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SIMULATOR AS A TEACHING SYSTEM

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Abstrakt. *Different aspects of simulator as teaching system were analyzed in this article, including main simulator components, learning process parts inclusion into sessions, relationships between systems and elementary processes on the simulator, connections between modes of providing information, types of mistakes and simulator systems. As a result complex model of simulator that shows mutual connections of all elements mentioned above was proposed.*

Keywords: training, aviation simulators, simulators; education.

Introduction. Nowadays a person is the most complicated part of the mechanism, which provides any aircraft safe flight, and at the same time active and partially unforeseen element, which is the main reason of different errors, that may cause the undesirable consequences [1]. Despite the complexity of on-board equipment and continuously changing instructions, pilots and stewards, engineers and managers play an important role in the aircraft flight. Their personal qualities determine the result of some events. Even with significant quantity of addition equipment in many cases human`s skills are final at the moment of decision making in the air. Simulators as education tools have been used for a long time in various branches of human activity [2]. Since their origin, simulators have passed significant evolution [3] and are constantly being improved by modern technologies.

Simulators in aviation. Training of aviation specialists is provided by means of various equipment designed to perform some action. Simulators as the elements of the educational and training process play an important role in teaching of aviation specialists not only in the final stages, but also during startup and advanced training as well as knowledge, skills and ability testing [4]. Simulators have always been a necessary element in the training of any specialist who must deal with a complicated system. Modelling of complex processes using software emulation raised simulators to a new level. Aviation as a branch that uses the best achievements of scientific and technological progress and requires perfect technology and possible emergencies knowledge from aviation professionals as well as the ways to correct them during the flight, repair, improvement, immediately began to use new features. Significant amount of information about the possible emergency and dangerous situations in aviation were accumulated for statistical purposes. Simulators and simulator complexes make possible to reproduce such situations on the ground in safety, work out possible behavior scenarios and provide opportunities for training. The importance of using simulators or simulator complexes in the student preparation is so obvious that there is a special ICAO documentation for aircraft simulator quality evaluation [4]. It is noted there that the piloting simulators can be used during training and checking pilots more often than before. Advanced use of such teaching methods is caused by the increased complexity of modern aircraft, the cost and conditions of its operation. At the same time, simulators are able to provide even more advanced training than in real terms with respect to safety and correspondence to real life. Recreation of different influence on the aircraft today helps to implement such training and ensure that the pilot will be able to reproduce its actions during the real situation in flight. Fuel economy and absence of harmful effect are also important for the environment.

Development and implementation of simulators in aviation continues for decades [5]. Using computer technology makes it possible to emulate the complex behavior of the aircraft and its effects even for groups of users that form a complete crew. There are a number of documents according to which simulators standards have been defined [4]. They were adopted for use. Thus, according to ICAO documentation, simulators can be recognized as belonging to one of two levels (I and II). In documentation of other countries, these simulators are recognized according to levels

C and D for the U.S.A. and Europe, or levels 3 and 4 for Great Britain. These simulators allowed to be used by person without flight experience. In general aviation training is mandatory part of pilots and other aircraft experts training and their use is recommended by ICAO [6].

Simulator as automated training system. Automated training system is a hardware-software system designed to teach students and to check their knowledge without the instructor intervention. Although automated training system architecture could be different depending on the desired functionality, there are certain necessary elements. Depending on the basic functionality [7] automated training system should include user interface, DB and educational information providing subsystem. Main automated training system function consists of providing the user information from the DB via the interface by the rules and algorithms, which are defined at the design stage by the instructor and fed to the subsystem to provide educational information. The actual role of the instructor in such a system is proper planning. Although instructor interference within the work can be provided, it is not necessary with properly organized system operation. Additional system properties, such as the availability of certain educational information or different knowledge control subsystems access rights that depends on user status or availability of certain special modes of the system are determined when system management rules and their implementation in the subsystem of control over the training process are developed.

The simulator – is, in fact, a developed automated training system. The main thing that distinguishes it – is the process simulation and the ability of the student to manage the simulation. Certain elements of the developed automated training system may remain in the simulator as a support (such as management system (MS), knowledge testing system (KTS) and electronic textbook (ET)).

