THE ROLE OF THE SIMULATION DEVICES
IN AIR TRAFFIC CONTROLLER TRAINING

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ABSTRACT

Air traffic controller training is regulated with strong requirements prescribed by the authorities. A specific characteristic of this training is its division into phases and a fact that candidates have to acquire theoretical knowledge and perform adequate skills and theory during practical exercises on simulation devices during all phases of training. This work will show the role of such devices in air traffic controller training with specific view on basic and rating training with an example of a practical exercise. The documents regulating usage of the simulation devices and their different types will also be presented.

KEY WORDS: air traffic controller, training, simulation devices, practical exercises, basic training, rating training

1. INTRODUCTION

Air traffic control service is regulated by the specific rules and regulations which define minimum requirements to achieve and maintain safe, orderly and efficient flow of air traffic. These rules and regulations are prescribed by the main international aviation organizations and adopted by the national designated authorities. Air traffic controllers (ATCOs) provide services which among theoretical knowledge require adequate level of skills and training. This adequate level of skills and training must be achieved on the simulation devices where candidates acquire proper amount of practical exercises for usual and unusual situations. As well as air traffic control service and air traffic controller (ATCO) training and licensing are regulated by the international and national rules and regulations. International Civil Aviation Organization (ICAO) has prescribed minimum requirements for air traffic controller training within its Standards and Recommended Practices (SARPs). European legislation in this field is more detailed and defined by European Commission (EC) through its regulations

23/2006 and 1108/2009. In this paper all relevant documents regarding practical exercises and simulation devices in the field of air traffic controller training will be presented.

2. REGULATIONS ON ATCO TRAINING

2.1. ICAO

ICAO prescribes the minimum requirements for the field of air traffic controller training through Annex 1- Personnel Licensing [1] which defines the following fields:

- student air traffic controller
- air traffic controller license
- ATC ratings
- medical requirements
- requirements for Proficiency in Languages used for radio-telephony communication
- requirements for approved training organizations

In this Annex, the term student air traffic controller is established with basic requirements but more detailed requirements are left for regional or national regulatory frames. Annex 1 basic requirements define that each of the Contracting States shall take the appropriate measures to ensure that student air traffic controllers do not constitute a hazard to air navigation and must hold a current Class 3 Medical Assessment for working in operational environment.

Annex 1 prescribes requirements for issuing air traffic controller license and defines air traffic controller ratings. Requirements for issuing air traffic controller license take into consideration age, knowledge, medical fitness and experience. The applicants must demonstrate an appropriate level of knowledge for defined subjects. Candidates gain experience through completion of an approved training course and not less than three months of satisfactory service engaged in the actual

control of air traffic under the supervision of an appropriately rated air traffic controller [1]. Requirements for practical exercises on simulation devices in the field of training are not prescribed by Annex 1. They are prescribed within requirements for training organizations as requirements for facilities, such as synthetic training devices. Such devices must be qualified according to the national requirements and approved by the Licensing Authority. ICAO Document 9625 gives guidance for the qualification of Flight Simulators but not for air traffic control simulators.

2.2. European Commission

The Directive 2006/23/EC on a Community air traffic controller license has been prescribed for the European Union (EU) countries by the European Commission. Other European countries have to harmonize their national regulations on ATCO training in accordance with these prescribed in the Directive [2]. It defines the minimum ATCO training standards that recognize the specific role which air traffic controllers play in the provision of safe, orderly and efficient air traffic. Also Directive establishes the new procedures of ATCO training and licensing which ensure competence standards.

It prescribes that training consists of theoretical courses, practical exercises, including simulation training, which is needed for candidates to acquire and maintain the skills to deliver safe, high quality air traffic control services. As it is prescribed by the Directive, examiners should demonstrate their detailed qualifications. According to the Directive, training providers must demonstrate their compliance with the requirements proving that they have necessary facilities, equipment and accommodation appropriate for the type of training offered. There are no specific requirements what equipment and simulation devices should be used. Therefore, the regulation can be considered as a 'double-edged sword' which leaves the Member States, i.e. their certified training organizations, to

decide on their own what devices they would use and to choose the most suitable one available on the market according to their training needs. Still, the regulation does not give enough details to be the subject of proper harmonized simulation devices selection.

Directive 1108/2009 is the only document that prescribes minimum requirements for instructors on practical skills. This document defines Synthetic Training Devices that allow adequate simulation of the working environment and operational situations appropriate to the training provided [3].

