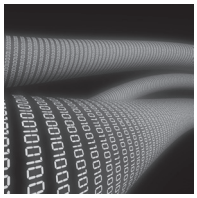

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Simulating techniques in aviation training

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ABSTRACT

Flight simulators are the media without which it is difficult to imagine flying personnel, technical service personnel and air traffic service personnel training. The present study concentrates on simulators and simulating techniques used in Air Traffic Service Training Centre WSOSP (Air Force Academy) in Dęblin

There are two centres equiped with ATC simulators i.e. Aviation Training Centre PAŻP and Air Traffic Service Training Centre WSOSP (Air Force Academy) in Dęblin. It can be said that the simulator used in Air Force Academy is a unique piece of equipment worldwide because several functions are combined in it. It is a simulating complex enabling to carry out air traffic controller training and forward air controller – "battle field operators" training

KEYWORDS: simulation, training centre

1. Introduction

The statement that safety in aviation is determined by flying personnel qualifications or qualifications of the personnel taking part in preparation and service of aircraft is a truism. Today we know that there is a direct dependence of flying operations on the quality of air traffic service functioning, and mainly on air traffic control service. The quality and range of service provided by ATC bodies depends on personnel's qualifications and the qualifications are a resultant of the factors among which training plays a crucial role.

Knowledge and skills which we expect from aviation personnel is of unique character, they rarely occur on the job market, therefore aviation organisations prepare and carry out training on their own, using their personnel and tangible assets. Such policy requires maintenance of adequately equipped training centres with teaching and instructing staff.

Operational posts in ATC require vast knowledge and experience supported by proficiency in its application. Practical skills are based on perfect knowledge of aviation regulations and procedures, aviation law, meteorology, navigation, performance and operational abilities of aircraft, airspace of responsibility. These skills are acquired through practical job training.

The job of air traffic controller is at the top of the list of the most stressful jobs. We can ask: why? It is connected with the ATC controller's responsibility for safety of people in the air and on the ground as well as responsibility for property of considerable value. Responsibility is the main factor of stress. Difficult work conditions (noise, electric lighting, microwave radiation) as well as continual pressure caused by concentration and divided attention are added to it.

To become an air traffic controller a candidate has to posses certain inborn personality traits, developed later through adequate training, aviation knowledge and job skills as well as abilities of coping with stress. Aviation knowledge is gained in lectures and from books. Skills are acquired through practical use of knowledge and systematic training. It is possible to train on the operational position, in real air operations, or in specialist aviation simulators.

The training on real air operations is time consuming and very expensive. The training of complicated and dangerous situations which can occur in air traffic cannot be carried out on real air operations. The truth is that the situations do not occur very often, but an air traffic controller does not know when such situation can occur and he or she must be prepared for „the worst". If a dangerous and not typical situation occurs, his or her actions must be confident, effective and in accordance with procedures in force, it can be said – perfect.

Unlike most jobs, working in ATC bodies requires qualifications, which must be supplemented by routine allowing to solve complicated situations in a short time. For these reasons it became necessary to use simulating techniques in aviation training.

Contemporary simulators are sets of machines and electronic processes which are able to carry out imposed programs. Nowadays huge sums of money are paid to build equipment which would closely imitate operational post of an air traffic controller, with the help of which it would be possible to solve certain situations in the time close to real time.

Increased meaning of radar in the fifties of the last century led to broadening of simulating techniques in the ATC personnel training. Radar simulators developed at that time were able to create six targets, but in some situations only four. Despite the fact that the equipment was not the best, it was used in the training centres for a long time. It is to emphasise that in the first phase of training simulators with a small number of objects are very useful. However, the requirements of today are different. Increase in air traffic forces to seek for new solutions in this area. Nowadays there is a demand for multi-position, multi--function simulators, working in the time close to real time. Moreover, they should be fully integrated.