These components could be optional despite the fact that direct knowledge control is absent, and it is replaced by the indirect verification of student’s behavior and actions performance in the control exercises. In such conditions, student skills are tested in a situation close to reality, but, unfortunately, there are a number of knowledge and skills that the simulator does not check. For example, this is the knowledge of air law [8; 6]. The knowledge that can be checked by the simulator may be so deep that their checking will require a lot of time, while with the knowledge testing system it can be checked much faster. The role of such a theoretical test could be reduced to determining theoretical issues that results in student's biggest problems. So students must be well prepared to undergo such tests. Electronic textbook, in its turn, could play a secondary role and enable the student to review the theoretical information while working on the simulator.

The simulator is designed to teach students to behave properly in predefined conditions. It helps the student get the knowledge to control their learning and use the simulated environment to practice the theoretical skills, although the simulator is not a full copy of the simulated object. To achieve new objectives achievement the simulator must contain separate structural elements to provide theoretical information, knowledge control, simulated environment, simulator operation control and to store information in its various forms. To summerise, the structure of the simulator, which includes all necessary components, is shown in fig. 1.

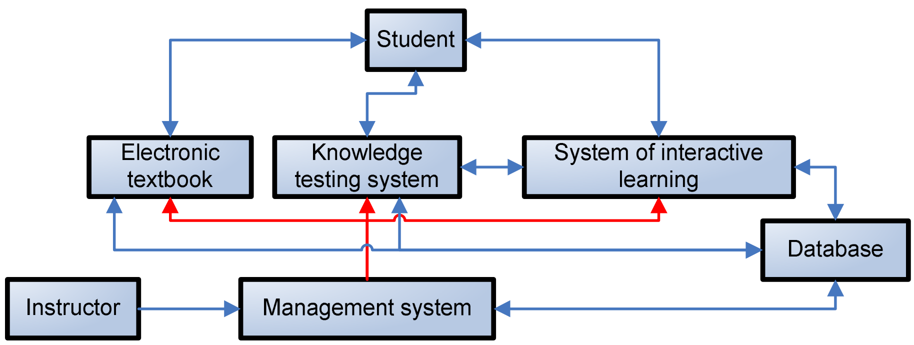

Fig. 1. Block diagram of the simulator

Management system manages the ET, KTS, and system of interactive learning (SIL) operation. Each of these four simulator systems performs its functions interacting with the student. Information obtained from the interaction of the student and any system is stored in the database (DB). From the DB theoretical information from the DB is required for learning and received by every system. The instructor is not required for the simulator, but he can control the learning process if necessary.

The student himself is constantly working with the MS and can operate in parallel with each of three other simulator systems. The operation of MS is not interrupted, and the student can make the necessary control actions since MS interface is not replaced in the case of the other system interface. There is no direct access to the DB for the student, each simulator system executes data exchange with the DB independently.

Simulator Operation. Every time student begins to operate the simulator, it works in one of different sessions that differ from each other by their purpose, composition and other properties. Despite the fact that each session is different, each one contains at least one of the obligatory parts:

– training;
– simulating;
– testing.

The training part includes the student's work with ET and studying theoretical material. Its presence in the session is caused by the need to provide the student with theoretical information, theoretical grounding of simulated processes, required explanations and other necessary theoretical material that the student should master. Training is executed with ET. Because there is no need to simulate the whole process while mastering theory, demonstration of the simulated process could be performed via video or non-interactive 3-dimentional animations while studying the theoretical material.

Teaching simulation includes students work with simulators and practicing necessary skills. These simulators form a modeled system and allow the student to work by the schedule in modeled environments. The student is assumed to master the theoretical material and do not need its demonstration. Moreover, demonstrating theoretical information can distract the student's attention and negatively affect his performance.

Testing includes student work in emulated environment as well as in learning the testing system. This part consists of providing control tasks combined from control exercises, which must be performed to study a testing system, or providing situations in emulated environment which the student must solve. The student's results on simulators and information about performing exercises are noted in the DB.

These three session parts do not have to fully occupy the time of a single session. Instead, different parts can go in the different order to form different types of special purpose sessions. The main types of such sessions are:

– Training session. In this session, priority is given to the presence of educational units, but testing parts are also present. Training and testing parts produce pairs. After each of the training parts a system provides testing one of small size. It enables students to learn a certain amount of educational material and test their knowledge. The proportion of available parts can be, for example, 90 per cent of studying, 10 per cent of testing.

– Testing-training session. In this session, testing part is a priority but some training is also available. Training and testing parts produce pairs. The purpose of this session is to estimate the student's progress, and identify the topics and theoretical issues that are recommended to review. The proportion of available parts can be, for example, 30 per cent of training, 70 per cent of testing.

