New Approach to Automation and Robotics Vocational Education in Support of Europe Reindustrialization

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Abstract. The post-industrial Europe cannot effectively fight the economic crisis. The Europa 2020 strategy goal is the advancement of the European Union economy which would be impossible without re-industrialisation. To reverse the declining role of industry, the re-industrialisation will notably be based on SMEs in which the production processes are not automated enough. In result the existing, as well as new companies will invest significant efforts in Automation and Robitisation (A&R) to minimise costs by eliminating manual work. The article presents the approach for preparation of the new generation vocational courses tailored especially to meet the needs and expectations of small and medium enterprises connected with introduction of new technologies, especially connected with Automation and Robotisation.

Keywords: automation, robotisation, e-learning, vocational training, reindustrialisation, SME.

1 Introduction

Reindustrialization of the European economy is a must. More and more people come to this conclusion, more and more new voices announces that there is no other way. The service based economy was a great mistake. There is no other way of strengthening the economy than creating goods the real one not virtual.

The Europe still suffers from economic crisis and if there will be no immediate actions performed to change the situation the crisis can last for a long time. One of the main reasons for that is based on a fact that the current, post-industrial, based on services, model of European economy does not have strong enough basement to fight the crisis efficiently. To overcome that one of the Europe 2020 strategy key priorities envisages advancement of the European economy. This was perceived by European Commission which in October 2012 announced communication to, among others, European Parliament 'A Stronger European Industry for Growth and Economic Recovery'. With the renewed industrial strategy outlined in this Communication, the Commission seeks to reverse the declining role of industry in Europe from its current level of around 16% of GDP to as much as 20% by 2020.

To achieve that goals the Europe must enter the path of sustainable development characterized by social inclusion and innovation which has to be supported by a

R. Szewczyk et al. (eds.), *Progress in Automation, Robotics and Measuring Techniques*,
Advances in Intelligent Systems and Computing 350, DOI: 10.1007/978-3-319-15796-2_26

reindustrialization of Europe economies. This approach was remarked by the Report on EU competiveness [1].

The reindustrialization will notably be based on manufacturing companies, especially SMEs and the main rationale for strengthening the manufacturing sector in Europe is rooted in evidence that the sector is the locus of significant innovation, which in turn also provide opportunities for growth in the service sector as well (in particular business services) [2]. The manufacturing sector can be still treated as the engine for modern economies because development in manufacturing has a multiplier effect on the growth of the economy [3]: a general increase in productivity of the manufacturing sector makes a contribution to the growth of GDP that is four times higher than that of other inputs.

The reindustrialization process requires new skills (in quantitative and qualitative terms) to support changes in technology and organizational models (within the companies and in their networks) [2] especially in SMEs where in comparison to large industrial enterprises, the production processes are not automated enough. These new skills can be nurtured in workplaces or their development can be incorporated in the educational pathway (beginning from the secondary level). New skills are also needed by the labour force already employed or seeking employment, and both the companies and training organizations, until now devoted to the adult training, can be better integrated with the general education system.

All of this means that, in near future, the market demand for high qualified specialists for different industry branches will explode.

Unfortunately, European education and training systems still do not provide proper skills for people employability. Moreover, there is no cooperation with business or employers to make the learning experience closer to the reality of working environment [4]. The education system changes are necessary and foreseen. However, it will be rather long time process; evolution not a revolution. There is still a place for smaller independent of the system initiatives providing focused on skills vocational trainings. The advantage of such initiatives is that they require much shorter time to appear and less efforts to sustain and with utilization of modern ICT technologies their impact is over national [5]. Over one year ago a consortium of several institutions from different European countries seeing the necessity of increasing skills for employability in reindustrialized Europe launched such initiative to elaborate vocational training system for automation and robotisation education for small and medium enterprises [6].

SMEs (small and medium-sized enterprises) represent 99% of all businesses in Europe and account in average for more than 60% of the employment and turnover figures (Source: European Small Business Survey, 2012). However only 24% of SMEs provide vocational education and training compared to 80% of large enterprises (employing over 250 people). SMEs play a key role in generating employment and creating economic wealth, but skill deficiencies in SMEs are adversely affecting their ability to reach their growth potential. Today more than ever before, the skills, motivation and activation of employees are crucial preconditions for the sustainable success, productivity and innovation of enterprises. However, the situation of SMEs with regard to training is characterized by a paradox. On the one hand, continuous training

and lifelong learning (both for workers and managerial staff) are regarded as crucial elements of competitiveness against the backdrop of globalization. On the other hand however, statistics show that continuous training and qualifications are less likely to be available to employees working in SMEs than to those in large companies [7]. By their very nature, SMEs are small, constrained by time and budget and reluctant to engage in learning/training programs.

