4) The Client Level (CL) groups the remote users of the VL and provides friendly and GUI (graphical user interfaces) that enable them to work with the remote WB-s in an almost realistic manner ("telepresence" with visual contact and local-like manipulations). The user's computer at CL, employed for remote access to the VL system is a PC or a Smartphone running a Web browser with specific plugin-s if needed (e.g. NI Run-Time Engine, Adobe-Macromedia Flash Player etc.). The connection between the CL and the WBS is protected with SSL (Secure Socket Layer protocol), enabling encrypted and secured communication.

### 3 POP3 / SMTP access to automated WBS

The most economic solution (with user's *shortest access to Internet*) is based on *e-mail services*, with the advantage to be simple and robust (no problems due to concurrent access):

1) The user completes and *sends an e-mail message* at [vlab@vega.unitbv.ro](mailto:vlab@vega.unitbv.ro) with a preamble containing his/her e-mail address and a password (given by the department where he/she was registered) including the programmed *stimuli* – "headers of the tables" to be filled.

2) The WBS is processing this message (by LV that splits the e-mail text in preamble and numeric fields based on special separation characters – e.g. ^, see details in fig.2 – extracts stimuli and programs accordingly the GPIB instruments), synchronous (in "real-time") or asynchronous (when requests pile over a "worthiness" threshold), controlling WB (for automated T&M) and sending an e-mail reply with the experimental data ("tables' content").

3) The user gets the information, *de-structures* it (according to the "subjective" structure of the primary e-mail he/she sent) and performs local computer-aided post-processing (sort, plot, interpolate, statistic etc.), using his/her own SW for mathematics, data bases, signal & image processing etc. or can further-on invoke expert systems that are distributed in the servers of the university, for diagnosis, shape- & pattern-recognition or automated classification.

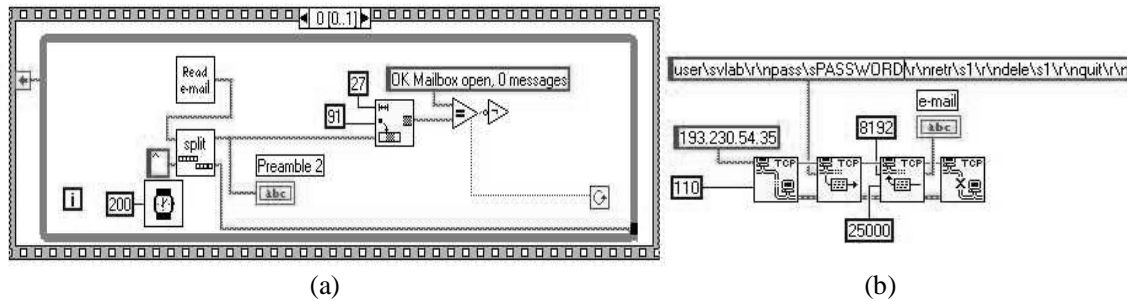


Fig. 2. LV diagram: (a) subsequence of the e-mail check procedure ; (b) Read e-mail sub-diagram

## 4 Mixed web-browser / SMTP implementation

A mixed solution, developed from the e-mail based one, implements real-time monitoring and control (this time in a step-by-step mode, essential for "*observation*" in learning or in R&D) via a dedicated web-page (see fig.3.a) built including MS-FrontPage (FP) WebBot components - "Save Results Form" Handlers (by SMTP) - to send GPIB commands and RB configurations to the remote WB controlled via WBS. The LV "Web Document Tools" generate HTML documents containing text and embedded pictures of the VI panel put together with the time-stamped image of the real WB (and UUT) taken by a "Web-Cam" (and published by its own SW over the Internet).

## 5 VB / CW / DSTP implementation of a "hyper-schematic"

NI CW is grouping 32 bit controls that can be "plugged into" any ActiveX compatible SW development packages. Active (eXchange) of SW components and of data between applications is possible by unified format and dynamic communication via OLE (Object Linking Embedding). These CW specific controls that complete the VB panels are dedicated to DAQ, processing and display, GPIB, VISA series (and USB) controls (for the data flow between the controller PC and automated T&M equipment connected to GPIB) and NI "data-socket transfer protocol" (dstp) controls, to exchanged and distribute data between different "targets" as there are unified by dstp (files, applications or web-servers of different kinds). By *dstp*, experimental data can be streamed efficiently, non-inter-locked, through Internet between T&M applications and distributed automation, towards multiple users, without the need of difficult low-level TCP programming (that slows down the specific SW development). A *specific problem of dstp* is the need of opening the dedicated *port 3015* by the user's web administrator. As the step-by-step measurement in this particular case of our experiments in electronics didn't take real advantage from the productivity of *dstp*, we also tested the alternative of *WinSock* transfer: in the VB SW (that must be deployed at CL) commands like *CWDataSocket1.Data.Value = CVar(byt)* were replaced by *tcpClient.SendData byt* and so on).

Judging productivity versus ease of use, the authors preferred a "wyswyg" simpler approach, very "visual": complete, real time duplex control / monitoring of instruments (by CW) was implemented in VB emulated panels (Fig. 3.b - left), yet able to be completed with video-conferencing support ; a "hyper-schematic" of the UUT with simple remote switching by mouse-clicks implemented an intuitive reconfiguration mode that makes RB control (that was done with an 8 bit code in the mixed implementation) "transparent" to the user (the "click event" changes also the color and respectively the position of the switches' representation) .



(a)

(b)

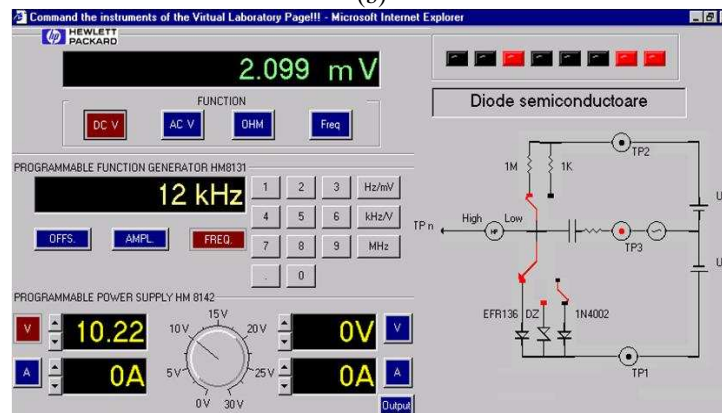


Fig.3 – (a) Mixed web-browser/SMTP solution ; (b) VB/CW solution with UUT "hyper-schematic"

## 6 Publishing the full-capability remote control of GPIB WB

The high-tech automated T&M "tower" of instruments can be (almost) fully controlled remotely by using the complete GPIB drivers offered by equipment instruments' manufacturers themselves. The integrative LV VI (fig.4) groups the front panels of 4 instruments (3 with full controllability and one – the HM1007 oscilloscope – limited to waveform visualization but offering remote access to the *high-speed* acquired samples). The VI-s offered by NI, HP (for HP34401A) and Hameg – for HM8142 and for HM8131 were integrated with authentication blocks, instruments' reset, stimuli annulation and outputs' disable. The LV diagram is structured on sequences, on loops and on user-triggered events (detected by comparators linked to shift registers). For remote control (via Internet, at CL, by a web-browser) of a VI panel, the built-in LV web-server must be activated and configured on WBS by the administrator. Users should address *http://<WBS name>:<port>/<application name>.htm* (e.g. *http://vlab.unitbv.ro:8080/stand.htm*). If WS cannot invoke a DNS, the WBS IP address should be used. Out of security reasons (one of the main justifications for the multi-tier architecture), only the WS is directly visible in Internet, but not the WBS (it is connected – together with the other WBS of the electronics lab and the WBS in other networked lab-s – in the *Intranet* of the WS, through a switch connected to its second NW card). For this reason *port forwarding* (fig. 5) was used to route the remote users' requests (send from CL and targeted to the 8080 port of the WS) directly to the WBS (addressed with its Intranet address, 192.168.200.x).

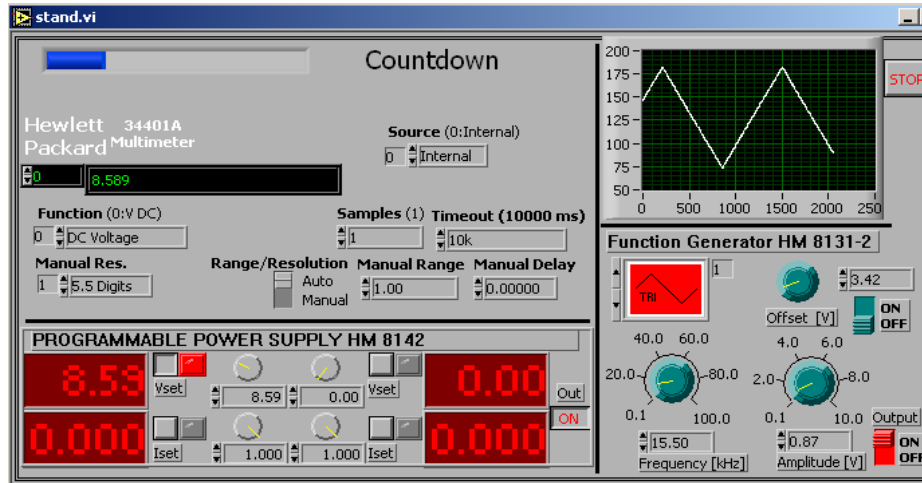


Fig.4: Web-page for Internet remote control of the WB

The SW chosen was "AnalogX Port Mapper" (that can also monitor active connections through this port and filter IP (classes of) addresses).

The remote user has to download and plug-in into his/her browser a *Real-Time Engine* from NI. By mouse right-click at CL on the published front panel and selecting the option *Request Control*, access permission is granted upon authentication (pre-configured by the administrator in *.htaccess* and *.pwd* files that contain encrypted user names and passwords). The administrator can also configure an access-time limit with all outputs brought afterwards to zero (else, they are forgotten, usually to... end-of-table most stressing values). In order to avoid denial of service (DoS) vulnerabilities of LV built-in web-server, its *logging* was disabled.

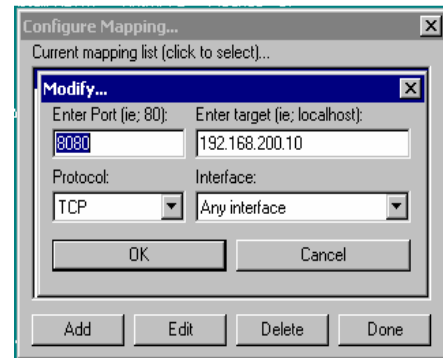


Fig.5 – Configuring port forwarding on the WS

## 7 WBS based on NI LV / DAQ & Distribution (DAQ&D) cards

The solutions presented in this paragraph (being among the most complete ones) are implemented with NI AT MIO 16E10 multifunctional DAQ&D cards (for the AT-ISA connectors on PC motherboards, with Multiple I/O, on 16 analog input channels – unipolar or, grouping the terminals two-by-two, with 8 bipolar "differential" inputs – and 2 analog unipolar outputs, Extended with 10 special digital I/O terminals that can be configured also for control – clocks, triggering etc.). These DAQ&D cards have an excellent resolution of 12 bits/sample and peak outputs of  $\pm 10V$  (then, the LSB corresponds with  $10\text{ V} / (2^{12}) = 0.00244140625\text{ V}$  which is appropriate also for small-signal studies). For most of UUT with voltage amplifiers (Voltage-Controlled-Voltage-Sources, "VCVS"), the remote tester can check that with an input amplitude  $V_{in} = 0.002441V$  only noise is visible at the output (around the average 0V) and that, for  $V_{in} = 0.002442V$ , positive and negative peak values become visible at  $T/4$  and  $3T/4$  - for our choice of 32 samples per period  $T$ , these peaks are singular as  $0.002442V \cdot \sin(90^\circ \cdot 7/8) < (\text{LSB})$ . In other case-studies we used also low-cost DAQ&D NI PCI-6024.

At CL, stimuli are posted with a mouse click on the „Submit” button in experiment's control page (see fig. 6), arriving at WS into a .TXT file associated to the web form (e.g. bjt.stimuli.txt for the particular case of Bipolar Junction Transistor, BJT, presented in fig.6). The VI runs, in „Continuous” mode, a wait-loop (based on the measurement of input.txt file's length – equal with 0 if no new forms were posted from remote; the file input.txt is purged after reading). If stimuli were posted, the step-out from the loop continues with a frame where they are extracted out from the labels, (e.g. U1\_start: , U1\_stop: etc. – based on the same procedure described above –see fig.2.a) and directed to the two analog outputs (AO) of DAQ&D card (in this case, for U1 and U2 that supply the base and collector's circuit respectively) in steps that are internally computed (e.g.  $(U1\_stop - U1\_start) / U1\_steps\#$ ) for *multi-point, automated, measurement*). "Soft-protections" are programmed (they can be also programmed "compatibility formulas" – e.g. stimuli products or ratios that have to be within certain limits – or "exclusion lists" – e.g. to avoid remote-configuring that can damage UUT by unwanted short-circuits etc.) to limit the AO (e.g. preventing dangerous FET grid potentials). The web-pages were developed to provide also remote user's *assistance* by AO *recommended values*, by devices' *data sheets* and *SPICE* models, by *sample test-reports*, Adobe-Macromedia "Flash" animated "*Visual-Help*", and authors' *published references*.

As soon as acquisitions from the (AI) analog inputs (for base and collector potentials, in the case of BJT) are accomplished, they are either directly incorporated in output files which are assembled progressively with the measurement (by writing in APPEND mode): the .HTML file (for intuitive publication of stimuli and results that are graphically published just on the schematic), and also the .TXT file (including both experimental results and SPICE-emulated results – see the following dedicated paragraph for details) and the .XLS file (useful for different post-calculations and plots) that can be, both, downloaded by the user. At the end (as already justified), the AO of the card are automatically reset to zero.

**Fig. 6** Web-site synopsis (<http://vlab.unitbv.ro/velab/index.php>) of the WB dedicated to electron devices, with remote access and PSpice simulation – including details of the page specific to BJT

The way these files are assembled is the "Columbus egg" for most of these solutions: instead of using expensive "Internet Toolkit" add-on-s for NI LV, direct and "intimate" (non-protocolled) publication is done by WBS, directly on WS (see an example, for FET T&M, in fig.7), as simple string that concatenates any pre formatted (e.g. by FP) "results" page (that can encapsulate WB & UUT images – e.g. .GIF in the example of fig.7 – with input and consistent output data - to avoid confusing it with the results requested by other user) with stimuli (inputs sent explicitly or computed by the WBS) and measured values ; the assembled string becomes a file (e.g. results.htm) that is saved directly in the inetpub/wwwroot directory of the WS.

