Current issues on Electric Power Engineering Education and Professional Training for Electric Power Engineers

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Abstract

The deregulation of electricity markets and the restructuring of the electrical power industry have resulted in a continuous change in technologies and methodologies used by power engineers nowadays. The changes are so rapid that Continuing Engineering Education (CEE) and Continuing Professional Development (CPD) for practicing power engineers is nowadays a recognized necessity. The Electric Power Industry is interested to increase productivity and performance of personnel, while Electric Power Systems are required to operate close to their limits. On the job education and appropriate certification is becoming necessary for professional advancement. Collaboration between different universities as well as industry has started for engineering education and training.

1. Introduction

The new competitive environment for Electric Power Systems has opened new challenges for the industry as a whole, and, at the same time, has brought some serious problems with it. Problems over the whole spectrum: Planning, Development, and Operation – I have previously used the term "*2003 – Blackout Odyssey*" to entitle the unprecedented series of blackouts during the year 2003. For example, one of the problems, identified in the context of recent important initiatives of the International Council for Electric Power Systems (CIGRE), is the shortage of qualified personnel, having appropriate skills and education, to meet the electricity industry's present needs. Indeed, in a series of five major international workshops organized by CIGRE in Paris (in 1998, 2000, 2002, 2004, and 2006), it was pointed out that the co-operation of the power industry with universities should urgently be strengthened, in order to deal with this serious shortage[1,2].

Today's Electric Power Industry (EPI) is characterized by rapid evolvement, especially with regard to[3]:

- worldwide liberalization of electricity markets, whereby the countries involved are going though this process with different speeds and approaches,
- fast and fundamental changes in technologies and methodologies used[4],
- substantial increases in interconnected areas with regard to their numbers and sizes, whereby the necessity to more and more introduce common standards and procedures,
- ageing of existing plants and installations, and

- the need for increased productivity, and operation of Power Systems close to their limits.

2. A glance at the current situation in Power Engineering Education

Power engineering is one of the oldest branches of electrical engineering. The current state of power engineering education is an area of on-going study[5]. Nowadays student-interest in newer fields, such as microelectronics, computers, information and communication technology (ICT), nanotechnology, etc has eroded interest in power engineering resulting in a widespread shortage of qualified power engineers. At the same time, the restructuring of EPI has decreased financial support for power engineering programs and research. Furthermore, the power faculty is ageing in many universities with the average age of professors going steadily upwards. Their number is decreasing as retirements outpace new hires. Hence, in the late '90s international organizations for Electric Power Systems (EPS), such as CIGRE (the international council for large electricity grids) have made an effort to alert people of this serious problem and to search for solutions.

To offset the current situation, universities have tried to augment power engineering curricula with hot topics[6], such as:

- microeconomic and finance elements
- environment and public policy aspects
- power electronics (FACTS), and ICT
- clean technologies, renewable energy systems and distributed power generation
- simulation laboratories
- cultural knowledge
- assets and human resources management
- electricity markets[7], etc.

Regarding the shortage of qualified people to join dwindling faculties, one approach is to create incentives to attract experts from industry to universities. One way to do it is for industry itself to act as a sponsor of a new university chair for an initial period (e.g. for the first 10 years after establishing the new chair) and after its successful initial tenure the university undertakes the related costs, thus expanding the faculty by this new chair.

As a result some progress here and there has been noted recently. For example, in NTNU university in Norway the Power Systems curriculum has had a substantial increase in student enrolment[8].

The situation in Greece differs from the western trends in that there is no student shortage, since Power System studies are included in the popular Electrical Engineering curricula.

3. Innovative Educational Technologies

The widespread use of computers and the internet has enabled educators to provide computer-assisted instruction[9,10] and deliver courses online. Recent advances in mobile and wireless communication technologies can enhance the delivery of power engineering educational programmes via what has been termed as Mobile Education Technology[11]. Web-based learning for regular courses as well as laboratory exercises have been offered featuring interactivity for the students[12,13]. Recently, e-training technologies are attracting a lot of interest, especially at the introductory level of training, while advanced

training requires additionally the personal contact between trainers and trainees.

An example of innovative educational tool available on the web for the studies in Electrical Power Systems was developed in the context of the program ARCHIMEDES II at EPSL[14]. The Electrical power system Lab (EPSL) of Technological Educational Institute of Crete (TEI of Crete) has developed a digital Database for the power system of Crete island. Students of the electrical engineering department as well as practicing engineers have the opportunity to be educated and trained on Crete's power system's operation and electrical data though the web pages of epsl-site. Students can observe system's data on the digital geographical maps of Crete island, as GIS (Geographical Information System) tools have been adopted in this direction. Distant users (students or any other authorized person) are able to choose which data will be displayed on their monitor (fig.1). Data have been organized by layers.

Besides, a load flow algorithm has been developed, in PHP language, for system simulation, using the Gauss Seidel method. This application is performing on the web: distant authorized users can complete the specific web-form for the necessary input data. The EPSL's server makes the calculation, using a MySQL DataBase, and presents the results on digital maps (google maps), see fig.2. The user does not need to have a simulation software installed in his computer.