– Training-simulating session. This session provides training and simulating parts. The purpose is to allow the student to learn both theoretical material and work out the associated action. Training and simulating parts provide pairs. After each training part, where the student studies a theoretical material goes a simulating part in which he is able to apply acquired knowledge and skills on practice. The proportion of available parts can be arbitrary, depending on the complexity of educational material and activities that are up to train.

– Simulating session. In this session, priority is given to simulating parts. It is characterized with the fact the system instructs the student how to perform correctly in a simulated environment. After performing properly a demonstration system allows the student to work independently.

– Testing session. This session requires performing testing tasks. Its purpose is to help the student to learn the properties of KTS as well as the properties of every particular topic before the final topic assessment.

– Testing-simulating session. It contains testing and simulating parts. This session is designed to prepare the student to perform tests in conditions close to the final assessment. The proportion of available parts is arbitrary and depends on many factors, including the already studied theoretical topics, scenarios that took place, the results of previous knowledge testing, etc.

– Testing-assessment session. As the previous one it consists of testing and simulating parts. Its purpose is to assess the student's progress, and student receives a rating as a results of this session.

– Session of independent work. In this session the student himself can choose parts, their order and amount of time needed. However, at the request of the student the system may make him some suggestions for work during the session.

Of course, there may be sessions of more complicated structure, but for convenience we confine ourselves to these eight.

Student's work in three parts of the learning process (teaching, testing and simulating) is spread between sessions. There are three types of sessions used in students' work with one part (teaching, testing and simulating). Other four types of sessions assume mixed proportion of parts of the learning process and only the session of individual work allows using three parts of the learning process. Fig. 2 shows schematic inclusion of parts of the learning process into sessions.

The session of individual work is not included into the scheme because it is a single session, where student chooses a workflow. Testing-assessment session is similar to the testing-simulating session thus it also does not need to be mentioned.

Working with the simulator the student participates in two elementary processes: the process of educational information testing. The process of educational information testing is performed not only with the help of ET because its means can't reproduce simulated environment qualitatively and adequately. For such reproduction SIL is used which provides possibility to work out required skills in the conditions close to the real world. Testing of progress and skills does not require only KTS because in can't reproduce simulated environment of required quality. SIL has possibility to test the student's skills but the information is formally sent from SIL to KTS. Relationships between simulator systems, the knowledge provided and testing is shown in fig. 3.

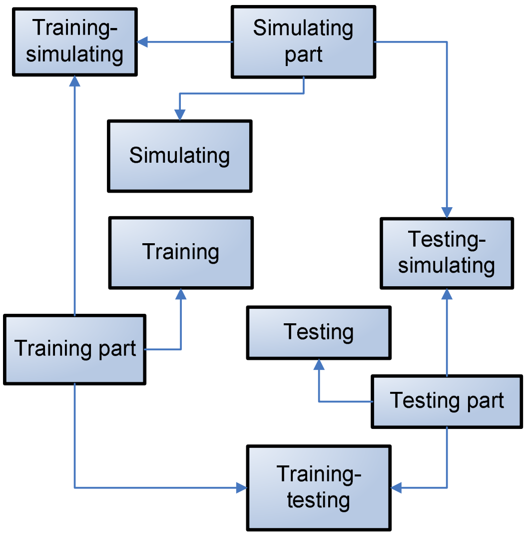

Fig. 2. Inclusion of learning process parts into sessions

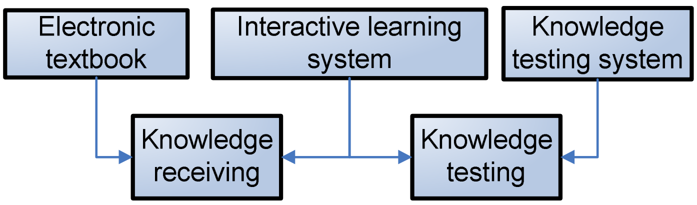

Fig. 3. Relationships between systems and elementary processes on the simulator

Electronic textbook, KTS and SIL are the systems most often used the students. Other components of the simulator are not used directly by the student as in case of DB or time of its actual use by the student is limited, according to functionality as in the case of MS. Students' work in ET consists of obtaining information. If knowledge control elements or imitation of a modeled environment are integrated in ET, their role is only supportive. Their functionality can't be compared with specialized KTS and SIL systems. Students' work in KTS consists of only progress tests of different level. Both systems do their own main function. Unlike these systems SIL is used in two cases: when it is necessary to provide information and testing. The student is provided with information in SIL by demonstration of work in emulated environment for him to acquire practical skills. Testing progress in SIL is done with the help of KTS, where student's performance is sent, but KTS only compares parameters of student's work with standard parameters, which are places in the DB.

