

Selected information on flight simulators - main requirements, categories and their development, production and using for flight crew training in the both Slovak Republic and Czech Republic conditions

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Abstract: *The objective of this paper is to present the selected information concerning the flight simulators. After some information from the general and historical point of views, the authors are focusing on main requirements for the flight simulators and their categorisation from different aspects, including outline of principal international documents published by ICAO, EASA (covering JAR regulation) and FAA referring to and/or dealing with the use of Flight Simulators Training Devices (FSTD) and technical and operational requirements in this area for aeroplanes. The concluding chapters of the paper introduce appropriate information on the development and manufacturing organizations in the flight simulators area and the using of this equipment in the both Slovak Republic and Czech Republic.*

Key Words: *flight simulator, flight training, training devices, requirements, ICAO, JAR, FAA*

1. INTRODUCTION

The use of flight simulators in both civil aviation and military air force training is commonplace and widely accepted. These simulators allow flight crews to practice needed level of training and potentially life-threatening manoeuvres in the relative comfort of a training building or centre. Similarly, military pilots are able to rehearse complex missions and to practise piloting skills that may be unacceptable in environmental terms (in peace time) or prohibitively expensive, for example, the release of expensive weapons.

The flight simulator provided the ideal platform to practise crew cooperation procedures and to improve the training of flight crews to respond to hazardous situations and such way to enable their readiness to be capable for real flight emergencies. In many training organizations, the flight crew response is recorded and reviewed in debriefing sessions. Lessons learnt from the analysis of cockpit flight data recorders and cockpit voice recorders, following aircraft incidents and accidents, have been incorporated in simulator training programmes. It is probable that the aviation industry has led the world in the use of simulation technology to improve training and safety.

Adequate and mature using of flight simulators during pilots and crews flight training enables the utilization and holds the full flight personnel capacity in the airline condition, without allowing for type conversion programmes for flight crews joining the airline or converting onto type. With airborne operations at least 10 times the cost of simulator operations, the cost of equivalent airborne training would bankrupt an airline. [1] There is a strong case that flight simulation has enabled budget airlines to grow and that, without flight

simulation, they would not be able to operate. It is clear, that using of flight simulators is a cost effective solution.

The obvious benefit of training on a flight simulator is that time spent training in a simulator can replace time spent training in an aircraft. If the simulator is effective, then an hour of training in a simulator could replace an hour, or even several hours training in an aircraft.

The majority of flight simulators are used for pilot training. However, flight simulation also plays an important role in aircraft design.

2. GENERAL AND HISTORICAL INFORMATION

A flight simulator is a device that artificially re-creates aircraft flight and various aspects of the flight environment. This includes the equations that govern how aircraft fly, how they react to applications of their controls and other aircraft systems, and how they react to external environmental factors such as air density, turbulence, cloud, precipitation, etc. Flight simulation is used for a variety of reasons, including flight training, the design and development of the aircraft itself, research of aircraft and flight characteristics, control handling qualities, decreasing of operating cost and more. [2]

The world is in continuously evolving. Science and technology is developing in very fast rate. It is not so long ago when we watched TV programs in black and white and adjusted the antenna to capture the strongest signal to watch TV with clearest picture.

Very fast development brings a variety of LCD or plasma monitors with clear detail and colour or even with HD quality. Some of those are already provide 3D view using special glasses or even without them. How evolution in this area, progress in modelling and simulation, SW engineering and other areas can have influence to the aero manufacturing in field of science and development of flight simulators, when in only seemingly simple area of the television viewing occurred so high progress?