Students of the electrical department can also execute lab exercises on power systems by using a personal computer. A specific electronic card connects a personal computer with the power system model (fig.3). This card can read several analog and digital measurements on the system's model. Also the card sends commands from the pc (user) to the model relays, in order to change the topology of the system network. So, the user can handle the system model through a pc, viewing its operational data (voltage, current, topology etc.) on the monitor. Furthermore, this job can be done also on the web, by a distant user. Security alerts have been taken into account.

4. Continuing Engineering Education for Power Engineers

We will now examine Continuing Engineering Education (CEE) in the following forms: Tutorials, Distance Education/Learning (on-line tele-education), Workshops, Seminars, Conferences, and International Fora.

Tutorials are regularly organized by CIGRE as Workshops combined with Symposia, and aim to achieve an intimate atmosphere and a very open state of information exchange with a purely technical approach. They address: (a) young engineers to give them a survey of a specific area, (b) all practicing engineers to keep their knowledge up-to-date. They use as instructors: (a) experts from industry and academia, (b) retired engineers of known expertise – a mix of international and local specialists. Another example the CESE: i.e.: the *Current Electro-technology Seminar* which is running well for about ten years, organized by the Electric Power Systems Lab (EPSL) of TEIC for students and professional engineers. A spin-off of CESE has been the international workshop on "Electrical, Computer and Power Engineering Education and Training" ELCOMPEET organized in 2004[15].

Notable international fora that include continuing education issues for power engineers are among others the Universities Power Engineering Conference[16] (UPEC), and the International Workshop on Deregulated Electricity Market issues in South-Eastern Europe (DEMSEE).

Recent reports point to successful University and Industry collaboration and Consortia for CEE in several countries such as Canada, New Zealand, Australia, United Kingdom, France, and the US. Other private organizations are also involved in Continuing Education and Continuing Professional Development (CPD) of Power Engineers. Some fields and subjects of particular interest for CEE of power engineers are: Operation of Power Systems, Operation of Power Exchanges, etc.

5. Education and Training in Industry

Continuing Engineering Education and in-house Training is practiced at many Power Companies. Many electricity companies have special Departments for on-the-job Education and Training. A crucial aspect of the various education and training programs is *Certification*.

In a recent publication[17] the in-house education and training is also a prerequisite for professional advancement within the company. In this report the successful combination of classroom instruction with interactive e-learning is introduced for the Continuing Engineering Education and Training, with many advantages for the practicing power engineers. It must be remarked that e-training technologies go best with experienced trainers.

The Operator Training Simulators (OTSs) are considered of fundamental importance for the personnel in Control Centres of Electric Power Systems. Nowadays the technical changes in Power Systems pose new challenges in the training of system Operators which can be met with appropriately upgraded OTSs[18].

6. Conclusions

On-going changes in Electric Power Industry make Continuing Engineering Education (CEE) and Training as well as Continuing Professional Development (CPD) programs for Power Engineers more important than ever. In this paper we have attempted to present the State-of-the-Art in CEE and CPD for Power Engineers and stress their vital importance. We made reference to the current situation in Power Engineering Education, to innovative Educational Technologies, and to Education and Training in Industry.

7. References

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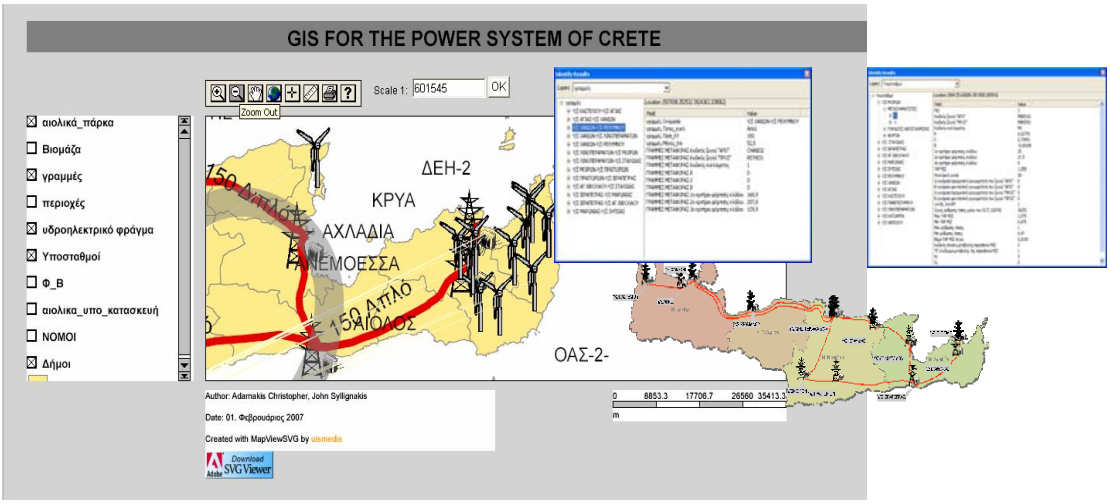