2 Building the Concept

The main initial assumption for new vocational education platform was that it will be based entirely on an e-learning solution. To assure as much as possible system functionalities and education content matching requirements of current skills demand the consortium adopted one of agile software development methodologies for the system development where close collaboration with stakeholders and potential end-users is one of the significant priority. The initial, general system concept required polishing and enrichment with details. At the beginning the end-users needs and requirements research was done.

Consortium partners have elaborated and distributed among project target groups a detailed questionnaire for requirements gathering and needs analysis regarding the way to plan and improve skills and professional knowledge for SMEs.

A total of 103 questionnaires were filled by the target groups: SMEs managers, employees, trainers and consultants involved in automation and manufacturing jobs. The answers were distributed among the partner countries as follows: 36 from Bulgaria, 25 from Italy and 42 from Poland. The answers collected at the end of survey analysis allowed achieving a good level of knowledge about SMEs needs in the automation and robotics training field.

The results of the survey illustrate how professional associations and consultants may contribute to the use of e-learning technologies for SMEs. It also shows that – besides significant cost savings – there are further advantages that make the use of e-learning technologies attractive. In fact online learning can provide several good opportunities to SMEs in overcoming part of their technological, environmental, organizational, and managerial inadequacies.

Savings of travel or hotel costs are an obvious advantage of e-learning compared to face-to-face seminars. There are, however, also a number of other benefits, which are less easy to express in numbers but that have been also frequently reported by the target groups' feedback:

- Time independence. Learning activities can be carried out in the evening or during the weekend. Thus, managers and employees are not inhibited in their daily work routine.
- Focus. In their daily work, managers and employees are used to focusing on the essentials. This working style is better supported by e-learning than by face-to-face seminars. Participants can concentrate on the specific Automation learning goals, in which they are interested.
- Learning at one's own pace. Participants of e-learning courses can take the time they need to assimilate learning material. By contrast, during seminars participants

are often reluctant to ask several times about the same problem, even if they have not yet understood it.
- Advanced learning culture in SMEs. The application of e-learning as part of the learning opportunities in a SME company leads to developing new learning culture. Compared to face-to-face seminars, e-learning allows for a prompt realization of the knowledge acquired. Consultants therefore interact more often and exchange information more frequently than was the case when attending face-to-face seminars.

The responders expressed their expectations for the future online course. They were based on their preferences and supported by a real assessment of the possibilities for course participation. First of all they expect flexible time and place for conduction for the course supported by well-structured materials on interesting and useful topics.

Simulations, good practices and exercises were also expected. Participants requested that the information presented will be practical and specific and not general. What respondents wanted as a result of the course was to improve their qualification and to widen their worldview. Maximum interactivity and availability of links to other sites was also recommended. There should be no excessive audio and visual effects, and still the information has to be detailed enough, if necessary there should be graphs (pictures) and video clips. Respondents also expect the course to be practically oriented, to present different case studies and to encourage the application of the learned in the production process, not to be only theoretical. The course has to be conducted with a real lecturer but in virtual environment, in real time in order to follow the results of the training, as well as online training with video materials.

From the analysis of the ARIALE questionnaires on end users requirements, several interesting conclusions can be drawn:

- The target group involvement in competence development and learning contents improvements can have a very positive effect on the individual SME's competitiveness and performance.
- Formal methods of teaching and learning are not necessarily the most appropriate way of engaging, motivating and transferring knowledge to SMEs workforce. So formal training is not the best way of learning for SMEs. Instead, non-formal and informal learning can constitute the most important way of acquiring and developing the skills and competencies required at work.
- Training activities have to be focused on the specific needs of the SMEs for example giving the possibilities to assemble the learning contents available in the platform. An active learning approach focuses on solving real problems and the employees' needs.
- The SMEs' heads frequently own a negative attitude to change and learning. In many cases, time devoted to learning activities is considered as lost time. When employees are involved in the learning process dealing with issues of relevance to their careers they become motivated learners. To get effective motivation the learner should be put in the centre of learning.
- SMEs are driven primarily by profit and they are focused especially on bottom line. The role of promotion is very essential. No matter how good the training and

support material, it has to be carefully promoted from the head and delivered to be effective. It must go to considerable lengths to highlight the commercial benefits of business improvement (non–commercial benefits can be promoted as secondary benefits once the main commercial message has been thought).

