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Analysis of Internet-assisted engineering education in universities with diverse education systems

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ABSTRACT: The article presents an analysis of the difficulties faced and solutions realised at the Belorussian State University of Informatics and Radioelectronics, Minsk, Belarus, with regard to the development of Internet-assisted courses for microelectronics engineering distance education. A comparison is also made with other institutions with different education systems, particularly with some Canadian systems.

INTRODUCTION

The Internet plays an increasingly dominant role with regard to engineering and technology education at institutions of higher education across the world [1-5]. However, the difficulties faced and goals that are expected to be achieved vary widely among these institutions because of the diversity of the education systems and societies involved [6].

There is no *one* global Internet solution that would optimise the incorporation of the Internet in engineering and technology education. It is important for educators to reflect on the use of the Internet within their own institution, as well as globally, in order to optimise the benefits that are sought.

This article discusses the difficulties faced and progress achieved at the Belorussian State University of Informatics and Radioelectronics, Minsk, Belarus, in developing Internet-assisted courses for microelectronics engineering distance education. Comparisons with other institutions with different education systems are also outlined.

MOTIVATIONS

Microelectronics is at the core of all of the major industries of global interest. Semiconductor-based systems are of increasing importance in various areas and have diverse applications that include the automotive industry, satellite communications, multimedia and consumer products. Microelectronics technology enables and enhances the functionality, performance and reliability of products.

Electronics-related enterprises must continuously update their design procedures and technologies in order to maintain a competitive edge so as to survive in the global marketplace. Even in industry sectors that may appear remote from microelectronics, such as automotive, textile and food packaging industries, innovation is increasingly dependent upon the timely and effective use of proper microelectronics products at crucial steps of production lines.

The complex nature of microelectronics can be better understood when one takes into account the existence of numerous, diverse and extremely important microelectronics related fields, such as microchip modules, micro-systems and solar-cells. This is in addition to the newly emerging and powerful area of nano-electronics.

Based on this analysis, it can be seen that the most important industries that need to compete globally have to incorporate the use of microelectronics and take advantage of new initiatives in the field. Such industries need to be able to learn to do this quickly, although the cost of such an undertaking could be overwhelming.

The economic burden becomes even more demanding (and sometimes even prohibitive) for Small to Medium sized Enterprises (SMEs). The fabrication of microelectronics products requires not only competence at the specification and design levels, but also continuous and professional interaction with foundries. The skills of individuals play a crucial role in the microelectronics development and incorporation in these enterprises. However, the improvement of *knowledge and skills* requires a huge investment in human capital and learning technologies.

Education and training have been recognised as essential in the transition to a knowledge-base society. The European Union (EU) has launched several initiatives in order to create a *critical mass* of resources that will be able to support, guide and stimulate research and innovations in education and training. The EU values the standardisation of learning essential technologies in order to ensure that such a critical mass of learning systems, services and contents can be established in a cost-effective manner.

The project described and analysed here has been motivated by the fact that microelectronics is of strategic importance for modern industries, as recognised by the EU. A cost-effective strategy is needed in order to meet the increasing need for up-to-date, educated and trained individuals, despite the increasing complexity of the microelectronics field.

OBJECTIVES

Distance education and training has the potential of meeting those needs described above in a timely and cost-effective manner. New platforms for distance learning and applications for schools, corporations, universities and life-long learning are currently in development in numerous countries and utilise Internet technologies. Internet-based distance learning has already made a significant impact on the education and training of individuals, and hence the competitiveness of industry.

The project discussed here has two main objectives. Firstly, the project seeks to facilitate the diffusion of microelectronics products into enterprises of the industrial sector in a timely and cost-effective fashion, thus fulfilling the need to educate and train a wide range of industrial sector specialists in microelectronics. Secondly, the project aims to provide basic microelectronics education to high school students in order to foster an interest in the younger generation so that they are more likely to choose microelectronics as their major when entering university-level education.

Among the Newly Associated States (NAS) of the former Soviet Union, only Russia has investigated and introduced the use of the Internet for distance learning and training since 1995. In Belarus, and in particular at the Belorussian State University of Informatics and Radioelectronics (BSUIR) in Minsk, distance learning via the Internet is gaining increasing interest and is steadily progressing. However, the pilot projects are usually faced with financial and organisational difficulties, and this project is no exception. Nevertheless, progress has been achieved thus far because of the enthusiasm of the contributing individuals.

Other difficulties that the project addresses include:

- A loss of graduates with relevant microelectronics skills to other employment sectors where they are desired commodities.
- All microelectronics graduates are gaining employment in the European microelectronics industry rather than in local industry.
- University professors are all too often isolated from industry.
- Technical subjects are less popular at the secondary school level.
- Students do not like to study electronics and microelectronics (they prefer economics, management, law, medical and other humanities studies). The low level of interest in electronics and microelectronics studies among high school students stems from the situation that, in order to be a highly qualified specialist in microelectronics design, greater effort is required than in other technical specialities. This is because of the rapid growth in the complexity of up-to-date microelectronics devices. Some students are also concerned that they will not be able to cope with the study demands of such complex theoretical material, ie electronics, microelectronics, integrated technologies, etc.
- Current European demographics are unfavourable.

THE PROJECT

In order to satisfy the worldwide demand for the further development of microelectronics, the EU Information Society Technologies (IST) programme approved the project called REsearch and training Action for System ON chip design (REASON). Detailed information about REASON can be found on the Internet [7][8].

This project seeks to facilitate the integration of those academic and research institutions across Central and Eastern Europe that operate in the field of microelectronics into mainstream R&D activities being undertaken in EU countries. Twenty-two scientific organisations currently participate in this project, mostly from EU countries and the NAS (in particular from Russia, Belarus and the Ukraine). Educational and training materials in microelectronics and Web-based training materials are being developed with the aid of REASON.

PROJECT PROGRESS

Despite the difficulties encountered, the project has been progressing well. The following is a summary of achievements to-date that are related to the project:

- Methods and tools were identified for the development of Web-based tutorial materials for the learning of microelectronics including Java applets.
- The Distance Learning Faculty at the BSUIR was officially opened this year, which is also the first of its kind in Belarus.
- The development of training programmes for some base microelectronics processes, including implantation and poly-silicon technology, which are currently accessible via the Internet through devoted Web sites [9-11].
- The development of a Web-based training course for end-to-end process routines.
- An international conference on distance learning will be held at the Belorussian State University of Informatics and Radioelectronics, Minsk, Belarus, from 26-28 November 2002.

COMPARISONS

The project introduced here is a pilot project that is rather unique, compared to distance learning projects currently being carried out by Canadian universities, for example. It also has the unique feature of including several states and universities and by being focused on microelectronics. The fact that this project addresses both university and high school levels is another special feature.

The project shares some of the objectives of typical distance education projects in Canadian universities, for example, in that it addresses the cost-effectiveness of education. Although the project is meant to be of some use to industry, it does not have a distinct commercial orientation, as can be found in numerous projects within the Canadian context.

CONCLUDING REMARKS

The Web-assisted distance education initiative described here is progressing well, despite various difficulties outlined in the paper. Future undertakings will include securing greater international interest and cooperation for the benefit of all partners.

The conference set to be held at the Belorussian State University of Informatics and Radioelectronics in late November 2002 is a first step in that direction. It would be especially useful to share experiences with other educators in this regard. Devising techniques for outcome assessment in order to measure its effectiveness would be of particular importance. Inputs from industries that the project is meant to serve, and from the students it is meant to help, would also be solicited and analysed. Furthermore, the impact on high-school students needs to be followed over the coming years.

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