Knowledge received from ET can be divided into two categories. The 1st category includes only theoretical information that must be learned by the student to understand the processes in imitation environment. This information is not used directly in SIL (for example, physics laws are necessary to understand the aircraft angle of attack). The 2nd category contains practical information that corresponds to the imitation environment and describes correct sequence of actions in different situations, explains data of indexation elements, etc.

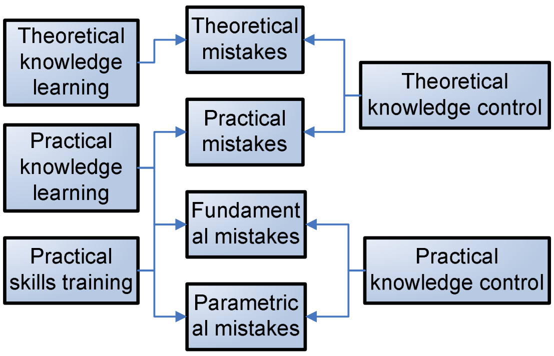

Fig. 4. Modes of providing information, types of mistakes and simulator systems

In the SIL the student obtains only practical knowledge and skills based on the received theoretical information from ET. Mistakes made by the student in KTS are divided into theoretical and practical ones. They are also divided into parametric and fundamental. Relation-ships between information providing modes, types of mistakes and simulator systems that are used in operation are shown in fig. 4.

A combined simulator model that connects parts of operation process, sessions, types of knowledge test processes, types of errors, types of knowledge received and simulator systems are shown in fig. 5. This model is of descriptive nature, it helps to design a functional simulator of proposed configurations, taking into account all possible mutual relations between its components.

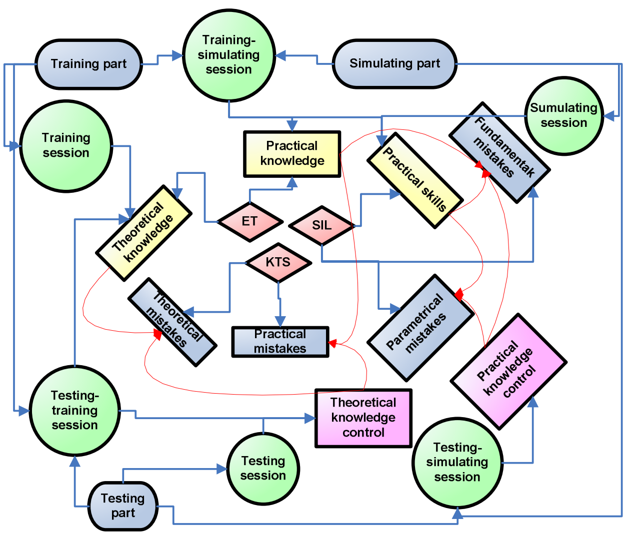

Fig. 5. Relationships between parts of operation process, sessions, types of processes to test progress, types of mistakes, types of processes to provide information and systems simulator

Conclusion. Proposed model allows to analyze every simulator structure with it's further improvement recomerndations. Since elements included into model are of different nature, examinet simulator may be improved not only in a single way, but in complex as one. This is the topic for future researches but one already can say, that received model is usefull although it is generally descriptional one.

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Тренажер як навчальна система

Розглянуто різні аспекти тренажеру як системи навчання, включаючи основні компоненти тренажера, входження навчальних частин у сеанси роботи, взаємозв'язки між підсистемами та елементарними процесами на тренажері, зв'язки між режимами надання інформації, типами помилок та підсистемами тренажеру. В результаті було запропоновано складну модель тренажера, яка показує взаємні зв'язки усіх вищезазначених елементів.

С. П. Борсук

Тренажер как обучающая система

Рассмотрены различные аспекты тренажёра, как системы обучения, включая основные компоненты тренажёра, вхождение учебных частей в сеансы работы, взаимосвязи между подсистемами и элементарными процессами на тренажёре, связи сежду режимами работы, типами ошибок и подсистемами тренажёра. В результате была предложена комплексная модель тренажёра, которая показывает взаимную связь всех вышеуказанных элементов.