The first of big air traffic control simulators was installed in American National Experimental Centre of Air Aids in Atlanta City. The simulator, brought into service in the sixties, was able to create sixty objects. The project of the simulator was based on conventional analogue circuits, the service consisted of sixty markers (pilots) plus a number of instructors in charge. A similar but smaller system was soon brought into service in the United Kingom. The conception of big simulators mentioned had a few basic flaws:

- they were expanded mechanically and electronically;
- it was expensive to operate them;
- they had little possibilities to create complex training scenarios;
- they required a large number of people to operate them.

Partial simplification of the system was possible by introducing electronics and applying transistor technology, which replaced a lot of mechanical processes. However, the changes of operational requirements because of the use of information from remote radars, secondary radar, processing of video signals and the necessity of converting the position with high accuracy decided, that the project reached its limits. As far as the operating of the simulators' by necessary staff is concerned, opinions are divided, because extending the functions led to excessive increase of staff. New solutions in simulators' design started to be sought for – based on computers working in the real time system and providing information which could be transmitted to radar indicators simultaneously printing flight progress bar.

Main differences between digital and analogue simulators laid in the fact that in the analogue system the movement of each object was calculated separately and in a continuous way, in the digital system all calculations were centralized. They are done sequentially in the central unit of the system, and the time of a sequence duration is measured in microseconds. Therefore the time needed to update the information on the radar indicator is very short. From the controller's standpoint the process of information updating was similar to a filmtape moving with the speed of 24 frames per second, which is treated by human eye as a single image. Moreover, accuracy and quality of information visualization is greater than in analogue systems.

A digital simulator gave a number of benefits, especially in system architecture, but the most important was the change of functioning philosophy. In analogue simulators "pseudo-pilot" could control one or two planes, while "pseudo-pilot" of a digital simulator can operate several planes. Its actions amount to responding to trained controller's voice commands and entering data visualized on the output (on the display) with the use of keyboard or another manipulator. Each plane performs a maneuver at the moment when the controller directs his or her voice to the pseudo-pilot. For this reason the pseudo-pilot does not have to remember any information. All reports, which have to be provided to the controller (e.g. request to achieve altitude, position) are presented to the pilot on the display by a computer. As would be expected, the first experimental real time digital simulator was also installed in American National Experimental Centre of Air Aids in Atlanta City. Similar simulators were also installed in the EUROCONTROL Experimental Centre in Bretigny, France and in ATC Experimental Centre in Hurn, United Kingdom. Orders for digital simulators for ATC training purposes date from that time. One of the first simulators, in use from the beginning of the nineties, was installed in the airport in Schiphol. The simulator in Schiphol reflected current trends in ATC controllers training, the more that displays identical to those on operating positions were used in it. Information in the form of visual map was brought to the simulator. In this way, after

completing the course, the participant was completely familiar with the operating device. The simulator in Schiphol needed only four pseudo-pilots who were able to operate fifty objects in any configuration.

Basic ATC controllers training on operating positions is inefficient, longlasting, expensive and it does not bring the expected results in a short time. For obvious reasons, carrying out basic training in "live traffic" is undesirable. Responsibility is simply too high for learning to correct own mistakes. The candidate air traffic controller has the right to make mistakes, because he or she is at the stage of mastering basic skills. Training in real conditions makes sense only when the trained candidate gained basic skills and acquired certain professional practice. On-the-job training is applied at a later stage, before allowing the candidate to work independently.

ATC simulators allowing to create imaginary airspace, in which the trained candidates can practise all control functions without a risk of causing delays or an aviation incident, are used in air traffic control training. Air traffic in such airspace is simulated according to a training scenario with a planned difficulty levelThe supervising instructor can stop the training course any time in order to indicate mistakes or potential danger, or to see which concept of further action the trained candidate has taken.

The advantage of simulator training is that the situation, solution of which is to meet a certain educational goal, is on request. Thanks to this, simulators are used during basic training as well as to conduct refresher courses. The aim of such courses is to refresh habits and to catch inappropriate practices. The matter of primary importance is possibility of practical training.

