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Enhanced E-training in the Field of Mechatronics: The Slovenian Case Study

Matija PIPAN[1], Borka JERMAN BLAZIC[2]
Jozef Stefan Institute, Jamova 39, Ljubljana, 1000, Slovenia
Tel: +386 1 4773863, Fax: +386 1 4773995, Email: matic@e5.ijs.si

Abstract: The main purpose of this paper is to introduce good practices into the areas of vocational training in the field of mechatronics supported with the state-of-the-art ICT, as well as with the established methodological and didactic approaches, all with the view of improving the quality and efficiency of education. The aim and the goals of the new innovative way of training in the field of mechatronics are directly focused on resolving the issue of the current market imbalances of supply and demand of qualified mechatronics staff. This should result in greater recognition and appeal of the profession, and will positively influence on the existing gap on the market.

1. Introduction

The profession of a mechatronic is believed to be a profession of the future, as many EU studies [7,9] have indicated it, placing it among the top three most perspective professions. The mechatronic area offers modern job opportunities, combining three main fields of interest: mechanical engineering, electrical engineering, and information technologies; this is why the mechatronics is considered an interdisciplinary technical field. These professions have just recently been born in the industrially developed states, due to an ever-greater automation of the production processes. Mechatronics is a new way of thinking, a new way of planning products and systems that enable the integration of precision mechanics, electronics, automatic management, and informatics into the basic processes of planning, instead of searching for engineering solutions for every task individually. Mechatronics is therefore an interdisciplinary technical field, founded on the grounds of classical technical science of mechanical engineering, electrical engineering, and computer science. Instead of electromechanically (with bits of electronics) based systems, more and more complex mechatronic systems are entering the market.

In Slovenia and other EU Member States formal training programs in mechatronics are already offered at the level of secondary school, as a programme of higher education and at university level [8]. However, market demand is much greater than supply. For the time being, the market is short of adequately trained staff; for that reason jobs that would call for experts in mechatronics are done, as a rule, by experts in mechanical or electrical engineering, who, due to their narrow orientations and focus on just one area, do not provide the possibility of a comprehensive insight into the installations and processes that require knowledge of mechatronics. Company research has shown that there is a great interest on the side of economy in additional vocational training for the staff, who have already completed their formal studies in mechanical or electrical engineering, to train them for work in the production processes, where mechanical machine installations are controlled by electronic control systems. In this way, the companies could at least partially diminish the currently existing gap on the market, which lacks qualified staff. Companies also voiced a demand for vocational training to be efficient substance-, time-, and cost-wise, and

implemented at an independent location, with the purpose of minimizing the effects on the company operations.

2. Objectives

The main purpose of this paper is to introduce good practices into the areas of vocational training in mechatronics supported with the state-of-the-art ICT, as well as with the established methodological and didactic approaches, all with the view of improving the quality and efficiency of education. The purpose and the goals of the project MeRLab (Innovative Remote Laboratory in the E-training of Mechatronics), founded by Leonardo da Vinci Lifelong Learning Programme 2007-2013, are directly focused on resolving the issue of the current market imbalances of supply and demand of qualified staff, trained in the field of mechatronics.

3. Methodology

If we wish to present mechatronic studies in an attractive and innovative way, if we want to facilitate training access to a wide spectrum of potential users, and be at the same time and cost-effective, then implementing e-training is an optimal solution. Therefore the focus of the project is in the preparation of the innovative e-course. E-learning alone, as a teaching method, is not news to the world today, the only thing that can be innovative is the e-learning contents. Besides the preparation of the interactive-multimedia e-materials for the chosen study modules [5], produced in the accordance with the SCORM (Shareable Content Object Reference Model) standard [1] which guarantees their interoperability and enable them to be further used in all e-learning management systems which support this standard, and implementation of a remote laboratory for practical work is another innovative dimension of our project (Figure 1).