- Learning for many SMEs' heads has seen unfortunately as a cost, and they do not always consider it as an investment for the future. The curricula should have a measurable impact within the organisation and should be affordable and value for money.
- SMEs use a short-term approach; they only set up a training action plan on Automation or Robotics only when they face meet problems. Approaches to learning, training and development in small firms needs to take account of the shorter planning time frames they use by relating learning opportunities and benefits to these shorter periods.
- Some of the advantages of e-learning directly address the needs of SME's: flexibility, cost benefits, location is not a barrier, freedom to work at own pace, less disruption to work schedules.
- An informal environment should be built to aid networking. The network should provide a forum for exploring ideas with peers, and give support to individuals. Network learning broadens access and participation of SMEs in real-life learning environments. Network technology offers the opportunity to facilitate, strengthen and connect SMEs in order to build and enhance networks of business at the regional, national, or international level [8].

The user requirements survey results was also used to specify e-learning system shape and features. Answers was grouped in three categories: course delivery and organization, communication in the course, course content. It is very interesting that despite the survey was done in three such a different countries the answers were very similar In most questions only small, negligible differences were observed only for some questions differences were noticeable but still answers were very similar.

Most respondents prefer web forms or e-mails for course registration. Fax or telephone were not very popular answer. It can be concluded that such way of communication seems rather old fashioned and not very convenient nowadays. Trainees should have possibility to assess their knowledge level before attending to the course to check if the new knowledge is appropriate for them. Minor differences were observed between countries regarding way of knowledge assimilation assessment. However most respondents prefer test questions after each lessons. Very important for the questioned potential end-users was overall system functionality and user friendly interface of the e-learning system. It should be simple, easy to learn its logic and to navigate. Respondents opt for clear introduction to the course explaining benefits for learner, scope of the knowledge and logical structure of learning modules and lessons. Each lesson should also have short introductory description. Access to entire course should not be restricted in any way, learner should have possibility to stop learning any lesson at any time and start another module/lesson. At the end of the course a certificate of course completion should be issued, but only for students who achieved at least 80% of proper answers for test questions. The system should have the possibility to provide courses for organized groups of students with supervision of the teacher/instructor.

Such events should have an introductory presentation given by the teacher. All respondents were interested in obtaining course materials off-line e.g. On CD-ROM. Practical tasks, e-tasks or out-of-class work were also considered as highly useful and helpful in the learning process.

For the communication channel between learners and between learners and teachers the online discussion forum an e-mails where chosen. Only for Italy respondents prefer the videoconferencing. Very important were e-participation, e-collaboration and virtual classroom. The system should allow such functionality. The learning process should be supported by teacher/instructor. It was not considered as necessary to have such support on-line. Just e-mail contact is satisfactory. But an online discussion functionality should be assured by the system. Teachers should have possibility to monitor course participants progress.

Regarding the course content answers in each country were most consistent. Course content must be arranged in clear and logical order. Learning goals and objectives should be clearly presented at the beginning of each lesson. Course content should contain as much as possible practical knowledge. The questionnaire presented proposed course structure and thematic scope. It was considered by the respondents as highly usable and should be followed in further development.

3 Prototype Implementation

At the early stage of the initiative the hardware server was carefully selected. The basic condition for it was to ensure high level of data safety. The installed sever hardware contains 3 hard disks configured in RAID 5 array. Such configuration ensures very high data security with reasonable storage area management in comparison to other RAID arrays levels. In case of one disk failure the entire array work without interruption and all the data is continuously available. Only read/write performance of the array is decreased during the time of new disk replacement. Other sever hardware specifications were at secondary importance, however it was considered that the server should ensure comfortable work in moderate internet connection load.

The server was installed at PIAPs premises and connected to the Internet by the local PIAP-LAM network.

As the operating system Linux Debian distribution was chosen. The open source solutions allows to decrease overall sever costs. Debian is one of the most stable and secure Linux distributions available. The complete software configuration necessary to establish e-learning system comprises:

- operating system Debian Wheezy (last, most stable release)
- web server Apache 2
- data base MySQL
- script language interpreter PHP
- Moodle LCMS

All software components are continuously monitored and upgraded to the last, most stable and safe releases.

Then based on above mentioned identified target audience needs and requirements the first prototype instance of an e-learning system with chosen training materials was developed. A set of learning objects was implemented to newly established e-learning platform. The vast range of knowledge related to automation and robotics was divided and grouped in six major thematic modules:

- ICT based means for automation and innovation
- Sensors in industrial automation
- Actuators in industrial automation
- Application of PLC in industrial automation
- Industrial networks and interfaces in industrial automation systems
- Industrial robots in automation systems

The main goal of technical development was to establish initial version of the e-learning system containing lessons in English language and to prepare the system for testing by end-users.