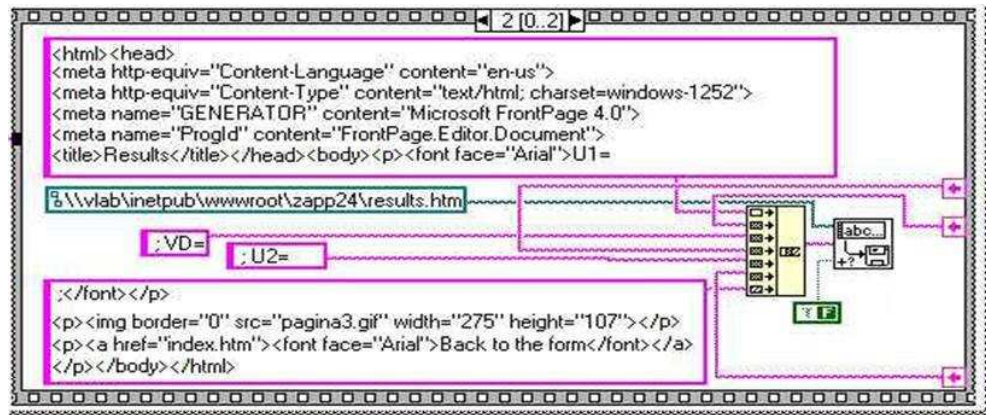


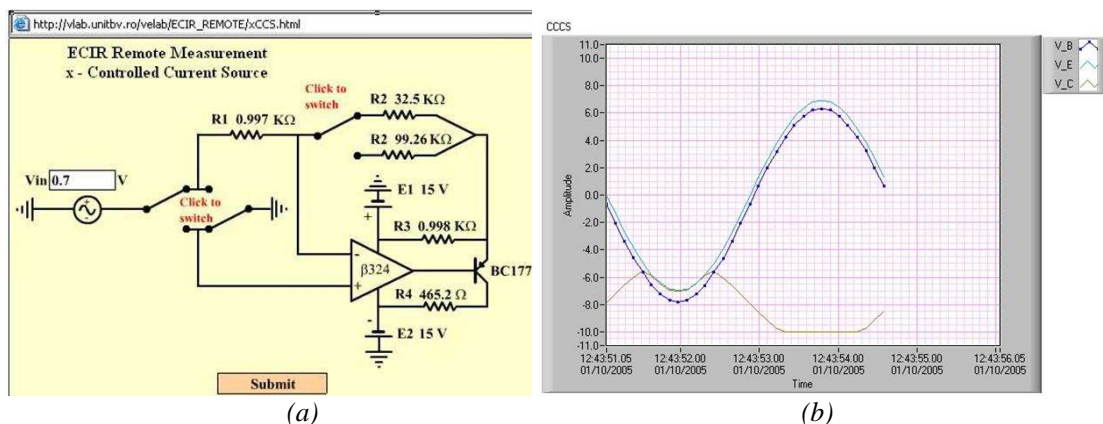
Fig.7 – VI diagram frame that assembles the results.html file by simple string concatenation

## 8 Enhanced hyper-schematics by Adobe-Macromedia "Flash"

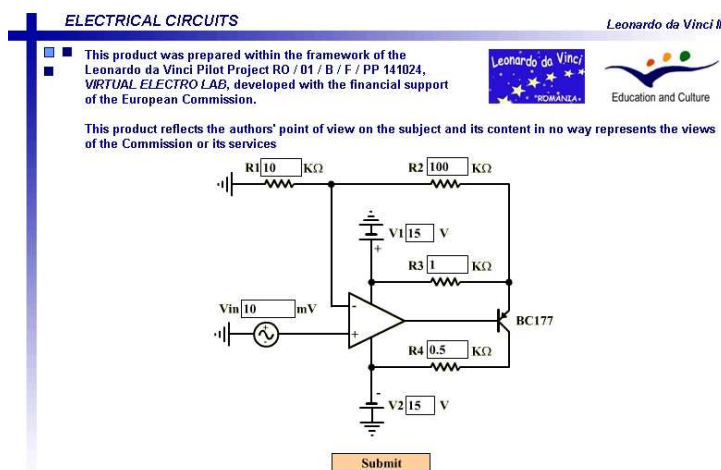
Another challenge addressed was the incorporation of hyper-schematics in courseware book-pages (it was used Click-to-Learn "Tool-Book Editor"): the reader can modify parameters of these "living figures", *working directly on the e-Book pages* and the real and remote system shown changes behavior and displays updated input-state-output values, modified connections, bias-points etc (see an example in fig.8). This easy-to-use interface and spectacular retrieval of results was implemented with Adobe-Macromedia "Flash", having the multiple advantages of *vector graphics* (and zoom without losing quality), easy editing (in a graphical environment), scripting language ("Action Script") choice and communication capabilities with other files (the own variables can be transmitted in both ways to/from a file).

## 9 Emulation in conjunction with real remote experiments

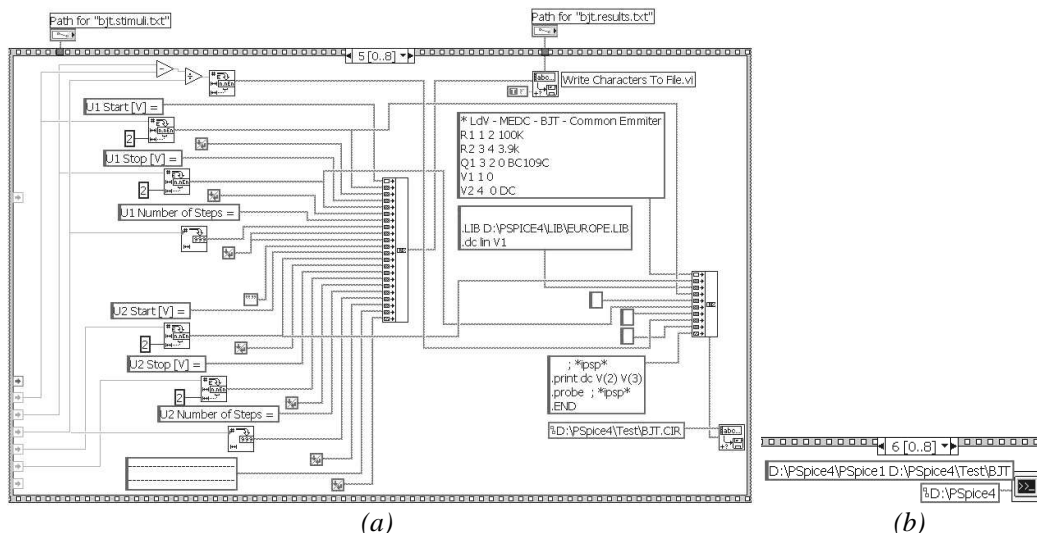
It was implemented the *backup and validation* of real remote measurement with emulation / simulation of systems behavior, based on advanced mathematical models (e.g. PSpice computer-aided solving of electron-devices equations with complex stimuli vectors). The user can access on the experiments' server the hyper-schematic of the UUT system under test where he can post data (stimuli and different parameters) for preliminary or post-measurement computation, in order to compare the measured results with the theoretical ones (see fig.9). An important step forward is *parsing* into simulation data (stimuli and/or configuration) of *the same* values / parameters that were sent to the real experiment (see fig.10 for NI LV implementation in the particular case of BJT)! A great educational impact was foreseen (besides the above-mentioned validation, virtual reality completes the preception and trustful computation and comprehension of theoretical models is encouraged).



**Fig.8** – (a) Hyper-schematic for remote measurement in the pages of "Electrical Circuits" e-Book (<http://vlab.unitbv.ro/velab>). (b) Waveforms [ + interpretation: one can notice the  $v_{\text{collector}}$  lower waveform: to the right, the flat area of BJT blocking and, to the left, the BJT saturation area where  $v_{\text{collector}}$  is almost coincident with  $v_{\text{emitter}}$  (and the distance between the upper sine  $v_{\text{emitter}}$  waveform and the dotted sine  $v_{\text{base}}$  dotted waveform, representing  $u_{\text{EB}}$ , is obviously greater!)]



**Fig.9** – A hyper-schematic embedded in a page the "Electrical Circuits" e-Book (accomplished with Click-to-Learn "Tool-Book Editor" courseware) for virtual (PSpice emulated) remote experiments on Voltage-Controlled A.C. Sources



**Fig.10** (a) NI LV frame for the assembly of topological, structural and dc sweep (stimuli parsing) information in the PSpice .CIR file. (b) detail on "System-Exec" LV sub-VI



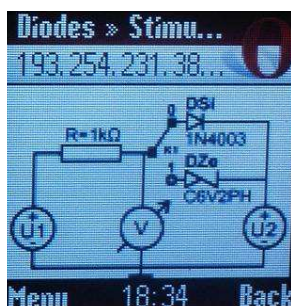
The source code of the first (index.wml) page includes also a *post method*, implemented this time by a *handlingwml.php* file (writing the values received from the operator in a *wmlvalues.txt "socket"* file into the wap-site main directory on WS). It is also included a redirection towards a *monitor.wml* page, that will ask confirmation to get the WB status (providing also a delay long enough for the completion of the automated T&M).

### 10.3 Mobile Access to Remote Experiments by Mini-browsers Based on Content-to-Terminal Adaptation

The principle of this implementation is the optimization of the processing load-share: central - on the server - and local - on (mobile) terminals - featuring embedded intelligence. Adaptation of normal web content for ME, shouldn't need anymore the re-writing (of initial Web-) pages into WAP-pages (like our implementation described in paragraph 10.2). It should then be based on the *innovative principle* of (pseudo-) minibrowsers (actually simple J2ME applications, very compact) that co-operate with *middleware* (intermediate servers that perform "*small-screen rendering*" (SSR) to prepare the content exactly for the terminal that requested it – taking over, this way, an important processing load from the terminal). Cheap terminals, provided they are Java-enabled, can receive customized pages as soon as, based on their ID that accompanies any query, the pixels' layout of the screen and its' color depth is known, to be used in the preparation of interpolated images and optimized fonts with sharp letters (see fig.12) – the pages fit exactly to the screen, without the need for horizontal scrolling. The most popular mobile browsers are actually: Pocket Internet Explorer (the default browser on Windows CE used on the Pocket PC or Windows Mobile edition on modern Smartphones), NetFront, Nokia Series 90 Browser, Konqueror Embedded, Minimo ("Mini Mozilla" - using the same engine as Mozilla and Firefox), Safari and Opera Mobile, with the freeware version Opera Mini (that it can run on devices with extremely low resources). Mainly this last one, provided by Norway's Opera Team, illustrates in a very spectacular way, the principle of SSR implemented by AJAX ("Asynchronous JavaScript and XML") for the Opera Platform and enabling the integration of the phone's local applications with online content. Out of the three approaches to create Web sites accessible for handheld devices (creating "cascading style sheets" / creating a mobile portal (web-pages dedicated to mobile terminals) / improving the HTML site) we choose the last one, which is the most practical: we rearranged the content in a single column; we limited the graphical content (to improve page loading time and reduce the scrolling necessary to view the entire content) – on the other side, there's no more needed the effort to prepare all figures in WBMP (bit-maps for WAP) format – that would create restrictions to "backward" access via normal browsers (only few of them, like Opera, have intrinsic capabilities to convert WML pages to HTML); we used hyperlinks instead of great images or icons; we limited text and icons' size (to be consistent with terminals' standard font sizes) etc. It was accomplished the "mini" version of the "Virtual Electro-Lab" web-site (<http://vlab.unitbv.ro/velab/mini-index.html>) – see fig.12.

Our approach aimed to extension of *e-Learning* towards ("mobile") *m-Learning* in this period of distributed and mobile computing, boosting personal communications on more intelligent and miniaturized mobile terminals (3G & WiFi compliant) – as a matter of fact another victory of modern education, on immobility (after distance and time restrictions were overcame by *e-Learning*):

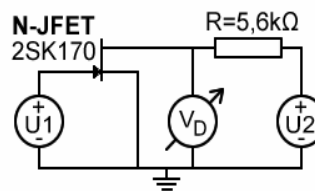
- *enhancing access by another degree of freedom* (mobility) – by specific software development (e.g. J2ME) and adaptation of some applications to virtual and remote experiments previously developed within "Virtual-Electro-Lab"
- *further contributions* could be related to *other degrees of freedom* ("*intermittent connectivity*" and "*pervasive connectivity*" – transparent handover of the mobile sessions between networks – GSM/GPRS/UMTS, WiFi (IEEE 802.11), Zig-Bee (IEEE 802.15) etc.



(a)

## N-JFET « Drain Voltage

The N-JFET is open for:  
 $-0,7 \text{ V} \leq U_1 \leq -0,3 \text{ V}$



The N-JFET DUT accepts voltages inside this limits:  
 $-10 \text{ V} \leq U_1 \leq 0 \text{ V}$   
 $0 \text{ V} \leq U_2 \leq 10 \text{ V}$

## Results

N-JFET Results File >> Generated by LabView.  
 V1 (Virtual Instrument) running on the Work Bench  
 Computer.

N-JFET Measurement #290

Date: 1/28/06

Local Time (Brasov: GMT+2): 6:11 PM

U1 Start [V] = -4.00E-1  
 U1 Stop [V] = -4.00E-1  
 U1 Number of Steps = 1

U2 Start [V] = 9.00E+0  
 U2 Stop [V] = 9.00E+0  
 U2 Number of Steps = 1

IP: 81.12.219.217

Total Steps (U1\_steps x U2\_steps) = 1

U1 (DATA IN) || VD (DATA OUT) || U2 (DATA IN)

-4.00000000E-1 || 6.5673828125E+0 ||  
 9.00000000E+0

End of measurement.

(b)

**Fig.12** (a) Web-pages of the "Virtual Electro-Lab" site mini-version with spectacular SSR on Siemens C65 ; (b) results of a complete N-JFET measurement: To check saturation, one could easily increment U2 (e.g. a step of 1V, from 9 to 10V) and notice, in the new results' screen that drain potential,  $V_D$ , increased by the same step (up to approx. 7,6V). This confirms that voltage on the serial resistor  $R=5,6k\Omega$  remained unchanged then the transistor is *saturated*.

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## Authors:

Florin, SANDU, Prof. Dr. Eng.

Paul Nicolae BORZA, Prof. Dr. Eng.