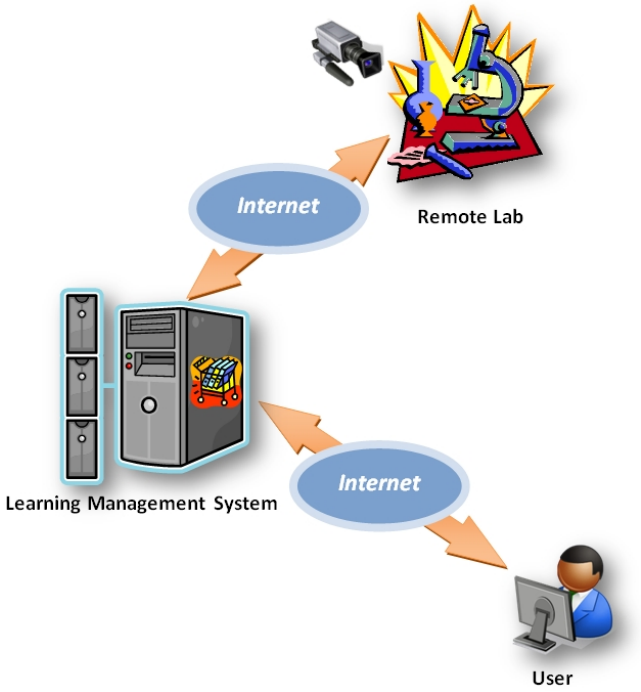

Figure 1: Architecture description

Companies demand more and more practical knowledge and skills from their employees, merely theoretical knowledge is no longer enough. Practical skills can only be developed by working in laboratories. Preparing a practical training course in a classical laboratory is normally very expensive and limited in space, time and number of participants. For this reason, within the E-Learning Distance Interactive Practical Education

(EDIPE) project a product called Remote Laboratory for Practical Lessons was developed, which resolves the above-mentioned problems and limitations [4]. A remote laboratory does not present web-based simulations. It truly makes it possible for students to perform actual experiments in the area of mechanical and electrical engineering, as well as programming, which take place in a physical laboratory. A user accesses the laboratory from a dislocated place using web tools (internet and browser), where (s)he can start to perform an experiment. The remote laboratory enables the user to have a full control over the implementation, measuring and monitoring of the experiment. The greatest advantage of the remote laboratory is that the users can perform their tasks anytime, anywhere, and can do so safely, without a laboratory assistant. The remote laboratory experiments are not only analysis-oriented (measurements and result observation); they can be synthesis-oriented, including also the planning aspect.

4. Case Study

To achieve the objectives of the above described methodology. we needed to accomplish four main concrete goals:

- Needs analysis: determining the actual company needs for mechatronic staff, based on company research, and determining its skill requirements for the employees. According to the needs analysis performed the mechatronic skills are much in demand, and we have noted a strong support from Slovenian employers to develop these types of professions. People with combined work tasks and knowledge in the field of electronics, mechanical engineering, and informatics are needed in automatic production and other processes (eg. for modern purification plants) at three levels of difficulty: as operators, processing installation administrators, and processing technology experts. The first ones – mechatronic operators – manage processing installations, supervise their operation, carry out simple maintenance works and serve them. Processing installation administrators – mechatronics administer the operations of the processing systems, diagnose mistakes, repair processing lines, maintain installations, maintain and archive software and documentation for the maintenance of the processing system. A mechatronic of processing technologies predominantly deals with the line and machine assembly, with production optimisation and adjustments of the processing lines and installations to suit the needs of an individual company. Our e-course is adjusted to serve as an additional vocational training course for the needs of the first two described professional profiles.
- Establishment of an innovative remote laboratory for the practical work in the framework of vocational mechatronics training: adaption of laboratory devices that shall be used by mechatronics e-course participants, translation and transfer of innovative remote laboratory into the Slovenian environment, usability evaluation and adjustment of the user interface for needs of a precisely defined target-user group [2, 3, 6].
- Adaptation of the Learning Management System (LMS): The very nature of technology enhanced learning, implementation dictates the use of modern information technology. For this purpose we shall put to use an already tested, reliable and stable learning environment eCampus®. This LMS system is based on a robust architecture, which facilitates adjustability to specific needs, such as multilayer connectivity with the remote laboratory (at the presentational level, at the data exchange level and user interaction between the two systems, as well as memorisation of past activities according to the identity of an individual user). Given the fact that communication is also an indispensable part of technology enhanced learning, it is supported with multiple options (forum, private message exchange, internal or external mailing list system communication, chat room, blogs, etc.), which offer both the learners and the mentors a wide spectrum of possibilities for communication. The portal will be publicly accessible through a special URL web address. For the purposes of

dissemination we will use the login portal site as an informative web page offering number of articles, news and best practices related to mechatronics.

- Production of multimedia-interactive e-learning contents: based on the company needs analysis we chose relevant mechatronic topics and organised them in modules; using the modern ICT and methods we rearranged them to modern interactive-multimedia e-materials, produced in accordance with the SCORM standard [1].
- Pilot training: with the e-topics prepared and the remote laboratory for practical work implemented, we prepared a 40-hour e-course, which will be entirely conducted via the Internet. We will organise a pilot training of at least 30 course participants, chosen from the main target group who are workers who have already completed formal education in the field of machine or electrical engineering, and are currently employed by SMEs or large enterprises, more precisely working within the production processes, which include mechanical machine devices for electronic control systems. Due to an increased complexity of devices, which require mechatronic know-how, their knowledge in either mechanical or electrical engineering only often proves to be insufficient; resulting as a substantial need for further training of such staff. The pilot training will be performed for the purposes of validation and evaluation of the e-course. Their competences shall be tested at the end of the e-course. The examination will include both theoretical questions and practical tasks. Every course participant who will pass the final exam will receive a training certificate.

