The Use of Modern Computer-Based Training-Simulator Complexes in the Educational Process

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Use of simulators in the educational process is a real opportunity to obtain practical competences and skills in managing the equipment of power plants, while dramatically increasing the effectiveness of training, because there is a unique opportunity to create conditions close to the production and prepare future professionals to work on industrial equipment.
In addition, training on the simulator will allow future specialists to actively use in practice their acquired competencies such as problem analysis, critical analysis of the situation, judgment, decision-making, the ability to convince and prove, etc.
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Experiments for obtaining modelling data are very difficult, time-consuming and expensive; in today's situation they are economically unprofitable, as they are associated with under-discharge of electricity and heat energy to the consumer; their conduct on existing equipment is associated with a violation of the normal operation mode, and in some cases (for example, pre-emergency, emergency modes, modes of deep load changes, etc.) - with a high risk of damage to the equipment.

Analytical models allow you to determine the change of those parameters that are not measured on a real object.
Automatic Control Systems of Heat Processes Department (NRU "MPEI") in different years used full-scale computer simulators, based on analytical models, of the company LLC "Simulators of power plants" in the educational process.

There are simulators of the thermal power unit T-250 of various modifications, and combined cycle power unit PGU-450T and PGU-450 (originally in Russian).
In relation to the unit of the T-250 is the first time the joint efforts of MPEI, LLC "Simulators for power plants" and firm "Niiteploprorbor" has created a unique computer simulator, where a mathematical model of the object is integrated in the emulator controller of PTC (program technical complex), which allowed use of the capabilities of the application software of PTC in full, display the operation modes of all equipment of the power unit as close as possible to the actual.
This and other simulators, among many advantages, allows you to solve the following important problems:

- obtaining acceleration curve for technological parameters, adjustment of regulators, reception of transients of regulation contours;
- testing of the developed new automatic control and control systems;
- study of the possibilities and feasibility of participation units of the T-250 and the PGU-450 in the normalized primary and automatic secondary frequency regulation of electricity and power grids in today's market, development and optimization of algorithms for implementation of these modes;
- development and research of ways to expand the adjustment range, optimization of operating modes of the studied power units;
- study of the influence of outdoor air temperature on the energy performance and maneuverability characteristics of CCGT power units;
- calculation of technical and economic performance of equipment and power unit as a whole;
- analysis of the impact of changes in the initial and final parameters of steam and the efficiency of the equipment, etc.
The experience of our Department showed that this approach gives positive results. So, during the last 10 years:

• 6 graduate students have successfully completed graduate school and defended their dissertations on the results of research on the above simulators;

• 4 of them have passed the above chain of work on simulators.

• every year 10-12 students and postgraduates are engaged in simulators, with great help to teachers at the initial stage of training provided by graduate students.
EXPERIENCE OF USING OF COMPUTER-BASED TRAINING-SIMULATOR COMPLEXES IN THE EDUCATIONAL PROCESS

During training on the simulator, the following known methods are used:

- **the “twin” method** - the student/students are attached to an experienced teacher and, observing how he/she performs a specific job, he/they copies his/her actions;

- **training manual** - students investigate certain actions on the simulator by studying the operating instructions of the simulator, training manuals for working on the simulator, computer training complexes, etc.;

- **method of mentoring** - an experienced graduate student or an undergraduate (masters) conducts classes assigned to him by the students;

- **experienced training** - the student gets experience working on the simulator according to a specially developed self-study program based on the job description.
The experience of using simulators in the educational process revealed some shortcomings at the initial stage of training. The fact is that a computer simulator is a complex software product and its development requires certain initial skills, for the acquisition of which requires considerable time on the simulator. In addition, the presence of knowledge about the object of research is a prerequisite for performing research on the simulator.
For elimination these shortcomings in recent years, a new, more modern approach to training has been applied, which was based on a training complex consisting of:

- an automated system of training and knowledge verification (ASTKV);
- a computer simulator;
- methodological materials.

The ASTKV includes a textbook on theoretical problems, a special section on the problems of operation for all categories of specialists, including ACS TP.

ASTKV for PT-60-130 turbine in learning mode (originally in Russian)
The examiner of ASKTV allows you to conduct the exam in test mode in two modes - *by time* or *by the number of control questions*.

The selection of questions and the order of the proposed answers are formed *randomly* and are *not repeated*. During the time allotted for the exam, the examinee *can return* to any question and change the choice of answer.

After the end of the exam, a *report* is formed in full and abbreviated forms, on the basis of which the program evaluates the student depending on the points scored as a percentage of the maximum possible.

ASTKV in exam mode (originally in Russian)
Software of the company "Simulators for power plants" is built differently from most other. Their workplace is a port on the server: the entire interface of a particular workplace is drawn by the simulator on the client computer through the port, control actions from the user's client computer are transmitted to the simulator through the same port. Therefore, for the organization of 30 or more jobs complex simulators enough to have one powerful server (or several) and allocate the required number of different ports.

If a University, for example, MPEI, creates the required structure and organizes the specified training system, then nothing prevents it from "sharing" the created system with other Universities, thereby creating an effective system of truly collective use of a set of simulators.

Today, all the necessary software with the necessary technical characteristics for the start of the described project of collective use of simulators in the framework of both a separate University and the whole country are available.
Thank you for attention!

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