Electronics & Computers Department

Electrical Engineering & Computer Science Faculty

"Transilvania" University

Bd Eroilor nr. 29A

Brasov – 500036

Romania

[sandu@unitbv.ro](mailto:sandu@unitbv.ro)

[borzapn@unitbv.ro](mailto:borzapn@unitbv.ro)

# GETsoft/LabWeb - a virtual electrical engineering laboratory for first-year students

Volker Neundorff, Vera Yakimchuk, Heinz-Uhlrich Seidel

Technische Universität Ilmenau

**Key words:** *virtual instruments, eLearning, WBT, Electrical Engineering*

## Abstract:

*The paper describes our concept of the web-based supporting environment LabWeb for the electrical engineering laboratory course for first-year students. To make the learning of instrument manipulating easier for our target group, all instruments available in the LabWeb have to look like real instruments. Results of a variety of tests together with protocol of ideal virtual experiment form the accreditation for real labor experiment. We expect this will in part disburden our teacher.*

## 1 GETsoft as a Virtual Learning Environment

GETsoft<sup>5</sup> is an open web-based interactive learning environment for electrical engineering undergraduate education. Its first components have been online since 2000 and further components are being developed. Our students and teachers use the environment for private study or during the lessons [23], [24].

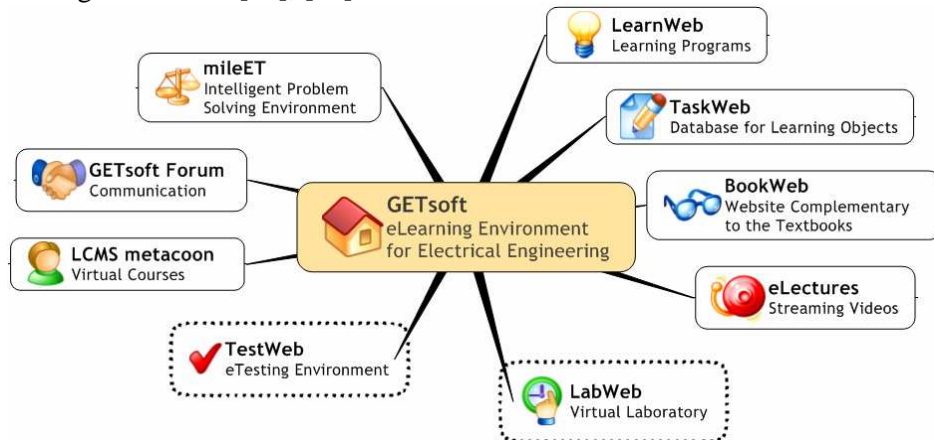


Fig. 1 Main components of GETsoft learning environment

One of the important roles of electrical engineering education is to teach a connection between physical phenomena and their technical uses with appropriate mathematical basis. To support different educational aspects, several components of the learning environment have been developed (Fig. 1).

LearnWeb contains a set of learning modules covering the electrical engineering topics learned in the first three terms. The modules including many tasks, animations, and simulations offer a good opportunity for home learning. TaskWeb is a web interface to our database for learning objects. Primarily intended to be a web interface to our task collection, it

<sup>5</sup> <http://getsoft.net>, GET - Electrical Engineering Department (In German: GET - Grundlagen der Elektrotechnik)

become a web access to all interactive learning materials from our learning environment. BookWeb represents a web-based extension to our curriculum textbooks. In case, an interactive module supposed to explain some textbook topic, an access code to a relevant online module is printed on the page edge in the textbook. One can type this code in the BookWeb interface or can scan it into it with the pen scan [16]. The appropriate learning object will be displayed in the web browser. As a result of some student projects, the video recordings of the lectures (eLectures) on the principals of electrical engineering are available online via TaskWeb interface. The recordings are structured and indexed; therefore one can search, choose, and play not only the whole lecture but also any wanted scene of it. One particular component of GETsoft is the intelligent problem solving environment mileET, a special type of intelligent learning environment<sup>6</sup>. mileET has been implemented during the AIED research project [25] and is planned to be integrated into GETsoft as a part of a new learning program. GETsoft Forum offers a possibility to the online communication between teachers and students and accompanies the classroom learning. There is a set of forums for different target groups. Any comments, additional information or links to the relevant web resources can be published. In some special cases, the learning takes place fully virtual on the learning platform metacoon [22]. However, it is not a very popular form for our student – most of them live on the campus and does not need virtual learning groups. This form of learning would be very useful for our student abroad.

Laboratory courses play a very important role as a link from theory to practice. Sometimes there are no possibility to organize such a courses (e.g. because of high costs or human resource). In such cases, a virtual laboratory as a substitute of real experiments is a possible solution. Our goal, however, is web-based support for the students while preparing for the real experiment. On the other side, this environment has to relieve our teachers by testing the learners and helping them to learn the manipulation of measurement devices.

GETsoft is a convenient framework to test our approach and to establish the virtual laboratory, called LabWeb, at our department.

## **2 Conception and Prototype Implementation**

As mentioned above, the main goal of the LabWeb is to support first-year students while preparing for the labor exercises. According to this goal, LabWeb offers the opportunities to learn the processing of real experiments by playing with virtual models of real measuring instruments and by virtual measurement setups. A variety of knowledge tests helps the students to evaluate their own knowledge state and at the same time the test results serve as accreditation to the real experiment. The LabWeb environment has to become an integrated web-based part of Interdisciplinary Labor Course at our department GET.

### **2.1 Interdisciplinary Labor Course at the department GET**

The students participating electrical engineering course have to attend the labor course at our department. This course includes between four and six real labor experiments depending on study semester (Fig. 2). The basics of measurement techniques and methods as well as experiment result analysis and explanation have to be learned during laboratory course.

Presently, the typical successful performance of any experiment assumes that the students prepare themselves to the labor experiment at home, pass a test at the labor, conduct the experiment, complete a protocol, and discuss their results with experiment supervisor.

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<sup>6</sup> IPSE – intelligent problem solving environment, <http://ils.informatik.uni-oldenburg.de>



Fig. 2 GET Laboratory



Fig. 3 Online materials for GET laboratory course

All learning stuff needed for labor preparation is stored in our web-based data base and available via online GETsoft learning environment (Fig. 3). Unfortunately, the preparation questions and the tasks are all the same for all students. As a consequence, many students just copy the solutions, and present these solutions as their own without expected knowledge about the matter.

With the grown number of course participations<sup>7</sup>, our docents can not spend as much time as in the past testing the every student's knowledge before allow them to process the experiment. To solve this problem, some tests have to be shifted into the virtual labor preparation environment.

Furthermore, many students do not have appropriate knowledge about measurements instruments or have even never seen them. To help the students to be more comfortable in handling the instruments, some virtual experiments have to be implemented. Conducting these experiments, the student should become familiar with instruments and can process the real experiment more effective and get more time for result discussions and error explanations.

## 2.2 Virtual Laboratories - State-of-the-Art

The idea of virtual experiments is not new one and many efforts with a variety of conceptions are being made. From the experiment and experimenter points of view, four types of experiment processing are defined: traditional lab, virtual lab, remote lab, and local simulation [14]. Traditional lab, in its part, can be pc-based or not. Some PC-based (local or remote) labs need some additional hardware components [18]. In some implementation, a computer-algebra-systems like mathematica [15] or matlab [21] or simulations tools like Pspice [17] play a central role, other are local simulations of particular phenomena<sup>8</sup>. The most virtual lab projects suppose the student learn the physical phenomena or analyze electrical engineering circuits by simulation [20]; the measurement is not a subject of matter in such cases. It plays a central role in remote lab [18].

In the first place, we intend to support our students while preparing to the real traditional not pc-based lab. For this purpose, a set of virtual instruments and measurement objects have to be implemented. The future authors of particular experiment will have the possibility to build different experiments from this set of elements. Simulations do not play an important role in our first year laboratory course; therefore they are not a part of LabWeb. Some learning programs in LearnWeb contain their own experimental environment where simulations

<sup>7</sup> The number of students at the university has been grown in last 5 years.

<sup>8</sup> Experimentierumgebung in <http://getsoft.net/wsmb/index2.html>

(Java-Applets) play a central role. In contrast to the most projects, LabWeb have an additional function – accreditation. The virtual experiments contain knowledge tests and only the students with positive results from virtual experiment may take part in real laboratory experiments.

### **2.3 Didactical, Technical and Organizational Conception**

Because of a variety of functions of the experiment environment, the conception of the LabWeb is based on different learning-paradigm principles. Learning the handling of the devices based on some behaviorist ideas with immediate control and instant feedback. The practicing of the construction of measurement setup and the realization of the measurement setup based on constructivist approaches, so that the selection of the tasks to be solved or the measurements to be processed are leaved to the user. Preparation of single test objectives and questions happens according to the principles of the instruction design.

The first-year students build the target group of the environment and the environment serves as preparation help for real experiments. According to this, the aspects of realistic instruments views and of easily instrument handling are more important than the simulation aspects. Therefore, the LabWeb are being implemented with Macromedia Flash. Flash is used, so Macromedia website, at 98 % of all internet users and it is a standard plug-in within all current browsers. Currently, we do not plan to implement the LabView or PSpice coupling; nevertheless such extension can take place in the future.

The LabWeb environment is supposed to be established in a modular way. Information about the program structure and the workflow as well as the user guides to the single measuring instruments have to be available at any time. Different help functions are implemented in LabWeb including links to the important information or helpful sites, to the forum or to the teacher's contact data.

In order to receive a practical training protocol (which serves as accreditation to the real experiment) as a result of the work with LabWeb, the user has to login themselves officially.

Because of the fact the environment is supposed to take over the correction work of the university lecturers, a creation of personalized tasks is necessary. Personalization is reached by means of a pseudo-random value assignment of the parameters used in the experiment. This assignment is based on the login-data.

### **2.4 Prototype <sup>9</sup> Implementation**

All virtual experiments are based on the real practical training instructions. In currently implemented experiment, students can learn to analyze the frequency properties of some circuits. The complete experiment “get8” (real part s. Fig.2) consists of the following four parts (Fig. 4):

1. Measurement setup, measurement processing and calculation – Task 1,
2. Identification of some components of large circuit – Task 2,
3. Graphic-, formula-, and text-based multiple-choice-tasks –Task 3,
4. Reporting.

At first, the user has to login with his/her name and matriculation number. Based on this data, random values for resistor and capacitor values are generated. In the Task 1, students have to build up the virtual measurement setup and to “measure” the frequency characteristic of the circuit to be analyzed (Fig. 5). Some parameters, like cut-off frequency or bandwidth, have to be calculated.

<sup>9</sup> The prototype has been implemented by Ronny Scholz and Daniel Schalewa as a media project in 2005 and is available under <http://getsoft.net/labweb/get8>.

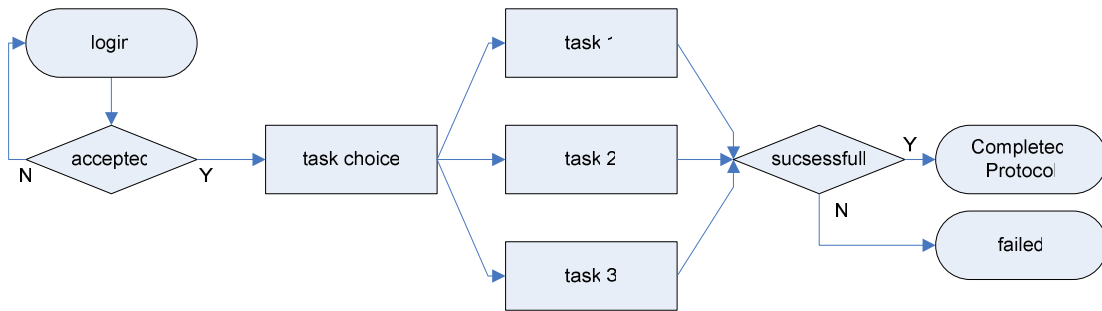


Fig. 4 GET8

In the Task 2, students are asked to identify in one large circuit some elements which build up a particular sub circuit (in our case – low or high pass filter). The Task 3 is a knowledge test in form of calculation tasks and multiple-choice-tasks implemented on the basis of the questions and tasks from real lab exercises. In “get8” this task contains 11 questions each with five possible answers. Graphical problems like diagrams or phase diagrams are elements of the choices (Fig. 6). Figure 7 gives the insight in the organization of Task 3. The orders of questions and of the answer choices are random, thus it is not possible complete the test just knowing the previous right answer order. In case the user made some mistakes, she has a chance to correct the wrong answers. In the second pass, the wrong answers are marked. The part “Reporting” is unlocked after successful finishing of all three tasks. The virtual experiment is completely finished after printing of the protocol.

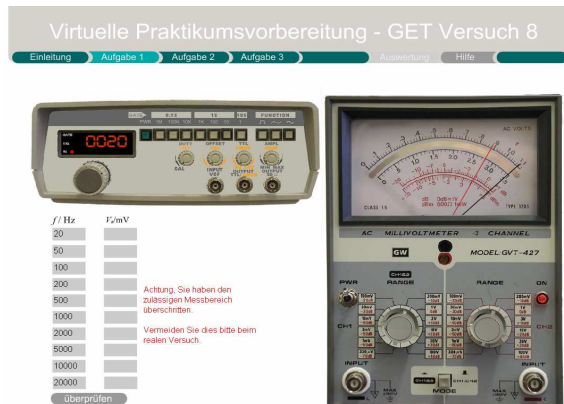


Fig. 5 Task 1/ Part 2: Measurement

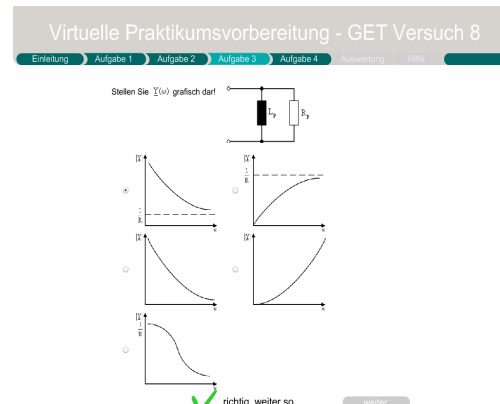


Fig. 6 Graphical multiple-choice

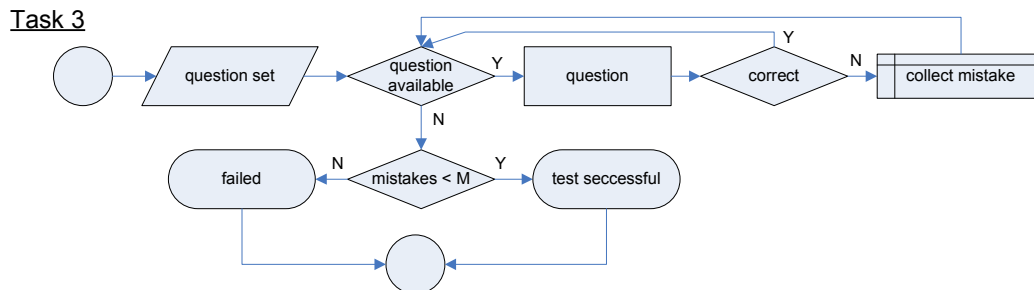


Fig. 7 Task Structure

In the current version, every single task must be completely solved during the experiment performing before another task can be started. Otherwise, the results of this task are lost. The user receives a protocol as a result of a completely passed experiment. This protocol is the admission to the real experiment in the laboratory.