2.3. EUROCONTROL guidelines and specification

However, there is a reference to EUROCONTROL's "Guidelines for Air Traffic Controller Common Core Content Initial Training" (CCC Guidelines) [4], which describes minimum learning objectives that should be achieved during initial training. There is also "EUROCONTROL Specification for the ATCO Common Core Content Initial Training" (Specification) [5] that is subsequent upgrade of the CCC Guidelines and will supersede it after its approval. The syllabi in the Specification are in accordance with ESARR5[1] – ATM[2] Services Personnel, the mandatory minimum Initial training requirement to be applied by all European Civil Aviation Conference (ECAC) Member States. In addition, for the European Commission Member States, these objectives are referenced in Directive 2006/23/EC.

3. TYPES OF ATCO TRAINING

There are two main parts of ATCO training, initial and unit training. Initial training is the first phase of training and comprises basic and rating training. Basic training is designed to

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[1] ESARR5 - Eurocontrol Safety Regulatory Requirement No 5
[2] ATM – Air Traffic Management

impart fundamental knowledge and skills to enable candidates to progress to more specialized and practical rating training.

Rating training provides knowledge and skills related to a discipline to be pursued in the air traffic services (ATS) environment.

Following ratings are recognized:

- Aerodrome Control Visual Rating (ADV)
- Aerodrome Control Instrument Rating with TWR Endorsement (ADI/TWR)
- Approach Control Procedural Rating (APP)
- Area Control Procedural Rating (ACP)
- Approach Control Surveillance Rating with Radar Endorsement (APS/RAD)
- Area Control Surveillance Rating with Radar Endorsement (ACS/RAD)

Unit training is given in the operational work situation with use of site-specific simulations and, upon completion, in live traffic where previously acquired skills and routines are further developed and consolidated under the supervision of a qualified instructor. It contains 3 phases of training: transitional, pre-on-the-job and on-the-job training [5].

4. SIMULATION DEVICES IN INITIAL TRAINING

Usage of simulation training devices in air traffic controller training is the best way in acquiring and demonstrating the skills required for the issue of a license or rating; in gaining the experience and also in demonstrating continuing competency. As the ATCO training is divided into four phases the National Supervisory Authority shall ensure that the simulation training device is qualified according to mandatory requirements established on the international, regional and national level, and that their use is appropriate to the phase of the training.

When optimizing the use of a simulation device, i.e. practical part of the training, it is

necessary to define for which phase of training the simulation devices will be used; which features the simulators will replicate; which degree of fidelity is required for equipment, environment and human actors; and how accurate should the model be to fulfill training objectives and improve the training efficiency. Performing the appropriate practical exercises after acquired theoretical knowledge proved to be a good practice that contributes to the systematic progress of candidates and the quality of the training process in general.

Task Force Technology - based Training Tools and Methods (TF-TTM) of the former EATCHIP[3] Human Resources Team analyzed the contemporary and future training processes using simulators and simulation media [6]. The following five types of exercises are determined:

1. Skill Acquisition (SA).
2. Part-Task Practice (PTP).
3. Individual Simulation (IND SIMUL)
4. Team Simulation (TEAM SIMUL)
5. Group Simulation (GROUP SIMUL).
The following four types of simulation devices are also determined:

1. High-fidelity Simulator (HI FI SIM).
2. Simulator (SIM)
3. Part-Task Trainer (PTT).
4. Other Training Device (OTD).

A characteristic of simulators that has been particularly emphasized is the fidelity to reality. Fidelity is the degree to which simulation matches the real system and the environment in terms of physical characteristics, functional characteristics (stimulus and response options) and conceptual fidelity (realism of the thought processes stimulated in the applicant). The following four levels of fidelity categorized from A-D are established:

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[3] EATCHIP - European Air Traffic Control Harmonisation and Integration Programme

A. No importance.
B. Generic.
C. Very close to real.
D. Real.

Requirements according to the type of exercise are shown in the Table 1. According to the results of the survey carried out by the Task Force, practice and theory have to be mixed right from the beginning of the training [5]. A training process where at first Skill Acquisition is proposed, followed by some Part-Task Practice and then by simulations, allows optimizing the efficiency of the training. The increase of the requirement of training resources is managed so that the additional resources are only provided when needed; SA is done on a generic device, the task is practiced on a Part-Task Trainer while integration of the tasks, strategy and judgment are performed in front of a realistic simulation.