Another often passed over use of air traffic control simulators is preliminary assessment of proposed changes in the organisation of air traffic, e.g. new ATC procedures, new approach, intake, departure procedures, verification of route mileage; determining control sector capacity and airport capacity, dislocation and use of technical infrastructure. Specific kind of simulators, so called fast time simulator, are used in the research centres dealing with this problems. Control commands belong here to the elements of scenario, and integration during simulation is quite limited. Simply, the effects are observed.

2. Requirements for simulators and other media used in traffic controllers' training

EUROOCNTROL has formulated general requirements for the media used in ATC service training. For the time being, these are informal requirements. It results from the information available, that requirements for ATC simulators, as well as for aviation simulators, will be formulated in the next few years. Devices which will not meet basic requirements cannot be used in training.

Several media facilitating and supporting training are used in training activities. Media, in the material sense, are aids with the help of which the instructor or the person carrying out training provides instruction. These are simulators, part-task trainers, real equipment and other training device.

The EUROCONTROL document: Simulations Facilities for Air Traffic Control Training introduces a classification of equipment used for simulation and training carried out with their use. Defining the basic concepts of media range is very important for the training organisers as well as for simulating systems' designers. Records included in the document mentioned above were considered while developing tactical-technical objectives for air traffic control simulator for Air Force Academy in Dęblin.

For the importance of media currently used in aviation training it was considered expedient to present basic concepts in this area. Following media are used in ATC training:

- real equipment – used in on-the-job training or in non-operative conditions (shadowing);
- simulators – pieces of equipment giving the student presentation of important features of a real situation and reproduction of operating conditions, which allows implementation of tasks in real time;
- High-fidelity simulators – full-sized replica of air traffic controllers' positions, including equipment and software necessary to present completed tasks for the sector or position, e.g. tower (in the case of airport control, it presents external environment);
- Part-task trainers – training equipment, which allows training of specific operational functions independently from other functions, which are not reproduced here, but are related in operational work;
- Other training devices – equipment which allows to train some operational tasks in the conditions of unreal reproduction of operational equipment; these can include multimedia computers or workstations, which are designed to work independently or in a small team (such equipment is available as standard on the market and is not specially modified for the ATC requirements).

Following ways of learning can be used in simulator training:

- (*SELF) - Self-paced Learning* – a learning / training system, in which the student can control his or her pace of working;
- (*RSTD) - Time-restricted Learning* – a learning / training system, during which the designer of the task or the instructor controls the pace the student has to work in;

- (*REAL) - Real Time* – a training, in which the student has to work in the pace like this of real operations.

Simulation can be performed with the use of suitable methods and types of simulations. There is a simulation and a guided simulation.

(SIMUL) – Simulation – it lies in the fact that behaviour of objects on the ground and in the air is consistent with the trained controller's decisions and corresponds to the conditions existing in the real environment. Simulation always includes briefing, tutoring and debriefing.

(GSIMUL) - Guided Simulation – extended interaction between the student and the computer, in the form of questions and answers, comments, instructions and evaluation. On the assumption there is a theoretical model to which the student is compared.

As far as the types of simulations are concerned, there is individual simulation, team simulation and group simulation.

(Individual Simulation »IND SIMUL«) – simulation in real time, involving one student.

(Team Simulation »TEAM SIMUL«) – simulation in real time, involving a section of many students (e.g. only approach control simulation). There are two or more students in the team working together and in a related manner.

(Group Simulation »GROUP SIMUL«) – simulation in real time, involving many students or teams working simultaneously (e.g. approach control with airport control).

The systematics and knowledge contained in the EUROCONTROL document mentioned is intended to help not only with planning and conducting classes, but also with investments related to the purchase of simulators. According to the EUROCONTROL concept, the kind of simulation should be adapted to the kind of exercises conducted (see fig.1)

A simulator consists of three groups of devices: user interface, technical devices used for modeling traffic and airspace, and managing position. User's interface are the controllers' consoles, with appearance and functionality similar to those that are on the operating positions. The trained person performs all steps appropriate to the simulated operating position.