## 2.5 Preparation for use in IDENTITY

Actually all existing components are in German. For use in the IDENTITY project we will translate all reusable components in English too. The modular concept auf LabWeb allows an easy integration in other web based environments. It is possible to use a small part like the multiple choice test components or the complete experiment. For future development is a multilingual support of LabWeb components planned.

## 3 Perspective

After testing by practice and evaluation, further experiment will be implemented under consideration the evaluating results. For reuse in the IDENTITY project the components of LabWeb are developed language independent and in a modular way.

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### Author(s):

Volker Neundorf, Dipl.-Ing.  
 Vera Yakimchuk, Dr.-Ing.  
 Technische Universität Ilmenau  
 Fachgebiet GET  
 Helmholtzplatz 2, Postfach 10 05 65  
 D-98684 Ilmenau, GERMANY  
 volker.neundorf@tu-ilmenau.de  
 vera.yakimchuk@tu-ilmenau.de

## DIBE - Existing e-learning products

*Anna Marina Scapolla, Domenico Ponta, Giancarlo Parodi, Giuliano Donzellini, Andrea Bagnasco*

Biophysical and Electronic Engineering Department - DIBE - University of Genoa

**Key words:** *e-learning tools, analog electronics, digital electronics, virtual laboratory, simulators, remote laboratory*

### Abstract:

*The Department of Biophysical and Electronic Engineering (DIBE) of the University of Genoa (IT) has an extensive experience in developing curricula and learning materials and tools in the field of electronics. This document provides an overview of the tools (simulators and remote lab) and the associated learning material, including details on the design and the maintenance of virtual laboratories. Last, it explores the current experimentation on novel network based cooperative learning methodologies.*

## 1 Introduction

The Department of Biophysical and Electronic Engineering (DIBE) of the University of Genoa is engaged in the development of curricula, e-learning materials and tools for the electronic engineering domain and has participated in several European projects in the field of Open and Distance Learning.

Nowadays, the Socrates IDENTITY project gives the opportunity of sharing this expertise with the project partnership and provides new motivations and stimuli to encourage the production of integrated VR based practical laboratory activities and face-to-face tutorials.

## 2 Learning material and tools

Figure 1 represents the general framework of the learning materials and tools provided by DIBE on electronics for the courses of the Engineering Faculty.

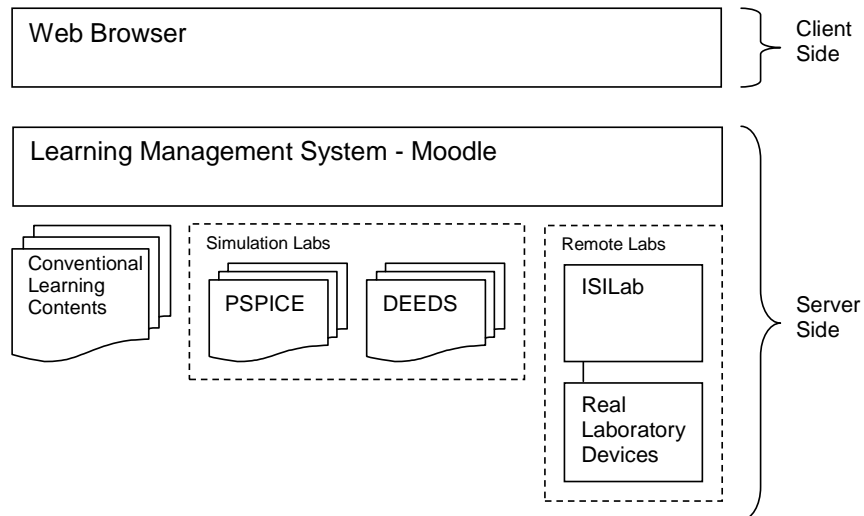


Figura 1: Learning materials and tools provided by DIBE on electronics

On the client side, students access the system using a simple web browser. Courses are managed by the Moodle (<http://moodle.org>) Learning Management System (LMS). It provides users authentication, content delivery, forum, and other services. In addition to the conventional learning contents (textual or multimedia documents), the LMS gives access to the following virtual laboratory experiences:

- Simulated experiments of analog electronics with PSPICE, a well know software environment for circuit simulation;
- Simulated experiments of digital electronics with DEEDS, a digital circuit simulator developed at DIBE;
- Real remote experiments in digital and analog electronics with ISILab, a remote laboratory developed at DIBE. Some experiments of electronics for telecommunications using Windows remote desktop

The simulation tools, in our case the PSPICE and the DEEDS, are just software applications that need to be installed on the client machine. The LMS is in charge of making accessible the simulator input files that can be stored in the LMS repository.

On the contrary the remote laboratory does not require a client application: when receiving a request for the execution of a remote experiment, the LMS links the remote laboratory system, in our case ISILab, which executes the instruments control tasks and the management of the measurement session.

Figure 2 shows a mosaic of Moodle pages of a course where access tests, tutorials on instrumentation and laboratory activities are scheduled.

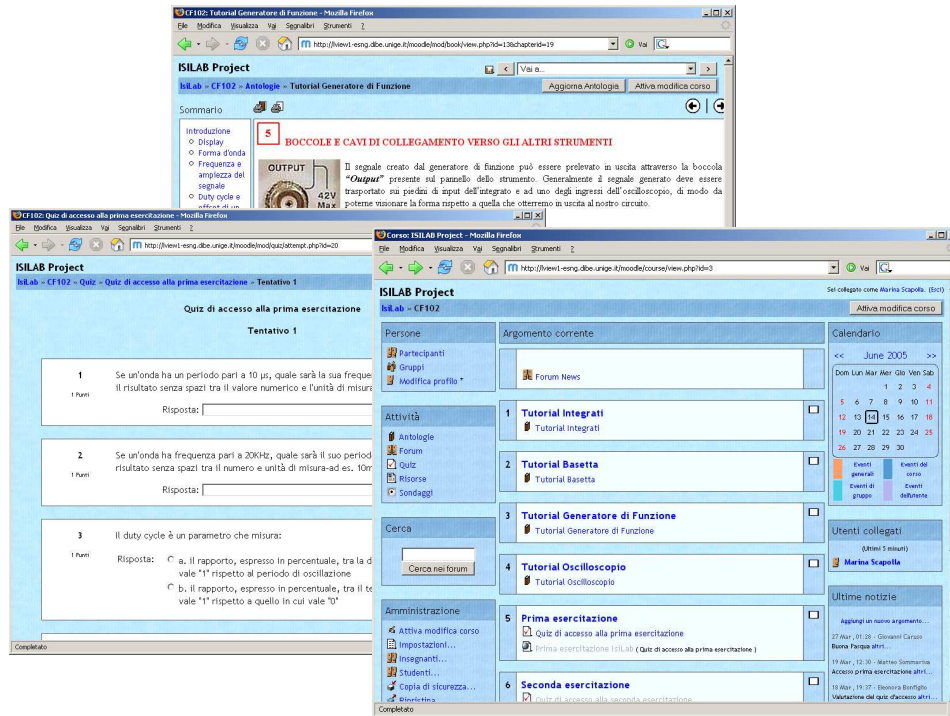


Figure 2: an example of a Moodle course

### 3 Virtual laboratories

Virtual laboratories include two classes of tools: simulators of the behaviour of analog and digital circuits, and the remote laboratory.

This section details the functionalities of Deeds, the simulator for digital electronics, and of the remote laboratory ISILab.

#### 3.1 DEEDS

Deeds is a set of tools and resources, totally developed at the DIBE, to support Problem Project Based Learning (PBL) in the field of digital design [8]. The simulators contained in it cover and integrate together combinational and sequential logic networks, Finite State Machine (FSM) design, microcomputer interfacing and programming at assembly level.

The Deeds package runs under Microsoft Windows. It includes a graphical schematic editor for digital networks, based on a library of basic logic devices. The library includes user-definable components and a simplified microcomputer board.

The user-defined components are designed as FSM and can be built with a dedicated graphical editor/simulator. Once completed, the user-defined FSM can be inserted in the digital schematic and connected to standard logic digital networks.

Also a microcomputer board can be inserted into the digital system under development. The board makes available standard input-output parallel ports, besides other inputs as clock, reset and interrupt request. The board can be programmed at assembly language level. Using standard logic and/or FSM, the schematic editor allows building specialized input/output devices that can be connected to the microcomputer board.

The main difference between Deeds and the professional CAD tools available commercially lays in its strong pedagogical orientation that allows the learner to bypass most of the "technicalities" of simulators designed for professional use, while still providing very realistic features.

The development of a digital design project is the field where Deeds can be fully exploited. Students download the assignments, which consist of functional specifications of the systems that students must design. Project development phases are guided, when necessary, by help and instructions supplied through Deeds's "Assistant browser". The fact that the interactive logic simulator, the finite state machine module and the microcomputer board emulator can work simultaneously allows the simulation of a system where standard digital components can be controlled by state machines and/or a microcomputer board, as it is the case in contemporary digital design. Obviously, the modules can be used independently, to test separately the system parts.

The approach is meant to replicate the features of a professional environment, within the guidelines suggested by the educational purpose of the project.

Deeds has been specifically designed to support PBL not only in a local context but also in a geographically de-localised environment. Therefore it lends itself both for local and distance education and has the capabilities to extend project work within an inter-institutional and international context.

Deeds has been extensively used in our institution by thousands of students of the first and second year of the information engineering curricula and as a support for project-based courses. Students' feedback has been very encouraging. Several colleagues from European universities have adopted Deeds, which is made available to the academic community free of charges.

#### *Deeds exercises*

A Deeds exercise appears as an HTML document with text and figures. Text, figures and visual objects can be active, because they are 'connected' by the browser to the editing and simulation tools of Deeds. For example, let's suppose that the text presents a digital circuit, and displays its schematic. When the user clicks on the schematic, Deeds launches the corresponding simulator, and opens that schematic in it. As necessary, the Deeds open another browser (the Assistant) that can contain step-by-step instructions on how to design, explore or test the circuit itself. The role of Deeds is to allow students to work out a solution, or to check its correctness, when obtained manually, and to provide graphical tools for editing the web page containing their reports. When learners are satisfied with their work they use Deeds to deliver the reports through the Internet.

The development of a digital design project is the field where Deeds can fully be exploited. In fact, the interactive logic simulator, the finite state machine module and the microcomputer board emulator can work simultaneously in the simulation of a system where standard digital components can be controlled by state machines and/or a microcomputer board, as it is the case in contemporary digital design. The approach is meant to replicate the features of a professional environment, within the guidelines suggested by the educational purpose of the project. The assignment consists of a functional description and a set of specification of the system that students must design. Project development phases are guided by help and instructions supplied through the Assistant browser, even if such instructions, in this case, are at higher level and the use of the simulation tools is less guided and left more to the user initiative.

### **3.2 ISILab**

#### *The hardware set up*

ISILab is a remote laboratory for practicing on electronic instruments and measurement methods executing real experiments of scalable complexity on analog and digital circuits [7]. The experiments deal with basic electronic measurements, such as the delays in digital

circuits or the gain and the distortion of amplifiers. There are measurement devices (i.e. waveform generator HP 33120A, oscilloscope Agilent 54621D, power Supply INSTEK GPS-4303, spectra analyzers, and data acquisition boards) connected by IEEE 488, serial lines and PCI bus, and 2 multiplexing boards (ISIBoard) hosting the circuits under test (derivator, integrator, complementary symmetry amplifier, AC amplifier, inverting amplifier, and others). Multiplexing boards (Figure 3) let to share the same instrumentation among different circuits, which are present on the same workbench. The selected circuit is dynamically connected to the instruments when the user demands it, and it stays connected just the time necessary to the measurement. Thus a workbench serves many students at the same time, using a time sharing technique. Students operate as if they had exclusive control of the experimental set-up.

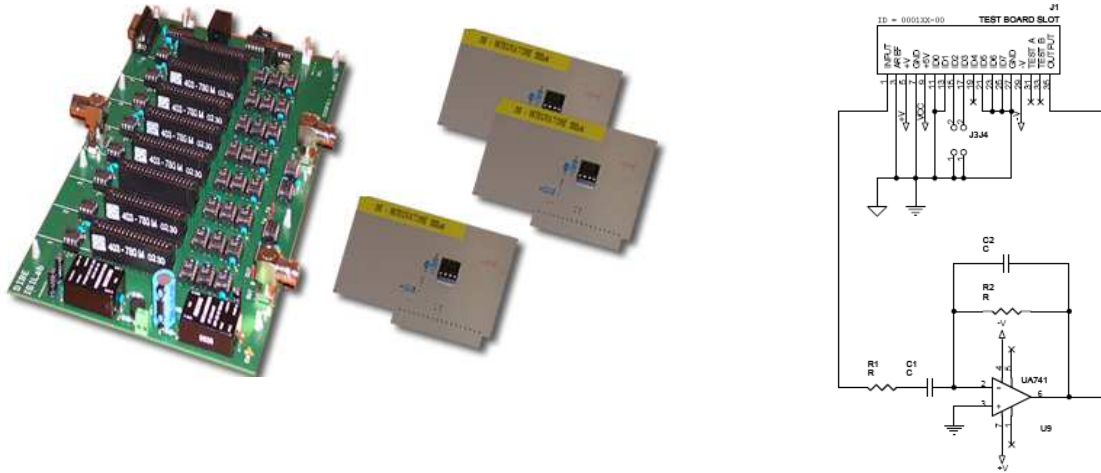


Figure 3: the ISIBoard, the SUT cards and the card schematic diagram

#### *The front-end*

Students execute the experiments interacting with appropriate graphical interfaces, which allow to control the instruments and to move the probes on the circuits. Figure 4 shows the execution of an experiment, as seen from the student's point of view. In this example, the circuit under test is an integrator; it is based on an operational amplifier and the student is required to verify the circuit response when it is stimulated by different signals. The web page on the background shows the electrical diagram of the circuit, and states the steps to follow for the execution of the experiment. On the top, the virtual instrument control panels are visible; clockwise, they are the Waveform Generator, and the Oscilloscope. They are interactive interfaces: acting on the proper panel the user can modify the settings related to the underlying instrument. Also the panel representing the circuit is interactive: the student can move the probes of the oscilloscope among different test points on the real circuit, changing the settings of the multiplexing board.