Table 1. Specification for different training events [7]

Training event[1]	Training event[2]	Method[2]	Media[2]	Rate[2]	Mode[2]
Case	Case	Case	Vid, MMC, Vsl (Backup Txt)	Rstd	I, G
Computer-based Practical Exercises	CBPE	Ex	Vsl	Rstd	G
Computer-/Web-based Training	CWBT	Inter	MMC	Self	I
Group Work	GrW	Facil	Vsl (Backup Txt)	Rstd	G
Hands On	HO	Sup Pract	RE	Rstd, Real	G
Multimedia or sound Laboratory	Lab	Les, Ex	MMC, sound	Self, Rstd	I
Lecture	Lec	Lec	Vsl (Backup Txt)	Rstd	G
Lesson	Les	Les	Vsl (Backup Txt)	Rstd	G
Part-Task Practice	PTP	Pre-Simul	PTT	Rstd	I
Skill Acquisition	SA	Pre-Simul	OTD	Self	I
Structured Briefing	StBf	Brief	Vsl	Rstd	G
Individual Simulation	ISimul	Simul	Sim, Hi Fi Sim	Real	I
Team Simulation	TSimul	Simul	Sim, Hi Fi Sim	Real	I
Group Simulation	GSimul	Simul	Sim, Hi Fi Sim	Real	G
Supervised Practices	Sup Pract	Sup Pract	Vsl (Backup Txt), MMC, RE	Rstd	G
Virtual Classroom	VC	Facil, Ex, Les, Lec	Net	Rstd	G
Visit	Vis	Sup Pract	RE	Rstd	G, I

[1] In full – [2] Abbreviated

Table 1 shows types, methods, media, rates and modes for different training events. It can be noticed that all types of simulation exercises

(methods) recommend simulators and HI FI simulators.

4.1. ATCO Basic Training - Training Plans

Since Faculty of Transport and Traffic Sciences is certified as ATC Training Organization with approved Basic Training programme, this paper will present the usage of the simulation devices in Basic Training with more detail.

ATCO Basic Training - Training Plan [7] is EUROCONTROL's document created with purpose to assist the creation of ATCO basic training plans. Training plan is an example of training strategy to meet the training objectives stated in the CCC Guidelines. They include the procedures used in simulation, a description of training area and description of a simulation test.

What is of great importance are the details of candidate's expected performance in simulation and the content and workload of a typical simulation at the end of the training (possibly a final exam simulation). ATCO Basic Training - Training Plan also defines the training more accurately than the syllabus which specifies the objectives of the basic training but does not include performance objectives or duration.

Corresponding to the syllabus, where performance objective are stated within the ATM objectives, simulator candidates shall:

- apply the skills of ATC in accordance with the operational procedures;
- perform several skills at the same time as required in a simple air traffic control exercise.

With respect to pedagogical and didactical aspects of the training, after practicing individual skills, these skills should be integrated into suitable simulation exercises. Most of the skills are developed separately on PTT. The best way to achieve the objective of performing several skills at the same time is using a simulator. However, it is stated that a suitable PTT may be used when a simulator is not available.

As the basic training is common for aerodrome, procedural and surveillance services, the general ATM objective, which is '*Learners shall describe the basic principles of air traffic management and apply basic operational procedures*', is set to provide future air traffic controllers with prerequisites for any rating training and to give them a general understanding of their professional environment. This is why the achievement of the ATM objective is limited to a simple performance of the corresponding tasks in the basic training with consolidation and further development of skills made in the rating training.

Exceptions are recommended in cases where the use of different practices is more conducive to the needs of continuing training. For example, when the basic course is provided in an environment where aerodrome control is more appropriate to prepare the rating training, the PTT may be replaced by a 2D-Tower simulator and the radar simulator by a 3D-Tower simulator. Likewise the 'content' of the ATM objectives may be revised taking into account not to infringe the general ATM objective.

In the following text a list of duties is given. These duties are to be performed during the typical simulation exercise:

1. Check and use the simulation equipment;
2. Develop and maintain situational awareness by monitoring traffic display(s);
3. Monitor and update flight data display(s);
4. Maintain a continuous listening watch on the sector frequency;

5. Issue appropriate clearances, instructions, and information to simulated traffic;
6. Use standard phraseology;
7. Apply vertical and radar separation;
8. Apply exit conditions with regard to longitudinal and lateral separation and level as pre-given by the exercise script;
9. Conduct coordination as necessary.

It has been emphasized that the taxonomy of these duties does not lead beyond Level 3. That means that the required performance does not include the analysis and subsequent solving of any unknown problems. Candidates must only demonstrate their ability to make accurate use of learned knowledge and skills within the framework of known simulation parameters.