5. Expected Business and Education Benefits

In Slovenia, we currently do not have a model and even less an enviable level of cooperation between economy and the systems of education or their institutions, due to some known specific circumstances. Thus, this project should serve as a linking element and an example of how such connections can be improved and cooperation between the two parties enhanced. It shall ensure the establishment of connections between economy and education at the national level and further on EU level, since its main purpose is to meet the demands of economy. The economy, which for the time being is well undernourished with the above mentioned profile of labour force, shall at least partial mitigate the needs. The individuals will acquire an additional professional qualification and upgrade their skills, thus improving their employability potential on the labour market, which fits the spirit of lifelong learning. Through activities such as presentations, dissemination, etc. the project will have a direct impact on the public awareness regarding the new field of mechatronics, regarding the companies' needs of workers with such a profile and regarding the ways and possibilities for education and training in the field of mechatronics. In this way, young people will be encouraged to undergo formal processes of education in this area of expertise, and adults will be encouraged to either participate in the training process as provided by this project or through the system of National Vocational Qualification (NVQ) or in some other way. Potential mechatronic e-course participants, besides the main target group, are also the employed or the unemployed, who have completed their formal education in other fields (eg. textile sciences, chemistry, pharmacy, etc.), but have some experience in managing electronically controlled mechanic machine installation systems. This training will provide such staff with the necessary theoretical and practical knowledge (requalification), which is a necessity for the management of mechatronic installations. Requalification of people with very low and low employment prospects will improve their competitive position on the labour market, and will consequently have an additional impact on diminishing the gap between supply of and demand for qualified mechatronic staff, indicating a high potential for the future use of the results to be achieved by this project.

More direct impact of the project result are mostly for the course participants, because the training will provide them with the necessary new knowledge and skills, which will

make them more competent at work and will provide them with better career development opportunities.

Furthermore the project results – e-course – will also be used by the companies, since on the basis of adequately qualified staff they can increase their production efficiency and diminish the number of mistakes, which consequently leads to a higher cost-efficiency and higher profits. The project results may also be used by the institutions of education, who are implementing various professional and vocational training programmes. They will have a possibility of integrating the e-mechatronic course prepared in the framework of this project into their study programmes.

Table 1. Expected Impacts of the project results

	Short term impact	**Long term impact**
Target group(s)	*Predominantly already educated and trained staff with secondary vocational, specialized or post-secondary education in the field of technical and natural sciences will undergo further training or retraining for the current field of interest – where there is a great demand.*	*Diminishing unemployment levels of those, who might have no employment prospects for the time being. Expand employment possibilities for persons with mechatronical skills.*
Target sector(s)	*Most of all, the employees (or those who intend to become such) in companies with technological processes shall contribute to improved company results and efficiency.*	*Diminishing the gap and lack of staff trained in the field of mechatronics.*
Potential user(s)	*Production and service companies shall increase their efficiency, while it shall facilitate employees' work and increase job satisfaction.*	*It will be easier for the companies to carry out and support undisturbed technological or production process.*
Vocational education training systems & practices	*National Institution forVocational Education and Training, which carry out programmes in the field of mechatronics, they will access new, innovative and, most of all, efficient mechatronics teaching and learning tools.*	*Schools will be able to implement the mechatronics programmes in a more attractive and innovative manner, offering better, more sustainable and, most of all, more innovative know-how to students and future employees.*

6. Conclusions

Given the fact that according to the European Commission's Joint Report on Social Protection and Social Inclusion the number of elderly employees will rise from 41% in 2005 to the foreseen 50% in 2010, and given the fact that mechatronics, or computer technology connecting, foddering and mechanical elements are the third fastest growing sector in Europe [5,7], we have to make sure that the method used in educational process (formal and informal) is effective and reconciliated with the market demands. One step to meet these requirements is also our innovative and efficient teaching method, which is fully technology enhanced learning based, and mechatronic training puts significant emphasis on practical work, the decision to transpose and implement the remote laboratory innovation into this e-course is absolutely necessary. This method offers the possibility for additional vocational training (further training or retraining) of employees and unemployed, who had already completed their formal studies, and whose knowledge has become insufficient due to great technological changes. Since our teaching method provides for time and space independency, it minimizes the company work process disturbances and fulfils the requirements of the companies, as expressed in the research previously carried out.

The added value of the MeRLab project, if compared to the EDIPE project, is that the remote laboratory, which was the end-product of that project, will be upgraded with some additional interactive-multimedia e-contents, connecting them with an established methodological and didactical approach into a modern, attractive and innovative course of mechatronics for a specific user target group. This should result in greater recognition and

appeal of the profession and will positively influence the gap between supply and demand of mechatronic staff on the Slovenian as well as on the whole EU market.

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