The instrument panels have been implemented as Java applets, in order to have multiplatform capability. Unfortunately, this approach presents some limitations, i.e. the need of the Java virtual machine and firewalls crossing. In line with the newest changes in web applications, we are moving to adopt the AJAX development technique. In particular, we are now testing the potential of the ZK framework [<http://www.zkoss.org/>].

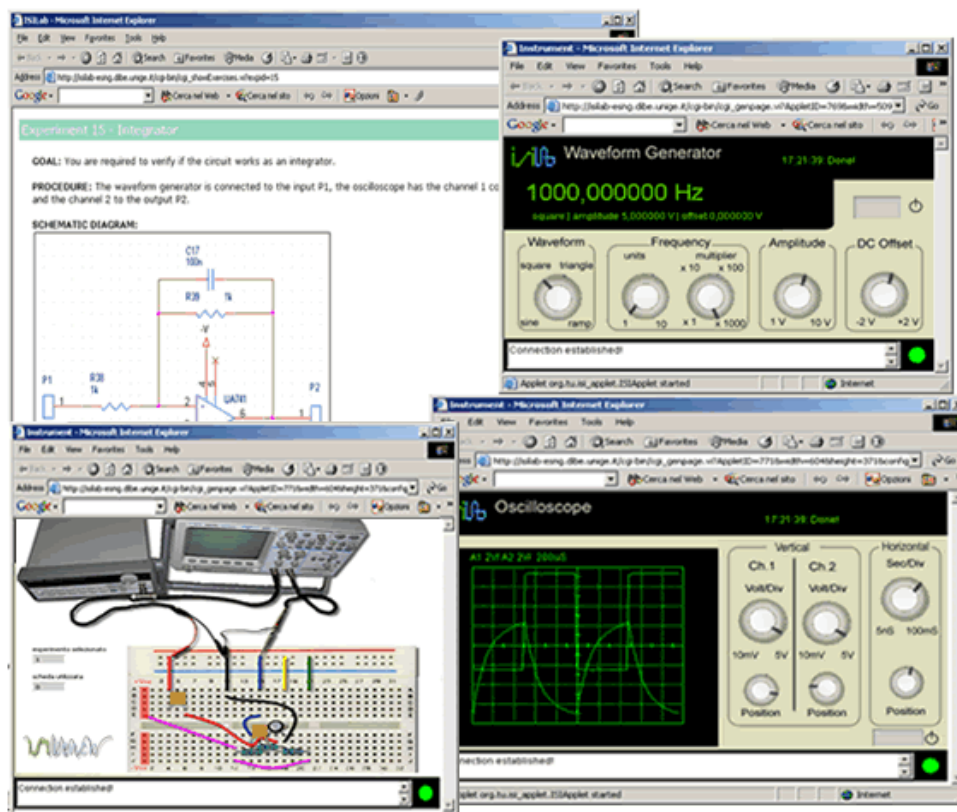


Figure 4: The views of the circuit diagram, instruments and equipment on the student computer monitor during the execution of an experiment

## 4 Tutorials and interactive e-learning modules

The following table summarizes the courses on electronics and the e-learning materials used to support the lectures in presence and to introduce virtual reality tools in the educational process.

Subject	ANALOG ELECTRONICS	
Pedagogical level and target	Fundamentals of analog electronic circuits analysis and design.	
Topics:	<ol style="list-style-type: none"> <li>1. Diode used in discrete components circuits: rectifier, zener, varactor, light emitter, light detector, solar cell, etc.</li> <li>2. Bipolar transistor used in discrete components circuits: bias circuits, large and small signal analysis, models and equivalent circuits, frequency response. Linear and non linear circuit design criteria, switching applications.</li> <li>3. Field effect transistors: their usage and classification, bias, large and small signal analysis, models and equivalent circuits, frequency response. Applications and linear/non linear circuit design criteria.</li> <li>4. Multistage circuits, block analysis of complex structures, operational amplifiers.</li> <li>5. Analog integrated circuits, design methodologies, circuits with operational amplifiers, conditioning of linear analog signals, non linear functions, astable operations, signals generation, etc.</li> <li>6. Thermal analysis of power circuits.</li> <li>7. Overview of analog complex circuits design.</li> </ol>	
Materials available	Type	Quantity

<i>Tutorials</i>	PDF, Power Point and Flash documents with audio (mainly in the format of SCORM-conformant products)	about 50 hours of audio presentation (Italian)
<i>Software Simulations</i>	Design and simulation of analog circuits with PSPICE	160 exercises
<i>Remote experiments</i>	Pre-assembled circuits available: <ul style="list-style-type: none"> <li>◊ BJT amplifier</li> <li>◊ BJT switch</li> <li>◊ BJT complementary symmetry stage</li> <li>◊ Operational amplifier – inverting amplifier</li> <li>◊ Operational amplifier – non inverting amplifier</li> <li>◊ Operational amplifier – integrator</li> <li>◊ Operational amplifier – differentiator</li> </ul>	ISILab

<b>Subject:</b>	<b>ELECTRONICS FOR TELECOMMUNICATIONS</b>	
<i>Pedagogical level and target</i>	Fundamentals of electronic circuits/systems for telecommunications.	
<i>Topics:</i>	<ol style="list-style-type: none"> <li>1. RF amplifiers.</li> <li>2. Oscillators.</li> <li>3. Mixer.</li> <li>4. RF filters.</li> <li>5. PLL.</li> <li>6. Synthesizer.</li> <li>7. Modulators and demodulators, modem.</li> <li>8. Structure of transmission and receiving systems.</li> </ol>	
<i>Materials available</i>	<i>Type</i>	<i>Quantity</i>
<i>Tutorials</i>	PDF	
<i>Simulations</i>	Design and simulation of circuits with the COMMSYM simulator	Available only inside the DIBE LAN
<i>Remote experiments</i>	<ul style="list-style-type: none"> <li>◊ Analysis of analog complex signals by FFT analyzer.</li> <li>◊ Characterization of software defined radio receiver and DRM transmissions.</li> <li>◊ Analysis of QPSK modulations in DVB satellite transmissions.</li> </ul>	Windows remote desktop

<b>Subject</b>	<b>DIGITAL ELECTRONICS</b>	
<i>Pedagogical level and target</i>	Fundamentals of digital system design	
<i>Topics:</i>	<ol style="list-style-type: none"> <li>1. Analysis of simple logic gates</li> <li>2. Multiplexers and Demultiplexers</li> <li>3. Application of Boolean Algebra</li> <li>4. Arithmetic circuits</li> <li>5. Delays and Hazards</li> <li>6. Flip-Flops and Registers</li> <li>7. Counters and other sequential networks</li> <li>8. Introduction to Finite State Machines</li> <li>9. Design of finite state machines</li> <li>10. Design of FSM-based digital systems</li> <li>11. Micro-computer systems: introduction to assembly programming</li> <li>12. Micro-computer systems: assembly programming techniques</li> <li>13. Micro-computer systems: parallel interfacing and interrupt handling</li> </ol>	
<i>Materials available</i>	<i>Type</i>	<i>Quantity</i>
<i>Tutorials</i>		
<i>Simulations</i>	Design and simulation of digital circuits with DEEDS	60 projects

<i>Remote experiments</i>	◇ Propagation delay of a gate	ISILab
	◇ Maximum clock frequency of a counter	

<b>Subject</b>	<b>INTRODUCTION TO ELECTRONIC SYSTEMS</b>	
<i>Pedagogical level and target</i>	Introductory material providing general concepts on state –of-the –art digital and mixed signals systems	
<i>Topics:</i>	<ol style="list-style-type: none"> <li>1. A/D – D/A conversion and data acquisition.</li> <li>2. Power supplies, AC/DC and DC/DC converters.</li> <li>3. Microcontrollers and digital signal processors.</li> <li>4. Programmable logic devices (CPLD, FPGA).</li> <li>5. Field bus.</li> </ol>	
<i>Materials available</i>	<i>Type</i>	<i>Quantity</i>
<i>Tutorials</i>	PDF, Power Point and Flash documents with audio (mainly in the format of SCORM-conformant products)	about 10 hours of audio presentation (Italian)
<i>Simulations</i>		
<i>Remote experiments</i>	Pre-assembled circuits available: ◇ A/ D and D/A converters	ISILab

## 5 Network based cooperative learning methodologies

The previous chapters describe the technical foundation and the characteristics of the learning material developed by DIBE. We believe, though, that it is important to consider the pedagogical environment where the material is used. In the following we provide information on the novel network based cooperative learning methodologies, we have experience with.

### 5.1 Network-Based Project Learning

The NetPro project [1,2] has integrated Problem Based Learning with Internet-based methods and tools, extending its application from a classroom to a wide, geographically delocalized environment. The result, Network Based Project Learning (NBPL), is a teaching/learning model that involves students in problem-solving tasks, allows students to actively build and manage their own learning, and results in students-built realistic deliverables. The underlying principle is the assumption that learning occurs during these unstructured, complex activities. The NetPro experience has been very significant, establishing the validity of the approach and the will to further develop it by taking advantage of new and emerging technologies, such as the ones investigated by the KP-Lab project. The same team that contributed to develop and pilot NetPro in our institution is now engaged in a new project, Knowledge-Practices Laboratory (KP-Lab), which, building on the previous experience, (cooperative work, distance work etc) explores a new, advanced approach.

### 5.2 The KP-Lab project

KP-Lab [3], an Integrated Project sponsored by the 6<sup>th</sup> EU Framework Programme for Research and Development aims at creating a learning system that facilitates innovative practices of sharing, creating and working with knowledge in education and workplaces. The project's partners come from research communities active both in the pedagogical and technological domains.

The project builds on the idea that beyond the metaphors of learning as a process of knowledge acquisition (monological, within mind approach) or of participation in a social community (dialogical, interactive approach), there are central theories concerning learning and human cognition which do not fit within these distinct categories. These theories are a basis for a third view involving what the project calls the knowledge-creation metaphor of learning (triological approach). According to it, cognition is seen to develop through

collaborative work in systematically developing shared, conceptual or material artefacts, such as concepts, plans, products, or social practices

The project promotes co-evolution of individual and organizational learning with technology through the development of a learning system based on technological, theoretical, pedagogical, and social innovations aimed at facilitating innovative practices of working with knowledge ("knowledge practices") in education and workplaces.

KP-Lab embodies a novel theoretical approach to human cognition which assists going beyond acquisition and participation metaphors of learning to consider also knowledge-creation processes, and related tools and practices critical for answering the challenges of the emerging innovation society. Knowledge creation takes place through reflective social practices around shared knowledge artifacts [4]. To do so, KP-Lab provides the participants tools for reflecting on, making visible, and transforming their knowledge practices. In order to be truly productive, collaborative technologies cannot be fully specified beforehand but need to co-evolve with social practices and be further modifiable according to the users' emerging needs and practical innovations. Consequently, the KP-Lab is really a "laboratory" in terms of providing a testbed for developing transformative knowledge practices for educational institutions and workplaces.

### 5.3 KP-Lab Tools

KP-Lab is developing, by taking advantage of the new generation of web technologies, a cluster of inter-operable applications, which include:

- a virtual collaboration space;
- common tools for working with knowledge artifacts and for managing knowledge creation processes [5, 6];
- specific tools that facilitate the discovery and exploitation of tacit and practice-related knowledge;
- shared multimedia annotation tools;
- ubiquitous cooperative conferencing and communication services;
- semantic web knowledge middleware for learning applications.

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**Author(s):**

Anna Marina Scapolla, Professor.  
Domenico Ponta, Professor  
Giancarlo Parodi, Professor  
Giuliano Donzellini, Professor  
Andrea Bagnasco, PhD  
University of Genoa, Biophysical and Electronic Engineering Department  
Via Opera Pia, 11a, Genoa, Italy  
{scapolla, ponta, gian, bagnasco }@dibe.unige.it

## Simulation, Emulation and Remote Experiments

*Fernando COITO, Luís GOMES, Anikó COSTA*

*Universidade Nova de Lisboa, Faculty of Science and Technology, Portugal*

**Key words:** *applications, e-learning, remote labs*

### **Abstract:**

*Bologna Declaration has put the stress on the “What students do?” paradigm, shifting the center of the learning process to the student. Such paradigm also supports life long learning objectives. The remote laboratory concept provides a tool to sustain this shift towards a student-centric teaching approach. However, in engineering education, this means an additional stress on laboratories, as a result from the pressure to increase experimentation, and raises the question: how to handle overcrowded laboratories? Remote labs present a solution to this problem, allowing students to access experiments without time and location restrictions..*

## **1 Introduction**

Automatic control is a major field in almost every engineering subject and is an important part of the respective engineering curricula. Unlike many other areas, automatic control is more of a scientific area than a technological area, with applications ranging from chemical processes, through mechanics, electronics up to communications and economics. Thus, from an early stage, some means to relate concepts and reality is required, in order to turn words such as signal, system, process, controller and sensor into meaningful notions to be dealt with by students. For this purpose two approaches are followed, each with its own advantages and flaws, taking its own place across students learning process – dynamic simulation and real-time experimentation. While being commonly accepted that practical education needs to be based on real events that occur in real-life systems, and that experimentation with a plant cannot be replaced by simulations, it is also true that simulation has its own place [1]. Both tools are needed when used at the right moment.

While most of the students learning process deals with conceptualized objects – mathematical models, linear time-invariant systems, low complexity systems – reality is much more complex. Thus, on early stages while students are getting acquainted with the field, it is better to make use of simulation tools than to distract their attention from key notions to implementation problems which are often amplified when a real-scale process is replaced by a lab-scale prototype. This is why automatic control has always relied on simulation, both analog and digital, as a useful tool not only for learning but also as a design tool. In the sequel we will explain the way how we integrate these two approaches and some we will describe some tools developed within this framework.