Managing positions are people's directly controlling the conduct of the exercise, pseudo-pilots' work places. This controlling lies in keeping radio communication with the trained controller and directing objects in the air and on the ground. This directing is a little different than in a flight simulator. The pseudo-pilot „directs" on his or her terminal up to ten (sometimes even more) planes at a time, so the simulated planes move according to the program (flight plan) until the pilot's integration. It can be assumed, that the flight course depends on the exercise scenario. The pseudo-pilot's commands refer to performance of typical maneuvers, such as: change of flight course, altitude, reaching position with regard to a certain reporting point, performing a holding or landing approach.

Table 1. Use of simulation devices depending on the exercises conducted (original version) (Źródło: Simulations Facilities for Air Traffic Control Training, EATMP – EUROCONTROL 2000, s. 11)

	Other Training Device (OTD)	Part-Task Trainer (PTT)	Simulator (SIM)	High-fidelity Simulator (HI FI SIM)
Skill Acquisition (SA)	Best use	Not necessary	Not necessary	Not necessary
Part-Task Practice (PTP)	Not sufficient	Best use	Best use	Not necessary
Individual Simulation (IND SIMUL)	Not sufficient	Not sufficient	Best use	Best use
Team Simulation (TEAM SIMUL)	Not sufficient	Not sufficient	Best use	Best use
Group Simulation (GROUP SIMUL)	Not sufficient	Not sufficient	Best use	Best use
Guided Simulation (GSIMUL)	Not existing	Not existing	Not existing	Not existing

It can be said, that the controller can see on the simulator a pseudo-pilot as pilots of a few planes. Moreover, the pseudo-pilots perform functions of managing the simulated airspace parameters (meteorological phenomena, technical devices failures, events, etc.) as well as the simulation progress (pause or resume the exercise, reproduce the record of the exercise progress, etc.)

Different kinds of ATC simulator are used in the training centres, from the simplest – procedural simulators, through radar simulators, to the very sophisticated tower simulators, which present a real picture from the tower of the airport seen through the controller's eyes.

The simplest and the oldest simulator is the procedural simulator. It is used to train the air traffic controller candidates. As the name suggests, it is used in the procedural control training, with the use of radio communication and the record of the air situation on the flight progress bars. The device is quite simple (see fig.1), it consists of consoles with the bar holders and communication means in the form of intercom and panels, imitating radio communication devices.

Pseudo-pilots perform modeling of movement position manually, using communication and flight progress bars. Despite the lack of technical sophistication, procedural simulator plays an important role in the training process. Except shaping imagination, anticipating situation development and conducting radio communication with pilots, the candidates air traffic controllers are

Fig.1. Procedural simulator in Aviation Training Centre ARL (PAŻP)

confronted for the first time with the elements of control system. They familiarize themselves in practice with the relationships between the separate control bodies and information flow between them.

The radar simulator is a set of devices allowing presentation of the simulated situation on the screens of typical radiolocation indicators. The system of radar data visualization on operational and on simulator's indicators is similar, but on simulator's indicators aircraft position data and their movement parameters are modeled by computers. Characteristics of space, such as: shaping of the ground, weather phenomena, airways, airports, navigation aids, etc. have to be considered in simulation to make the work on the simulator realistic. Characteristics of simulators in use are also considered. All these things create the infrastructure of the exercise, i.e. environment, in which the scenario of the exercise is played out. The infrastructure can reflect real or fictional space – depending on the training strategy adopted.

3. Conclusion

Significant training and economic effects are obtained thanks to the use of simulators in the process of basic training and perfecting skills of ATC controllers.

The benefits include:

- Teaching correct interpretation of an air situation and taking optimal decisions in complex situations of movement.
- Considerable reduction in training costs.
- A significant increase in training effectiveness, expressed in shorter time of training of a bigger controllers' number, with the involvement of smaller teaching staff.
- Continuous and systematic conduct of routine training and perfecting training based on methodological assumptions.
- Faster mastering of skills needed in the workplace.

Fig. 2. Raytheon radar simulator (APP and ACC) - below radar situation display on radar indicator.

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