The start of the development of flight simulators can be dated from the period before World War I. The first known flight simulation device was the Antoinette monoplane (Fig.1), which helped the pilots to simulate the flight. The Antoinette used two wheels mounted on the left and right side of the pilot, one for pitch and one for roll. A training rig was developed in 1909 to help the pilot operate the control wheels before the aircraft was flown. [1], [2]



Fig. 1 The Antoinette flight training simulator [1]

The best-known early flight simulation device was the Link Trainer (Fig. 2), made by Edwin Link in Binghamton, New York, USA, built in 1927. The Link Trainer was a basic metal frame flight simulator usually painted in its well-known blue colour. His design had

a pneumatic motion platform driven by inflatable bellows which provided pitch and roll cues. The motion platform gave the pilot cues as to real angular motion in pitch, roll and yaw. The U.S. Army Air Corps purchased six Link Flight Trainers, specifically for the task of instrument flight training. This was the first time that the value of flight simulation was recognized in flight training and it can be said to mark the start of the world flight simulation industry. [1],[2]



Fig. 2 Link Trainer [3]

Link's early contributions to flight training were fundamental: [1], [3]

- He exploited specific engineering technologies to produce a successful flight training device,
- The flight trainer was developed to meet a specific training requirement,
- Although his flight model was simple and inexact, the trainer was effective - it had a positive benefit on pilot training,
- The introduction of the Link trainer established the concept that flying training was not limited to airborne training – effective training could also be undertaken in a ground-based trainer.

Over half a million allied airmen trained on a Link Trainer during the Second World War. Several other devices for pilot training were developed during World War II. Development progressed steadily. People were looking for different methods and technologies that would be able to faithfully reproduce the flight as the real aircraft with all its motion, sound and visual impulses.

The further development of flight simulators depended particularly on used technology level especially in the computing and electronics areas. From this point of view we can divide further flight simulators development into the following periods:

- Analogue Computing (1945–1965),
- Digital Computing (1965–1985),
- The Microelectronics Revolution (1985–present).

Continuous development and evolution of technology during these periods improved the flight simulators. This led to the production of new, improved and more sophisticated flight simulation devices. Nowadays high quality flight simulators are available, which can fully and faithfully imitate all phases flying an aircraft. For example abnormal and emergency events as well as the variety of motions and effects of weather, strength, damage to engine and many other.

The main reason for the use of simulators in training pilots is safety and training emergency conditions such as fog, wind or turbulence. Another reason is the financial benefit of lower training and operating costs. The benefit of flight simulators is also their effectiveness in training, because the flight simulator fully simulates real aircraft. These benefits are important especially in training tasks when flight cannot be practiced in the real aircraft.

3. MAIN REQUIREMENTS FOR FLIGHT SIMULATORS

All Flight Simulators and Flight Simulation Training Devices (**FSTD**) have to be designed, produced, installed and their evaluation, qualification and approval must be provided under the current regulatory standards, criteria and requirements of aviation legislation, primarily specified in the relevant ICAO documents, EASA/JAR regulation (in Europe), FAR regulation (in USA), according to the required level of certification. Important role in the area of FSTD requirements accomplishes also the IATA, which has been published document “Flight Simulation Training Device Design & Performance Data Requirements”. This IATA data document is the industry standard for FSTD data requirements.

Among main international documents published by ICAO, EASA (covering JAR regulation under former JAA) and FAA referring to and/or dealing with the use of FSTDs for aeroplanes and technical and operational requirements relevant to FSTD data and design as well as FSTD qualification and approval pertain the following documents: [4]

A. ICAO

- ✓ ICAO Doc 9625 Manual of Criteria for the Qualification of Flight Simulators;
- ✓ Annex 1 - Personnel Licensing, Amendment 167;
- ✓ Doc 9868, Procedures for Air Navigation Services — Training (PANS-TRG).

B. EASA/JAA (Europe)

- ✓ JAA JAR-FSTD A, Aeroplane Flight Simulation Training Devices;
- ✓ JAR-STD 1A, 2A, 3A, 4A: Aeroplane Flight Simulators, Flight Training Devices, Flight and Navigation Procedure Trainers and Basic Instrument Training Devices;
- ✓ FCL TGL #7, Multi-crew Pilot Licence Training — Air Traffic Control Environment Simulation.