## 2 Simulation tools

Simulation is an important stage on the development of any automatic control system. Thus it is not surprising that it takes such an important role also on the students learning process. A number of computer based tools is available, such as Matlab, MatrixX or SciLab. These tools present generic capabilities for the analysis and simulation of dynamic systems and its use is essential when properly building an automatic control solution. However, this simulation tools are focused on system description mechanism and its analysis, failing to give the early student the feeling of the “real-thing”. For this purpose, as a complement or an alternative, a number of dedicated simulators may be used in areas such as electronics, mechanics and aeronautics. These are, however, focused on representing then reality, making generalized use of complex non-linear dynamics.

Most of these tools are proprietary solutions and require the payment of expensive licenses, making it impossible to make them available for students outside the university grounds. A number of Matlab like freeware tools exist but they are still under development – SciLab is a good example.

Aiming to respond to the need for simulation applications which place the early student in contact with the “real thing”, filling the gap between concept and reality, and simultaneously have simple dynamics and may be distributed to students with economical viability, a number of small dedicated simulators were developed. Each of these simulators represents a process under study. Their dynamics is in most cases linear and configurable. The animated graphical interface is developed showing the student the physical nature of the process and its behavior (lying in the frontier to virtual reality) and the simulation is focused on the concepts and techniques under study. The applications are required to be of small size and have a self-extracting version, in order for an easy distribution.

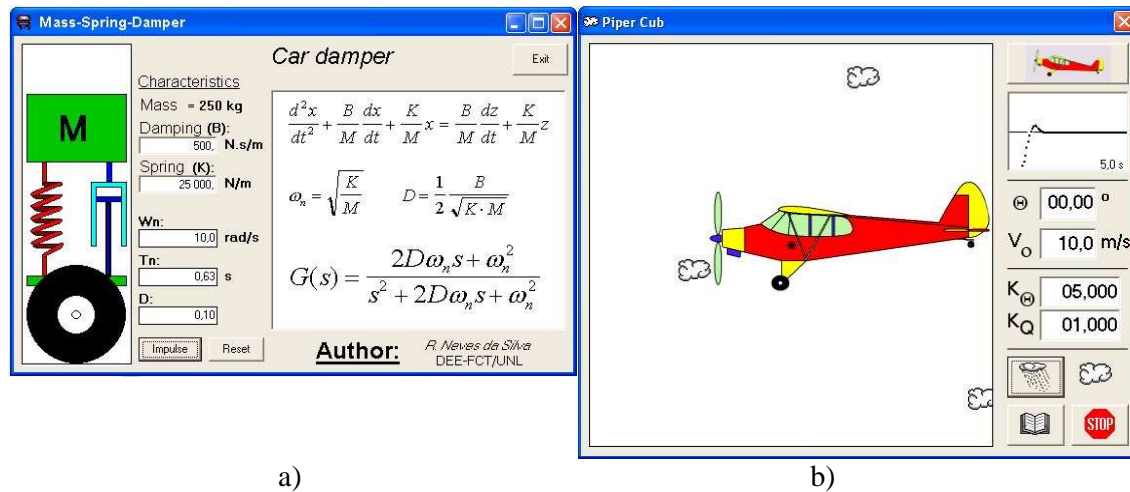


Fig. 1 Simulator interfaces: a) Mass-spring-damper simulator; b) Piper Cub roll angle control.

Fig. 1 shows two examples of such applications. The mass-spring-damper simulator is used to introduce students to the time behavior of second order dynamic systems and to build the relationship between parameters and system reaction. It simulates a car wheel damper as it goes trough a street hole – the systems impulse response. On the left window pane the simulator shows an animation of the damper behavior. The rightmost pane presents static data, composed by a set of expressions relevant for the systems dynamics. In the center pane students may change the damping factor and spring stiffness values, thus changing the

systems behavior. A set of associated data is automatically updated as system parameters are changed ( $\omega_n$ ,  $T_n$ ,  $D$ ).

The Piper Cub simulator allows students to do experiments on multivariable and state space control techniques. One again the left window shows an animation of the system behavior. The rightmost pane is used for user interaction: by clicking on the top button the user is given the possibility to change the relevant plane characteristics (inertial moments, geometric characteristics, etc.). Below lies a window showing how the roll angle  $\Theta$  evolves and its numeric value. Parameters  $v_o$  – plane air speed – and controller gains  $K_\Theta$ ,  $K_Q$  are to be adjusted by the user in order to achieve some desired performance.

### 3 Environment for remote control experiments [6]

Although modeling and dynamic simulation are basic tools for understanding and verifying theoretical subjects, the experimentation with a plant has also a fundamental role that cannot be replaced. Practical education needs to be based on real aspects that occur in mechanical, electrical, or chemical systems. However, due to their cost, the number of laboratory experiments is small when compared to the high number of students enrolled in the subject. Besides, work in a real laboratory imposes time and physical boundaries both for students and for academic staff. It requires significant scheduling effort and financial investments. Lately, universities are strongly advocating for the introduction of modern education technologies, and the option of online delivery of courses both for internal and external students.

Laboratory experiments are generally relatively large equipments, which are difficult to move and their set-up is time consuming. On the other hand, in order to increase efficiency, students should not be forced to move between different workplaces.

Remote control comes as a solution to these problems, allowing students to gain control of experiments, without leaving their normal workplace. Experiments may be located on the same room or on a different location. Taking advantage of the internet and the development of related technologies, an increasing number of remote access solutions is being developed [2-4].

This paper focus on the description of a tool called SMCRVI, developed as a response to the need of remote access to lab experiments on Control related classes. This tool provides an environment for remote control implemented based on the LabView platform and builds a client-server architecture for real and virtual laboratories. A real physical system or a process model can be remotely controlled from a personal computer (PC) via the Internet using virtual instruments. The system allows experimental data to be collect and transfer to the remote user for further analysis. The user is able to see the experimental results and analysis outcomes on a computer screen, display the results on the screen, or submit the results in electronic form for assessment. A distinguishing feature of this tool is the possibility for several students to share simultaneously the online data from an experiment, although only one may be in actual control of the experiment.

In spite the fact that, up till now, the only remote client application is based on LabView, this is not a limitation. In fact, remote control systems can be build using other technologies, such Common Gateway Interface, JavaScript or Active Server Pages, using a HTML browser for a simple interface.

### **3.1 The main characteristics**

#### **3.1.1 Basic considerations**

A characteristic feature of dynamic systems study is that a long time is spent on data analysis, model and controller development, and on simulation. Only a relatively small amount of time is used in direct contact with the plant. Thus, an experiment may be shared by several students without loss of efficiency.

Also, a large amount of work is associated with the gathering of data for modeling and system analysis rather than control tests. For this purpose, students need only to gain access to plant data. The experiment itself may be running as a demonstration while test data is made available for all the students.

Another issue is supervision. A supervisor (a teacher or a technician) should have some degree of control over the tests that are being performed. It should be possible to limit access time, to allow other students to perform their tests, and tests must be monitored to ensure safety.

#### **3.1.2 Specifications**

In order to comply with the above constraints SMCRVI was developed according to the following set of specifications:

- The experiment must be able to run standalone (without any student connected to it). It must have a demonstration mode, where tests are performed by an operator (ex: a teacher) and all the students have online access to the test data.
- Students should connect to running experiments. There are two levels of interaction with the experiment:
  - Full control of the experiment
  - Online access to the test data
- At each time only one student can control the experiment. However, at the same time, there may be a large number of other students accessing the data from the test he is conducting.
- The application is to be launched from their analysis environment and data is to be available environment variables in a transparent way. Up till now this feature has been implemented within Matlab.
- A degree of automatic supervision has to be included allowing to:
  - Automatically limit the access time of students in full control mode, when more then one student is pretending to gain this type of access.
  - Automatically granting access to the experiment, both in full control mode and data access mode.
  - Restricting full access mode to unwanted users.
  - Avoid undesired and/or unsafe operations.

- A degree of operator supervision has to be included allowing to:
  - Monitor the tests performed by students.
  - Perform tests for demonstration purposes.
  - Restrict access to the experiment.
- Remote access to the experiments is to be done over the local area network available in the laboratories.

An additional desired feature is that the software is to be compatible both with the existent data acquisition boards and those that may be acquired in a near future.

### 3.1.3 SMCRVI hardware structure

In order to give the experiments a standalone capability, together with the automatic and operator supervision feature, a Client/Server structure was devised.

The server is a PC type computer connected to a data acquisition system. It is to be located close to the experimental setup. The experimental setup may be in the classroom or some other location. For this implementation a National Instruments PXI-8186 computer, fitted with two data acquisition boards – one for analog voltage I/O and the other for analog current output.

The client stations are PC type computers, with no special requirements.

The communication between client stations and the server is supported by the some Ethernet network.

The server station must be able to run Matlab and LabView. The only Client software yet developed requires also the client station to be running LabView, but this restriction is supposed to be raised in the future.

### 3.1.4 SMCRVI software structure

SMCRVI is composed by two software packages – the Central Command Tool and the Client Station Tool. The Central Command Tool is located on the Server. Fig. 2-a shows its structure. This tool performs data acquisition and experiment control; it handles Client communication, commands and data transfer; it also provides a graphical interface for the operator. It is entirely programmed in Labview. It uses the Labview Matlab Script feature to allow Clients to implement their controllers and to handle Matlab data.

The Client Station Tool is located on the Client computers. It is designed to provide a graphical interface to connect with remotely located experiments. Its structure is presented in Fig. 2-b. If the client station is also running Matlab, SMCRVI may be called from within the Matlab environment and, at the end of the test, the results are collected directly as Matlab environment variables.

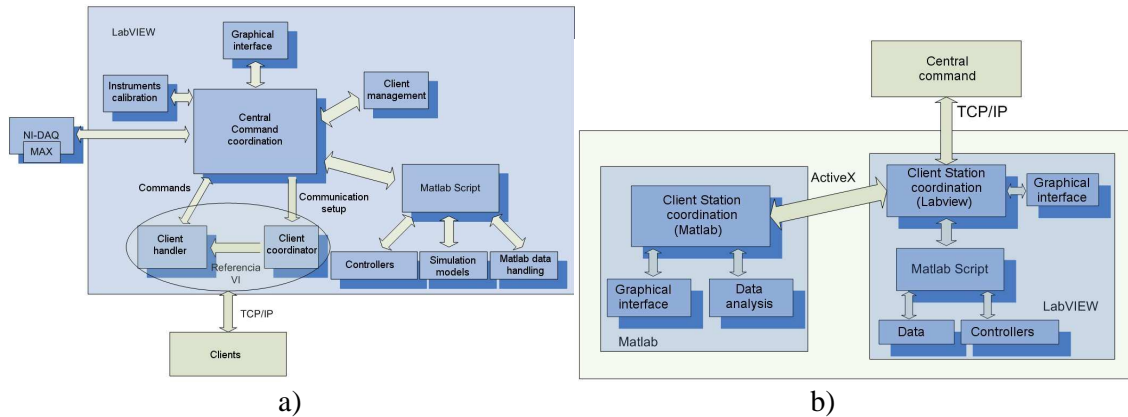


Fig. 2 a) Central Command structure. b) Client Station structure.

Thus, for the Client Station two tools are available: a Matlab tool and a Labview tool. The Matlab tool calls the Labview tool and handles the data transfer in a way that is transparent to the user.

The Labview tool handles the communication with the Server and provides the user a graphical interface with the experiment. The user may chose between monitoring a test conducted by another user or to perform a test himself - both in open and closed-loop. The use of this tool does not require any knowledge on Labview programming.

### 3.2 The main characteristics

#### 3.2.1 SMCRVI software structure

Once SMCRVI is called the graphical interface appears (Fig. 3).

The interface is divided in two sections. In the right half there is a graphic window showing online the experiment data – both commands and plant output signals. The user can select the signals to be shown and the scale (auto-scale is default). All the experiment signals are transferred to the user even if they aren't shown on the screen.

In the left half the user controls the experiment (if allowed). The interface's main tag (as shown in Fig. 3) is composed by two panels: the signal generator panel and the controller panel.

The function generator produces signals to be applied to the plant. To allow the user to switch between open and closed-loop mode without disturbing the test, two signal generators are implemented - in closed-loop mode the signal generator output is the controller's reference signal.

In closed-loop mode the user may chose between a pre-programmed PID controller and a user defined controller. In the latter option the user may select from the set of user controllers available on the Server, or he may upload his own controller to the server. User defined controllers are implemented using the Labview's Matlab Script feature.

The controller panel is used to tune the controller online.

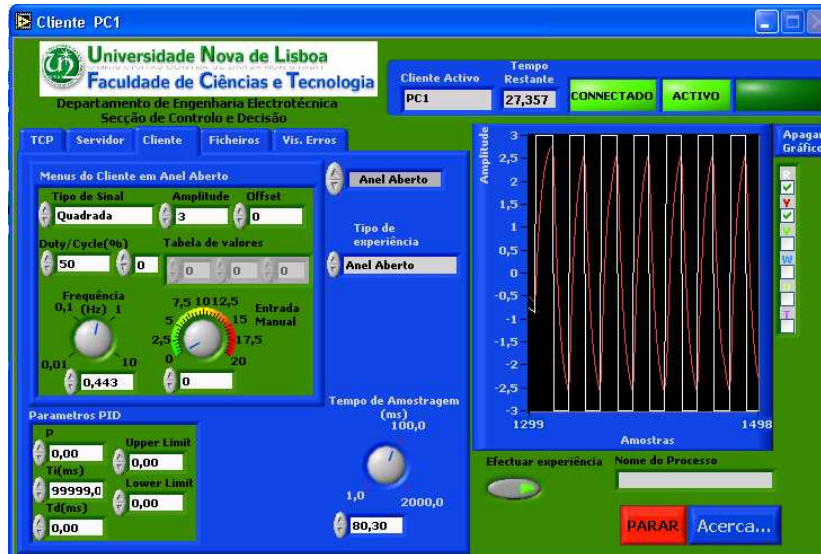


Fig. 3 SMCRVI graphical interface.

### 3.2.2 Signal handling

All the signals from an experiment are acquired and passed to Matlab. These signals are defined by the operator at the Server, when the experiment is started. SMCRVI allows up to 2 output command signals and up to 3 input signals from the plant. All signals are independently calibrated allowing the conversion of acquisition data into physical measurements. The sampling rate is selectable online and may be changed during the test.

Controllers are implemented in discrete time. SMCRVI ensures a buffer of 5 past samples of each signal for controller implementation.