Fig. 1. ARIALE system front page

The ARIALE system front page presents list of available courses for three target groups:

- SME managers,
- SME workers,
- Trainer and consultants.

The access to each course is restricted only for authorized users. Once the visitor chooses a course he is redirected to the login page.

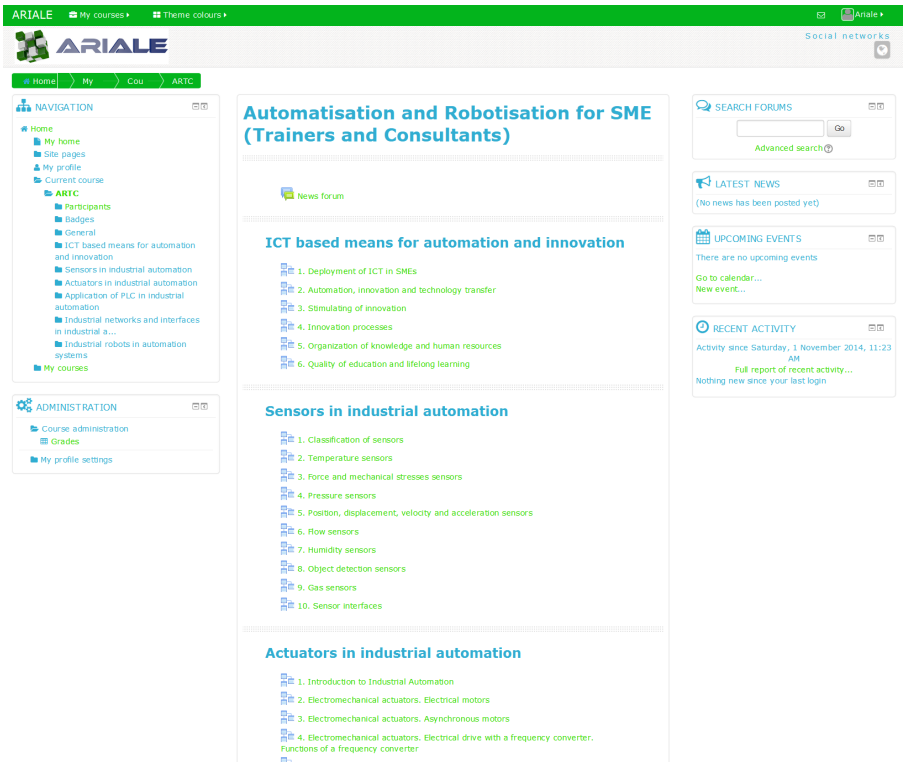

Fig. 2. Course structure

At the top of the page there is an area where news from discussion forum are presented. The user has access to the discussion forum where users can exchange opinions on the topics related to the course. On the left side of the page there is navigation menu allowing user to navigate through entire course content. This menu is also available in the lesson presentation pages.

The final version of the course will offer flexible array of activities including forums, glossaries, resources, chats and workshops. Students will be able to participate in those activities, contacting teachers or other students on- and off-line and this kind of a collaboration provides a way for experienced individuals to learn and share their knowledge. Some tools as discussion boards will also be capable of capturing knowledge and also will function as document repositories for storing files and searching for information and files.

Together with the e-learning system accompanying methodology is developed based on the previous approaches researched and successfully used by project partners in similar cases. Elaborated methodology comprises of detailed instructions

necessary to create and adapt course content, establish the ICT system and implement the content as well as to organise and execute the course.

4 Conclusions

The overall conclusion of the survey on SMEs was that it is possible to involve successfully them by using an engagement strategy that communicates needs and addressing their current automation problems. The combination of face-to-face and virtual action learning (blended learning) can work well, and help to encourage the SMEs to join online courses. The need for a clear structure of the curricula was underestimated and in the future, more attention should be given to informing potential participants on the structure, tasks and the expectations of their involvement.

There is also a need of tutors and/or facilitators to be in communication almost on a daily basis and use a flexible style to motivate the participants.

At present times vocational education of automation and robotics needs to be fast and efficient and shall maintain a balance between theory and practice tailored especially for chosen target audience. The solution which is being developed will be an answer to those requirements. The system shall now be tested by end-users for the compliance with requirements research done at the beginning.

Acknowledgements. Project "Automatization, Robotization for New Reindustrialized Europe (acronym ARIALE)" has been funded with support from the European Commission under the Lifelong Learning Programme. This publication reflects the views only of the authors, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

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