C. FAA (USA)

- ✓ 14 CFR FAR Part 60, Requirements for the Evaluation, Qualification and Maintenance of Flight Simulation Training Devices;
- ✓ Advisory Circular 120-40B, Aeroplane Simulator Qualification;
- ✓ Advisory Circular 120-40B, (International) Aeroplane Simulator Qualification;
- ✓ Advisory Circular 120-45A, Aeroplane Flight Training Device Qualification;
- ✓ FAA, Airline Transport Pilot and Type Rating Practical Test Standards, FAA-S-8081-5F, US Government Printing Office, Washington, DC, July 2008.

Flight simulator has to be assessed in areas that are essential to complete the training and testing of flight crew, such as: [5]

- The characteristics of the longitudinal, lateral and directional control;

- Performance on the ground and in the air;
- Specific operation;
- Arrangements of cockpit;
- Operation during normal operation, emergency operation and where is possible in other than during normal operation;
- Functions of the instructor station and control of simulator;
- Other requirements.

Concerning training of flight crew using by FSTD we would like to underline, that base for this training are training tasks (e.g. for MPL 1,2,3,4 – Multi-crew Pilot License, IR-Initial Instrument Rating, CR-Class Rating, TR-Type Rating a.o.) and training types to support licence and rating requirements, which are agreed by the ICAO/EASA/FAA. Agreed list of simulation features elements required to support any individual training task.

Flight simulator covers simulation in three areas: [6]

- Aircraft simulation,
- Environment simulation,
- Cueing simulation.

Each simulation area and relevant simulation sub-area and processes /activities in the framework of these areas/sub-areas (Fig.3) must meet defined requirements.

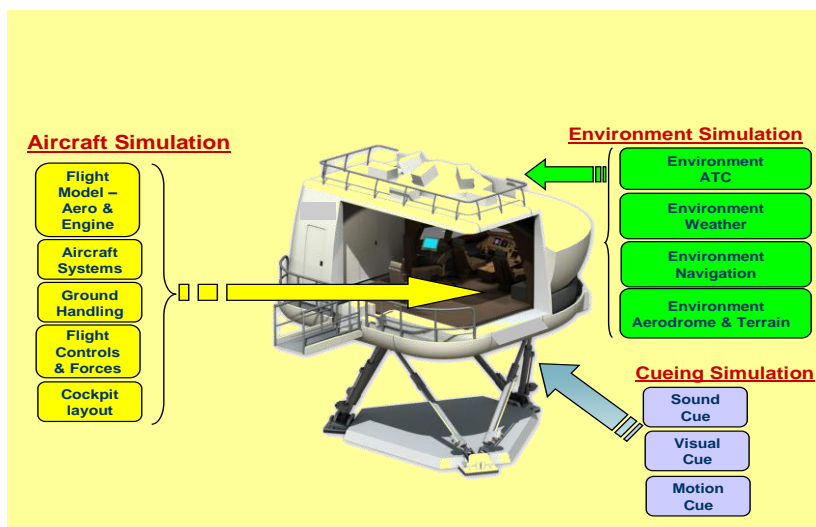


Fig. 3 Possible simulation in the flight simulator [6]

Like each aircraft product also each flight simulator has to be subject to various tests. With these tests we can find the correct category and determine the type of flight simulator. These verification tests are mainly: [5]

- Performance tests – taxiing, take off, climb, travel mode/fly, engines;
- Tests of characteristics – static, dynamic, longitudinal and lateral control tests, landing, the ground effects, wind;
- Motion system – frequency response, phase balance, over flight control, motion effects, repeatability of the motion system, indication of the performance movement feeling, characteristic vibration motions;

- Visual system – the system responses time, display tests;
- Sound system – simulation sounds of the jet aircraft, propeller aircraft, flight simulator background noise, significant aerodynamic sounds, sounds of landing gear or flaps, frequency response;
- Quality of service – control of static, longitudinal and cross-directional control and control of functions of flight;
- The instrument response – response devices in the cockpit;
- Transmission delay – transmission delay, response time;
- System of visual orientation – visible land segment, recognizing the characteristic visual signs, displayed scene, et cetera.