### 3.2.3 Remote control

Performing remote control over a computer network is a dangerous matter. Delays on data transfer and losses of communication are the main reasons to avoid this solution. Thus, all of SMCRVI's control signals are computed locally at the Server. The Server's control parameters (both for the function generator and for the closed-loop controller) mirror the parameter values from the Client which is controlling the test. When there are no communication problems over the network this feature is transparent to the user. Whenever there is a communication loss, the Server continues to ensure the experiment control and the user recovers the I/O data when the communication is re-established.

### 3.2.4 Remote control

The use of Labview's Matlab Script tool (Fig. 4) allows the use of all the functions available from Matlab within the Labview environment, by means of the ActiveX protocol. This feature is restricted to computers working under Windows operating system and requires Matlab to be installed on the computer.

For controller or simulation model implementation SMCRVI provides control signals  $u$  and  $t$  (analog output). There are 3 available plant signals (analog input) –  $w$ ,  $v$  and  $y$ .

SMCRVI keeps a buffer with the last 5 samples of each variable. As shown in Fig. 4, the past samples of signal  $w$  are represented as  $w_1, \dots, w_5$ . An integrated editor is provided for writing small Matlab scripts. An example of a script is presented in Fig. 4.

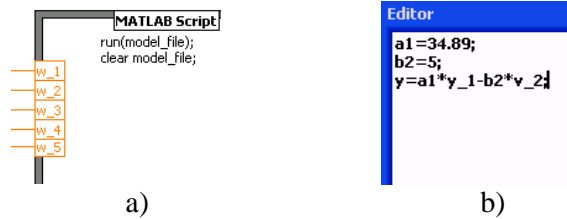


Fig. 4 a) Matlab script block and its inputs. b) Matlab script editor:  $a_1$  and  $b_2$  are parameters;  $y_1$  and  $v_2$  are past values of I/O signals.

### 3.2.5 PID controller

For single input-single output closed-loop control, SMCRVI considers a simple negative unit feedback type control structure. The reference signal is produced by the function generator according to user-defined settings. The control signal is computed by the controller. The user may choose between using an embedded controller or to provide the code for his own controller, using Matlab script.

SMCRVI provides an embedded PID controller. It implements a discrete time incremental version of the PID algorithm, as described in [5].

### 3.2.6 Client management

The Central Command Tool, on the Server, is responsible for Client management. Through the Client management window, at any moment the operator may verify which Clients are connected to the experiment; who is performing a test and which Clients are waiting to gain control of the experiment.

In order to grant everyone a fair access to the experiment, Central Command switches periodically between the Clients that are waiting to perform a test. This switching rate is defined by the operator. The operator may also grant unlimited time access to one Client or block/unblock a Client's access.

## 3.3 Available setups

### 3.3.1 Two-tank level control process

One of the experiments that are used with SMCRVI is a two-tank level control process. Water flows from a reservoir into a set of two connectable tanks. Available measures are water level and flow. Water flow is controlled by means of electrical driven motorized valve.

The process dynamics may be changed by connecting the two tanks together or by changing the section of the connection. Disturbances are introduced through mechanical and electromagnetic valves.

A number of experiments may be performed with this unit, ranging from a simple level control loop to cascade control and non-linear control.

### 3.3.2 Temperature-air flow process

The process consists of a ventilation unit coupled with an electrical heating element. The power to the heater is controlled through an electrical voltage signal and temperature measurement is available.

The process dynamics changes with the selected air flow or by placing the temperature sensor at different distances from the heating element.

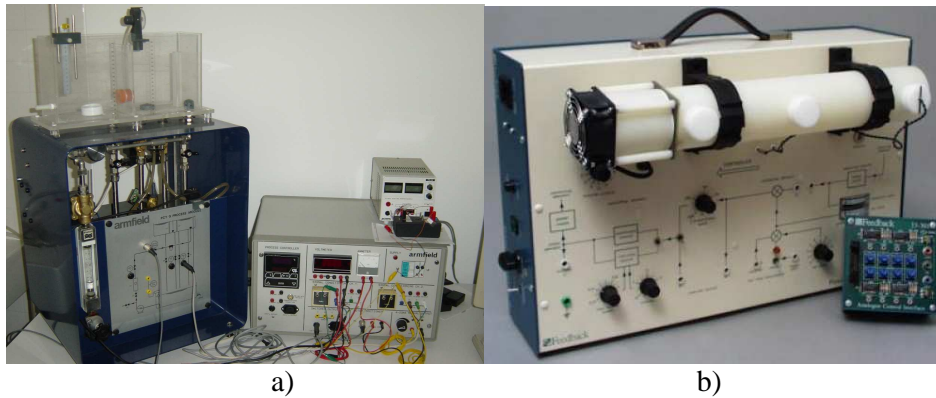


Fig. 5 a) Two-tank level control process. b) Temperature-air flow process.

### 3.3.3 Adding a new setup

Putting aside its features related to remote access and experiment data sharing, SMCRVI may be viewed as a data acquisition tool.

To setup a new experiment, the operator has only to interactively select, the set of I/O channels will be used. Each channel signal is converted from an electrical signal to a physical signal according to:

$$\text{Physical signal} = \text{Gain} \times \text{Electrical signal} + \text{offset}$$

## 4 Embedded systems experimentation

Experiments associated with electronics, digital systems and embedded systems share the common characteristics of being relatively low-cost, making it feasible to replicate experiments. Several examples on remote laboratories for embedded systems experimentation can be found in the literature [7 - 11].

At Universidade Nova de Lisboa, we are considering a remote laboratory based on a four level structure (see Fig. 6):

- Student, remotely connected to the local server using a browser through the internet;
- Local server, enabling virtual workbench to be used remotely;
- Virtual workbench adaptor, which interacts with the local server in order to produce inputs to the system under test and get current status of the outputs;
- Microcontroller system under test (which is a 8031 microcontroller based micro-system in the illustrated case).

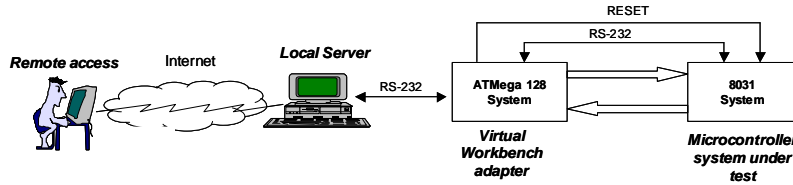


Fig. 6 Remote laboratory structure.

The current implementation of the local server is based on LabView, which can assure adequate connectivity to lower levels, while taking care of the internet connectivity.

Fig. 7 presents two snapshots of the LabView VI, the first one to allow remote reset of the system under test, followed by the download of the program and its launching; the second snapshot is activated afterwards and it's used to impose inputs and get output status from the system under test.

In this sense, the usage of the virtual workbench is very close to the procedures one has to comply when interacting directly with the 8031 microcontroller system.

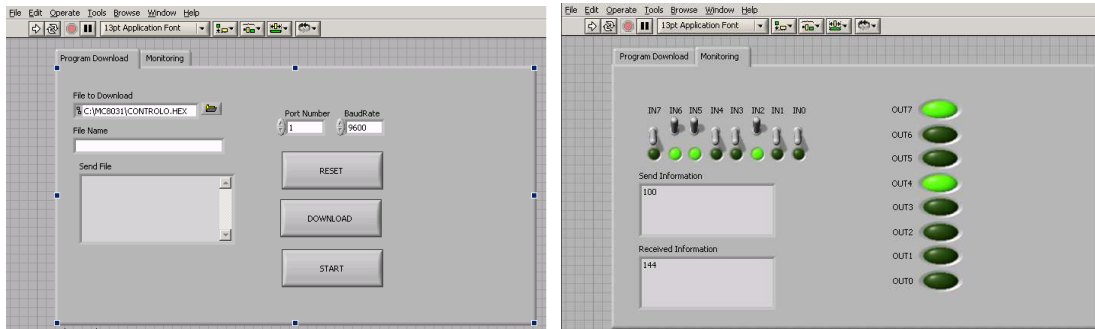


Fig. 7 Snapshots of the virtual workbench: download of a program and monitoring of the system under test.

For the virtual workbench adaptor, a simple system based on an ATmega128 microcontroller was considered. General features include:

- Two RS-232 links; one devoted to the connection with the local server, in order to receive commands from the user and return responses; the other is targeted to connect with the system under test;
- A set of inputs to acquire actual outputs of the system under test;
- A set of outputs to impose values at the inputs of the system under test;
- A reset output to assert reset pin of the system under test (and get control back to the monitor program).

From the point of view of connection between the local server and the workbench adaptor, a simple protocol was defined, including the following set of commands:

- Reset of the system under test;
- Download a file to the system under test;
- Download commands and binary sequences to the system under test (command at the upper serial link will be echoed at the lower serial link);
- Get actual status of system under test outputs;
- Impose specific values at the system under test inputs;
- A command to enable further use as a terminal (from local server to the system under test, being the workbench adaptor “transparent”).

This workbench adaptor can also be used for general virtual and remote laboratory experiments.

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**Author(s):**

Fernando Coito, eng. PhD, professor;  
Faculty of Science and Technology  
New University of Lisbon,  
2829-516 Caparica  
PORTUGAL  
Email: [fjvc@fct.unl.pt](mailto:fjvc@fct.unl.pt)

Luís Gomes, eng. PhD, professor;  
Faculty of Science and Technology  
New University of Lisbon,  
2829-516 Caparica  
PORTUGAL  
Email: [lugo@uninova.pt](mailto:lugo@uninova.pt)

Anikó Costa, eng. MSc, ;  
Faculty of Science and Technology  
New University of Lisbon,  
2829-516 Caparica  
PORTUGAL  
Email: [akc@uninova.pt](mailto:akc@uninova.pt)

# Advanced Education in Mechatronics

Viliam Fedák, Daniela Perduková

Technical University of Košice

**Key words:** *mechatronics, e-learning, interactive screens*

## Abstract:

*The paper describes computer based support of study programme in mechatronic systems. It covers e-learning modules with introduced interactivity and animations allowing students to acquire a possibly deep insight into the complex and dynamic interactions of a number of parameters in the mechatronic systems.*

## 1 Introduction

Mechatronics integrates classical fields of mechanical, electrical, and computer engineering, completed by information technology. A mechatronic system is characterized by diversity, variety and integrity of its components and parts and it encompasses several components: mechanical structure, actuators (power electronics, motors, drives), sensors, control systems, computers, algorithms and their programming, man-machine interface. The mechatronic system consists of several layers (compare design in Fig. 1a), where each layer is able to perform correctly only when the underlying one is behaving correctly, too [3].

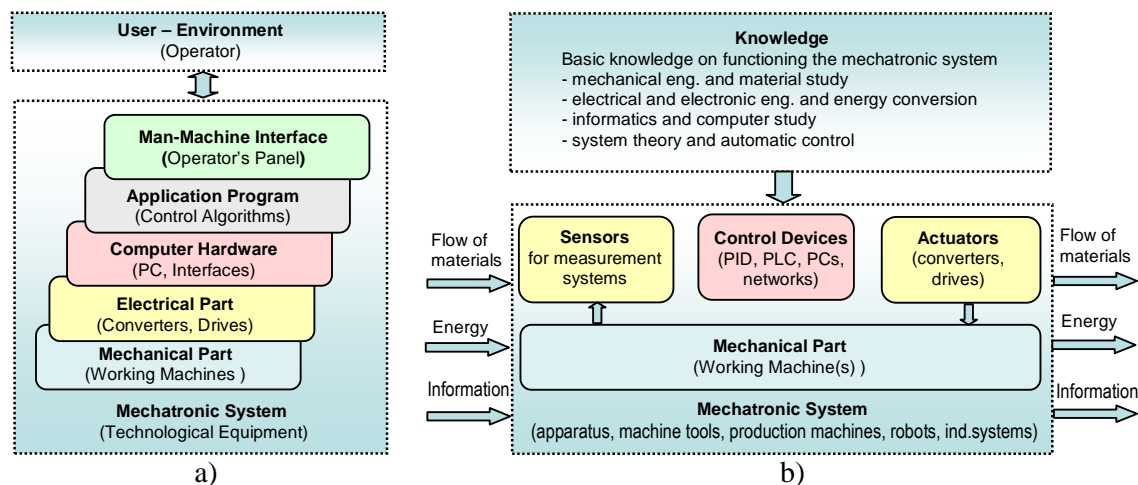


Fig. 1 Two views on mechatronic system

When going into nature and utilisation of mechatronic systems, they can be generally divided into the following groups:

### 1. Micromechanical integrated systems

- Intelligent mechanical sensors (integrated circuits with mechanical components)
- Apparatus with mechanical elements (printers, floppy drives, CD-ROMs, etc.)

## 2. Modern machines

- Robots – universal machines with complex mechanisms, sophisticated multimotor drives and intelligent control system performing a required motion/trajectory.
  - Machines with integrated electrical drives containing mechanical, electrical, electronic, and information or software components.
  - Machine tools consisting of precision mechanisms and instruments, high accuracy positioning drives, intelligent control, and visualisation system.
3. Industrial and building automation systems presented by integrated machines, transportation systems, manufacturing or production lines and centres, PCs, data networks (Interbus, Profibus, ASI, LON network, Instabus), information, protection and security communications, sophisticated software systems of virtual reality for technology operation, modelling and visualisation

From the overview presented it is obvious which subjects should be incorporated into the mechatronic course curriculum and how it should be supported by computer based learning.

## 2 e-Learning Support

To support education in mechatronics we adopted a long-year plan of e-learning modules preparation. Several of them are ready [1] (Power Electronics, Electrical Machines, Electrical Drives, Motion Control, Models of Dynamic Systems, Mechatronic Systems), a set of further ones are under preparation or planned (System Identification, Control Theory, Robotics, ...).

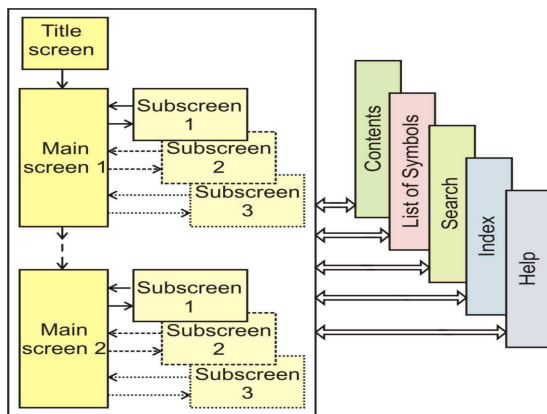


Fig. 2 INETELE module principal structure

Preparation of the modules is a time and money consuming work and this is the reason why the design of modules has to be performed efficiently and their utilisation opportunities should be manifold. To satisfy these requirements we accepted a philosophy that the modules should be used both for teaching and for (self) learning. They consist of two kinds of screens (Fig. 2): a) main screens for teaching in class, b) linked secondary (complementary) ones.