It is not stated that all potential elements of the objective have to be assessed in the final examination. A selection of key elements in the final assessment is sufficient. Regarding a workload of a typical simulation, number of aircraft has to allow a candidate to demonstrate basic ATC skills and to solve a maximum of three separation problems, but only one problem at a time. The complexity of the simulation run will require several of the duties to be performed simultaneously.

Here is the list of tasks during a typical simulation exercise. Students shall demonstrate their ability to conduct all of them:

1. to ensure the integrity of the working position;
2. to issue one en-route clearance;
3. to climb/descend aircraft to planned exit levels;
4. to descend aircraft from a flight level to an altitude;
5. to detect and solve three separation problems;
6. to comply with exit conditions;
7. to issue traffic information;
8. to maintain flight data display;
9. to use standard phraseology and standard radiotelephony techniques;
10. to prioritise actions correctly;

11. to transfer communication;
12. to pass/receive one estimate (no revisions and no negotiations).

At the end of the basic training candidates shall be assessed during individual simulation(s), carrying out all the tasks listed above. The duration of assessment exercise should not be longer than 45 minutes with total number of 10 aircraft, taking into account not to exceed the number of 4 aircraft on a frequency.

4.2. ATCO Rating Training – Training Plans

EUROCONTROL documents "ATCO Rating Training–Training Plans:Aerodrome Training", "Approach Control Surveillance Rating with Radar and Terminal Endorsements - Training Plans" and "**Area Control Surveillance Rating with Radar and Terminal Endorsements-Training Plans**" give directions for establishing rating training plans and recommend total number of periods necessary for practical training [8, 9, 10]. Recommended minimum number of periods spent on the simulation devices for every type of the rating training is shown in Table 2. Term *period* defines duration of a training event and lasts from forty to sixty minutes which depends on the various practices in different training institutes and according to the subject of training [7].

Table 2. Recommended number of periods for different ratings

	Periods	Simulation devices
ADI/TWR	30	2D aerodrome simulator or 3D Tower HI FI simulator
APS/RAD	106	Simulator or HI FI simulator
ACS/RAD	100	Simulator or HI FI simulator

It can be noticed that rating training requires significant time for practical exercises to be performed on the simulation devices.

5.   EXAMPLES OF PRACTICAL EXERCISE

In the following text the creation of two exercises for the purposes of Basic training will be explained. The exercises are planned for the very beginning of practical part of the training. The reason why both of them will be considered is because they are connected to each other, have similar performance objectives, and one follows the other. Together they form an entirety with the aim of acquiring primary skills and 'sense of airspace'. The exercises are simplified so that candidates understand how to use the equipment and familiarize with it. The equipment used for the creation and operation of the exercises was EUROCONTROL Part Task Trainer named Radar Skills Trainer, which is developed to support the delivery of Basic ATCO training as structured by the CCC Review Group [11].

In Tables 3 and 4 details on exercises' basic information, objectives and available options are given.

Table 3. Exercise 1 specification

| Exercise basic info	Exercise options availability:	
Duration: 35 minutes	Range and bearing measure tool	Not available
Number of a/c: 5	Radar scan rate	2 seconds
Number of potential conflicts: 1	Track history length	5 dots
Exercise objectives	Speed vector length	3 minutes
a/c to remain within allowed airspace	Crossing points distance	4Nm
	Compass rose	available
a/c to remain separated	Speed vector selection	allowed
	Lateral separation standard	5Nm
a/c to cross exit points at exit levels	Vertical separation standard	1000 ft
	Display airlane centre lines	available

Although the exercises will be explained in the following text, the Tables are given for better understanding and comparison of the exercises. Similarly, for easier visualisation of exercises' airspace, Figure 1 and Figure 2 show the PTT display during the exercises.

It can be seen to what extent the creation of air routes affects the need of heading assessment. And also, it could be noticed how creation of restricted airspace (red-coloured parts on the figures) determines a degree of accuracy in guiding the aircraft along the predefined air routes. Nevertheless a workload of a typical simulation in Basic training is reduced to only three separations at a time, it is obvious how increased number of aircraft raises the complexity of an exercise and requires higher concentration from candidates.

5.1.   Exercise 1

The exercise is an introduction into the simulation system. Candidates have to familiarize with the Radar Skills Trainer and learn how to cope with their working position. Candidates will also have to learn how to read out important information from aircraft label which reflects current traffic situation. As the developing of vectoring skills and assessment of headings and turns are the main objectives of the exercise, candidates will have to guide the aircraft along the predefined routes from their entry to exit point. The route center lines will be visible to help them get better visualisation and situational awareness.