Figure 1 – GIS maps of the power system of Crete

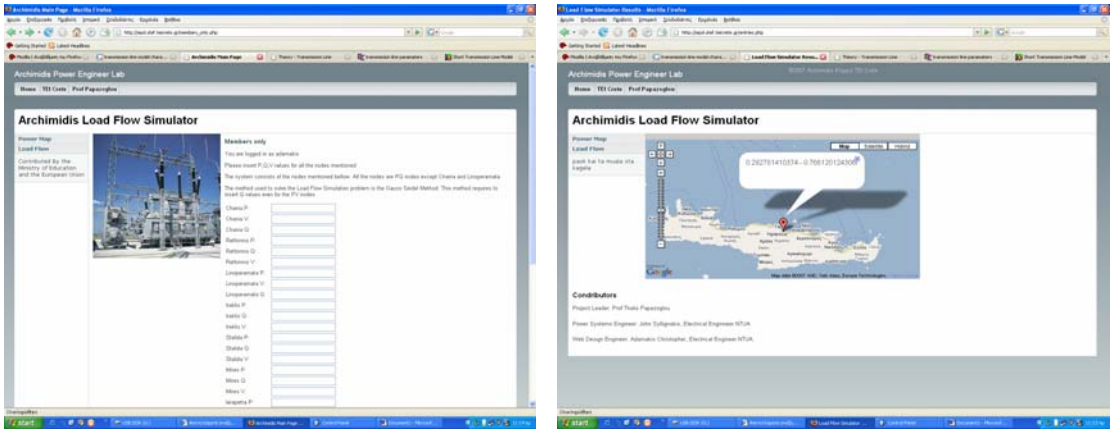

Figure2 – Web pages for the load flow simulation of the power system of Crete.

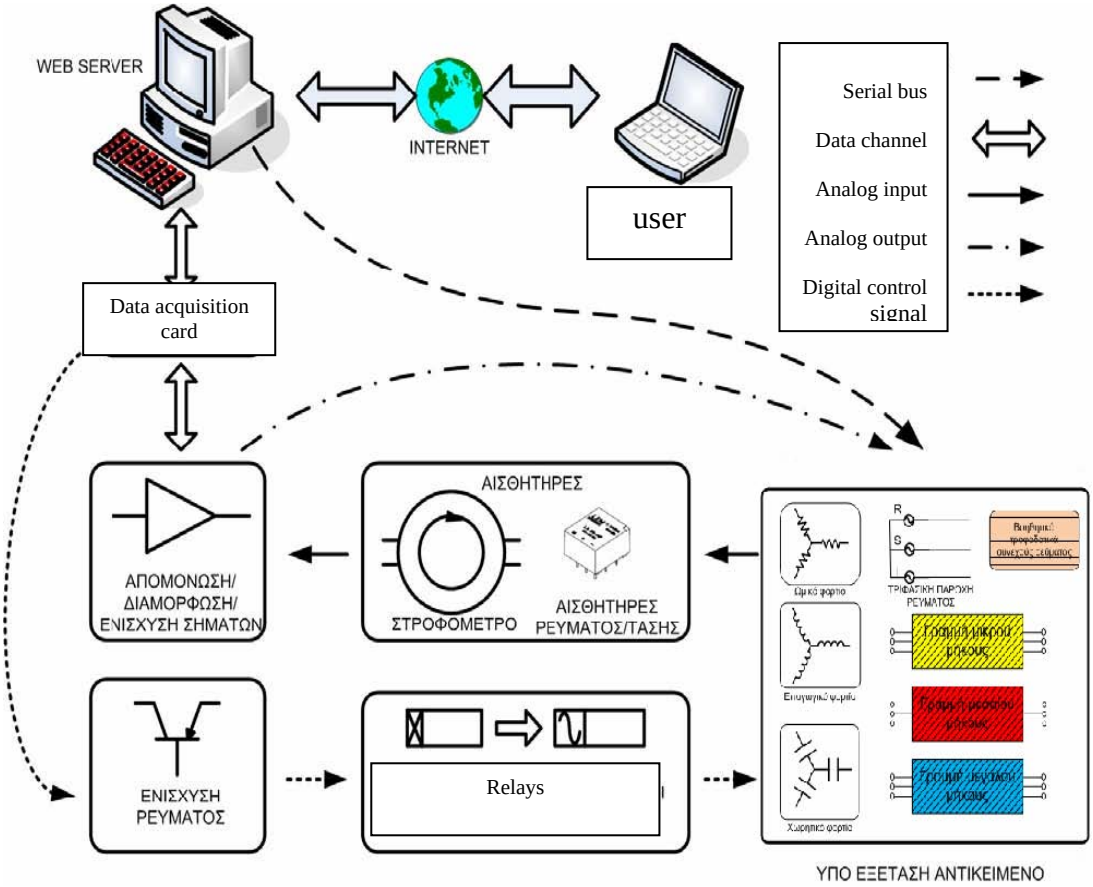

Figure 3 – Schematic diagram for the model of the power systems lab