The main screens are designed for projection in classroom. Large letters, figures, tables are used. Thus information content is limited and restricted to main ideas basic mathematical equations, etc. To explain satisfactory the phenomena, and to attract attention of the students the main screens contain animations and interactive graph enabling to observe influence of variable parameter on system behaviour – a some kind of system small analysis. A menu at bottom of each main screen enables to move between the screens, manage the flow of the screens, chapters, to enter to contents, list of symbols, search engine, index, and help file.

The secondary screens are designed for using it out of class-room for individual study. They contain explanations and derivations, phases of animations on the main screens as well as questions and/or answers and exercise problems reinforced the learning process. They apply smaller letters, figures, tables, and contains substantial amount of information and full derivation of equations on the main screen. It makes possible to study and learn the material of screens at home for students without teacher and also to make hardcopy of it.

### 3 Overview of Realised e-Learning Modules for Mechatronics

Based on the described principles for e-learning modules design we developed a set of e-learning modules in framework of the “INETELE” project [3] covering a wide area of Electrical Engineering a Mechatronics Engineering in four specialised groups:

1) Fundamental and Principles of Electrical Circuits; 2) Electrical Machines; 3) Power Electronics; 4) Electro-Mechanical and Mechatronic Systems.

The set of modules for mechatronics consists of:

- 1) Electrical Machines Module (sources of motion:)
- 2) Power Electronics Converters (electrical actuators)
- 3) Electrical Drives (controlled motion)
- 4) Models of Mechanical Subsystems (multibody systems with elastic and damping elements)
- 5) Motion Control and Controlled Drives (principles of feedback controlled systems)

Let's show main features that are characteristic for the modules.

#### 3.1 Electrical Machines – Sources of Motion

This group involves the modules dealing with principles of electrical machines based on application of electromagnetic laws. Animations show composition and principles of operation of electrical machines of various kinds transformers, AC asynchronous machines, AC synchronous machines.

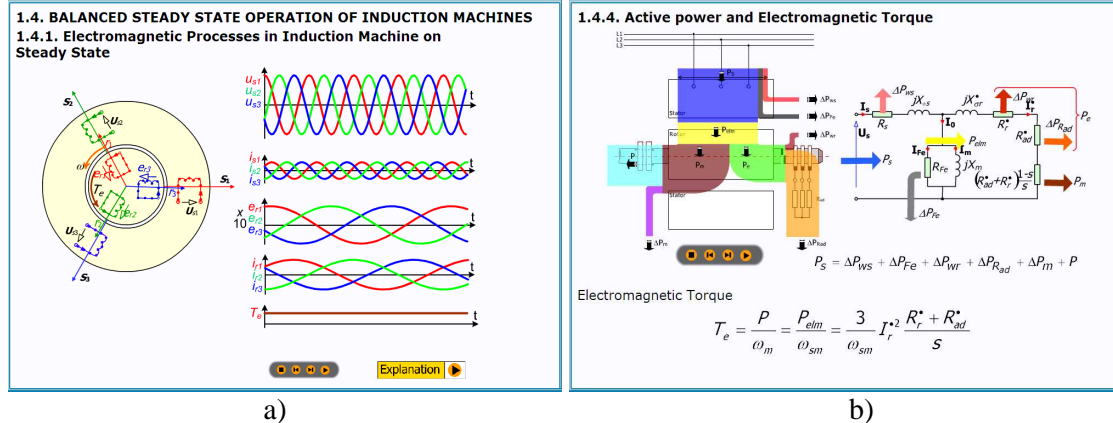


Fig. 3 Examples from AC Electrical Machines module

#### 3.2 Power Electronics Converters – Power Actuators

Several developed modules deal with electronic actuators from various sides – they are modules on Power Semiconductor Devices, Power Electronics, Control in Power Electronics, and Power Electronic Applications. The students learn different aspects of power electronics starting with power electronics components, continuing with control of power electronics and different issues related to power electronics and finishing with their applications. The basic module is Power Electronics dealing with DC-DC Converters, Energy Storage DC-DC converters, DC-AC Converters, AC-AC Converters (Single-phase and Three-phase AC Regulators). The module features by high interactivity: the circuit parameters can be changed

by a slider or by inputting a value of changeable parameter. Screens in Fig. 4 illustrate two approaches – on the left side wave form at firing angle change, on the right side one can observe switching sequence of semiconductor switches in various time instants.

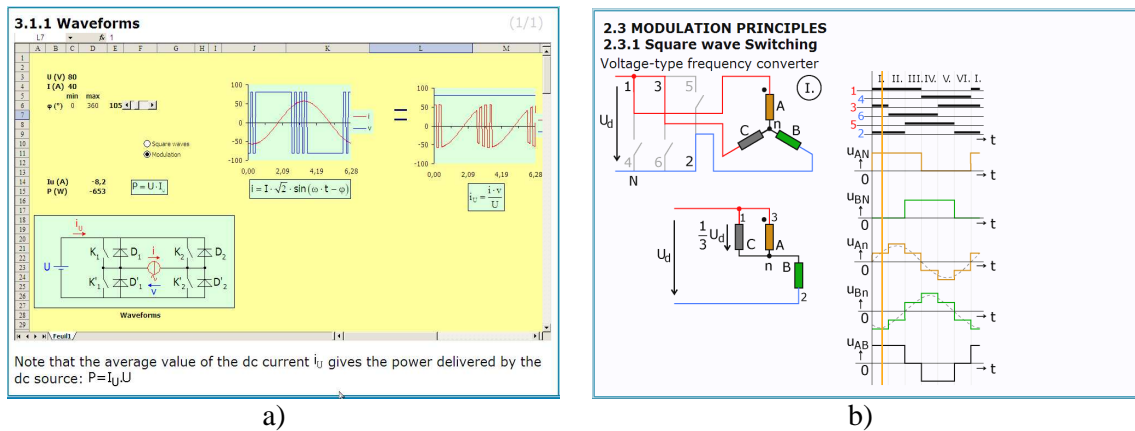


Fig. 4 Examples from modules dealing with Power Electronics

### 3.3 Electrical Drives

The students learn principles of controlled motional system consisting of electrical motor supplied by power electronic converter and system properties both in steady- and dynamic states. The module contains the topics on: Electrical Drive as a System, Mechanical Part of Electrical Drives, Mechanical and Thermal Transient Phenomena, Electrical DC Motor Drives, Asynchronous Motor Drives. Fig. 5 shows two interactive examples from AC drives.

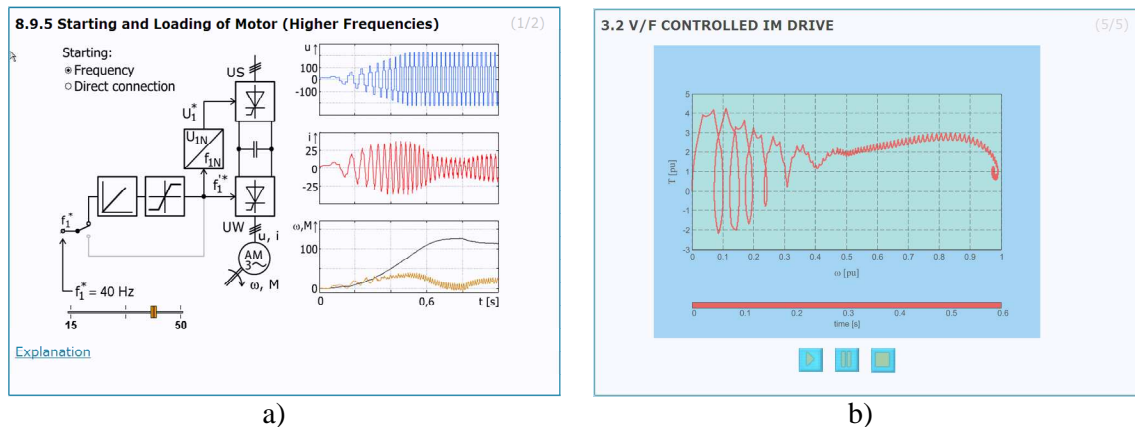


Fig. 5 Electrical Drives Module

### 3.4 Models of Mechanical Subsystems

The mechanical subsystems are inseparable parts of mechatronic systems. To control them, it is substantial to know their mathematic model, mostly in form of transfer functions and block diagrams. The main chapters of the module: Principles of Mechanical Systems Modelling, Oscillations in Mechanical Systems, Rotating Systems with Elastic Coupling, Shifting Systems with Elastic Couplings, Applications of Elastic Connections, Subsystems of Continuous Production Lines. The learner can change parameters (usually constants of elasticity and damping) and observes their influence on mechanical oscillations.

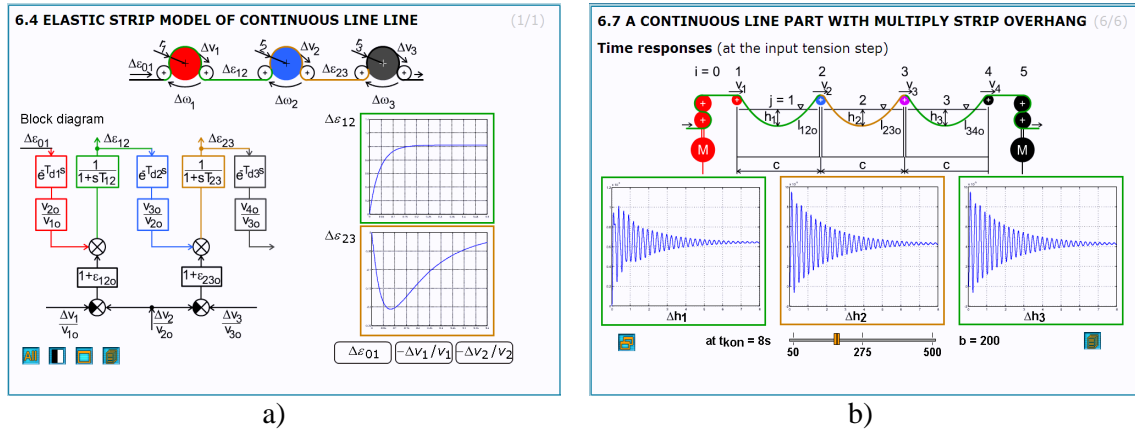


Fig. 6 Transient phenomena in mechanical subsystems of continuous production lines

### 3.5 Controlled Drives and Motion Control

The module deals with closed-loop controlled DC and AC electrical drives. The attention is devoted to explanation of performance of closed-loop drives, to methods of selection the controllers, design of control structure, design of controller parameters. It consists of 4 chapters: Linear Control in Frequency Domain, Linear Control in Time Domain, State Control of Non-linear Systems, Control of AC Drives. The philosophy of the module was chosen in such a way, that the main screens contain basic ideas, schemes and mathematical support to the matter presented. To the most of the mains screen there is adjoined a screen with example enhancing theoretical derivation that is called by a button.

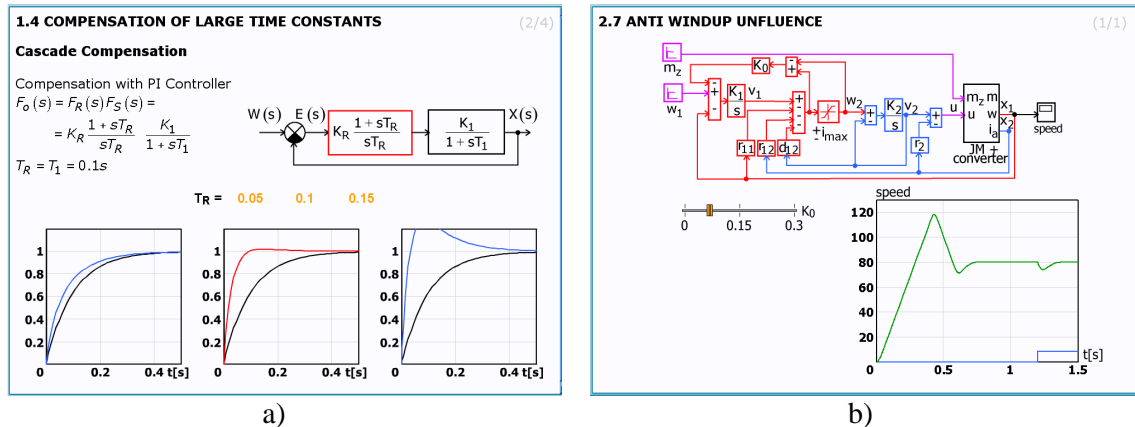


Fig. 7 Examples from Controlled Drives module featuring interactivity

## 4 Conclusions

The contribution gives an overview of needs and skills required by the engineers working in a mechatronic system environment. After brief presentation of the curricula background in Mechatronics course, the paper shows a philosophy of the web based interactive modules supporting the course. On several screens some typical results from realised e-learning modules enhancing the used philosophy and ways of visualization are presented. The animations in the modules were realized in Macromedia Director environment and finally implemented in the html using Macromedia Dreamweaver.

Based on results of the INETELE project another project – “DEBIPE” [3] in framework of Leonardo da Vinci scheme was successfully submitted. It deals with design and development of remote controlled experiments with measurements each with its own philosophy that will be available through internet at PEMCWebLab [7] (PEMC – Power Electronics and Motion Control). Twelve universities with the span across the EU (from the countries: NL, F, D, PL, CZ, SK, HU, RO, GR) are participating there.

Except of experiments from Fundamentals of Electrical Engineering (3 experiments), Power Electronics (6), Electrical Machines (4) we are preparing the following experiments from fields of Motion Control and Mechatronic Systems:

- 1) Basic Elements of Internet based Telematipulation;
- 2) Mechatronics, HIL (Hardware in the Loop) Simulation;
- 3) High Dynamic Drives - Motion Control;
- 4) Automotive Electrical Drive;
- 5) Complex Control of a Servodrive by a Small Logic Controller;
- 6) Intelligent Gate Control by a Small Logic Controller.

Course materials and case studies giving a guide to particular experiments are currently under development and will complement them in a short future.

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## Author(s):

Viliam Fedák, Assoc. Prof., PhD.,  
 Daniela Perduková, Assoc. Prof., PhD.  
 Technical University of Košice  
 Faculty of Electrical Engineering and Informatics  
 Department of Electrical, Mechatronic and Industrial Engineering  
 Letná 9, 042 00 Košice, Slovakia  
 Viliam.Fedak@tuke.sk, Daniela.Perduková@tuke.sk