Table 3 shows that aircraft must cross all the points on the defined routes within the range of 4 Nm (range is value of the radius from the center of the point). Aircraft will have to be precisely guided along the routes in order to remain within allowed airspace which is in the shape of air routes with width of 5 Nm from the centre line.
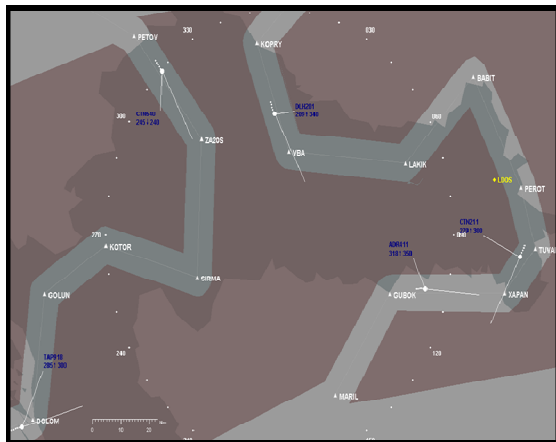
Figure 1. Part Task Trainer display during the Exercise 1
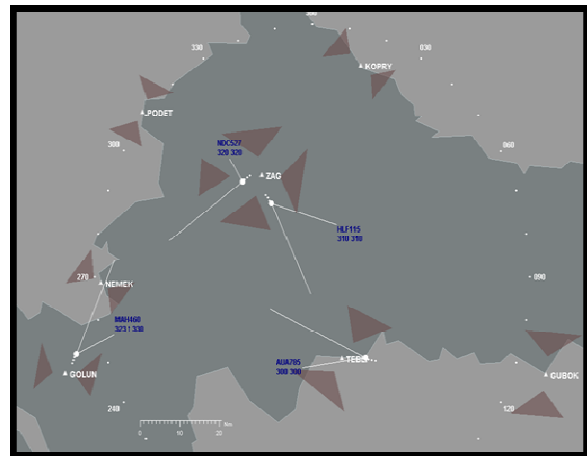
5.2. Exercise 2

Exercise 2 is a resumption of Exercise 1 within the meaning of developing vectoring skills and assessment of headings and turns. Specification of Exercise 2 is shown in Table 4.

Table 4. Exercise 2 specification

Exercise basic info	Exercise options availability:	
Duration: 29 minutes	Radar scan rate	2 seconds
Number of a/c: 6	Track history length	3 dots
Number of potential conflicts: 2	Speed vector length	3 minutes
Exercise objectives	Speed vector selection	allowed
a/c to remain within allowed airspace	Crossing points distance	3 Nm
a/c to remain separated	Compass rose	available
determination of range & bearing	Lateral separation standard	5 Nm
a/c to cross exit points at exit levels	Vertical separation standard	1000 ft

Candidates will have to guide the aircraft along the predefined routes from their entry to exit points. The airlanes and airlanes center lines will not be visible so that the heading estimation will be a little bit complicated than

in the previous exercise to enable students to develop their visualization and situational awareness to the next level. The aircraft must cross all the points on the defined route within the range of 3 Nm (range is value of the radius from center of the point). Aircraft do not have to be guided along the routes precisely as in the previous exercise, but will have to cross over all enroute points in order not to enter restricted airspace.

Figure 2. Part Task Trainer display during the Exercise 2

Throughout the exercise the program will generate random questions aimed at testing candidates' knowledge of the airspace and ability to judge ranges and bearings on the display and situational awareness. These questions will randomly select fixes and flights in all possible combinations (fix from fix, fix from flight, flight from fix, flight from flight).

6. Conclusion

Process of air traffic controller training is regulated with strong international requirements. There is no international regulation which prescribes minimum requirements for certification of simulation devices. National Supervisory Authorities must ensure that the simulation training device is qualified according to mandatory requirements established on the international, regional and

national level, and that their use is appropriate to the phase of the training.

Air traffic controller training contains of the two different methods – theoretical training and practical training. Practical training is very specific because it needs to be performed on simulation devices. Different phases and types of ATCO training need different type of simulation devices. During the phase of basic training PTT simulation device is recommended and can be used as a substitute for the simulator. In the ADI/TWR rating training 2D skill acquisition simulation devices are suitable with possible use of 3D HI FI simulator. In APS and ACS ratings with RDR surveillance endorsements simulators and HI FI simulators are recommended.

Every ATC training organization has to be certified for defined type of training and has to ensure proper amount of practical exercises performed on a specified simulation device. Simulator or HI FI simulators which are used for rating and unit training need to be certified by National Supervisory Authorities which is not the case for basic training if a Part Task Trainer is used.

7. REFERENCES

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