The intent is to evaluate the FSTD as objectively as possible. *Pilot acceptance*, however, is also one of the most important consideration. Therefore, the FSTD will be subjected to the **validation tests** and the **functions and subjective tests**.

Validation tests are used to compare objectively FSTD and aeroplane data to ensure that they agree within specified tolerances. **Functions tests** are objective tests of systems using aeroplane documentation. **Subjective tests** provide a basis for evaluating the FSTD capability to perform over a typical training period and to verify correct operation and handling characteristics of the FSTD.

The term **FSTD feature** has been used for describing the characteristics of each FSTD categories, e.g. for definition of the general and technical requirements for FSTD. In this regard it is important to assess the FSTD (device) feature fidelity level as the level of realism assigned to each of the defined FSTD features.

According to ICAO Doc. 9625 the **device feature fidelity levels** are as follows:

- **S (Specific)** - Highest level of fidelity

Where the fidelity level is S, the initial and recurrent validation should be based on objective evaluation against approved data.

- **R (Representative)** - Intermediate level of fidelity

Where the fidelity level is R, the initial validation should be based on objective evaluation against approved data, complemented if necessary by approved subjective development, to determine a reference data standard. Recurrent validations should be objectively measured against the reference data standard.

- **G (Generic)** - Lowest level of fidelity

Where the fidelity level is G, the initial validation should be based on subjective evaluation against approved data where available, complemented if necessary by approved subjective development, to determine a reference data standard. Recurrent validations should be measured objectively against the reference data standard.

- **N (None)** - The FSTD Feature is not required.

4. FLIGHT SIMULATORS CATEGORISATION

Flight simulation is used extensively in the aviation to train pilots and other flight crew for both civil and military aircraft. It is also used to train maintenance engineers in aircraft systems and has other applications in aviation, especially in aircraft design and development area. Several different devices are utilized in modern flight training.

The flight simulators is possible to divide according to various criterions and areas. From broad scale of flight simulators we introduce the selected categories / kinds of this equipment.

4.1 Flight simulators categorisation according to areas of using

Flight simulators are used in flight training and it is easy to assume that both terms are synonymous and interchangeable. However, flight training is provided to fulfill a training requirements.

The equipment used to provide this training may well include a flight simulator but in this role, the simulator is simply equipment.

The simulator, together with an instructor and a training syllabus constitutes the training package. According the areas of using we can divide the flight simulators to the following types: [1]

➤ **Flight simulator for commercial flight training**

The classical application of flight simulator is the training of airline pilots. The simulator comprises a motion platform, supporting an aircraft cabin with visual systems mounted above the cabin.

Pilots joining an airline from flying schools, general aviation or military organizations are trained on a flight simulator for specific type of aircraft.

➤ **Flight simulators for military flight training**

In military flight training, most basic training is undertaken in the aircraft. Instrument flying training is provided in flight simulators together with system familiarization trainers. However, the major developments in military flight training have occurred in operational flight training, where the cost of airborne training (particularly the deployment of munitions) and safety issues justify the cost of simulation.

In these advanced simulation facilities, simulators can be linked together, enabling flight crews to practice mission sorties, with instructors introducing enemy forces often where these synthetic forces have intelligent decision-making capabilities.

➤ **Flight simulators for Ab Initio Flight Training**

Although there is an understandable desire to get the student pilot into an aircraft in the early stages of a flight training program, with the reducing cost of simulation technology, there is a case to achieve more effective training by replacing some elements of airborne training with simulator-based training.

A few studies with *ab initio* pilots have shown that the quality of flight training can be improved with part-task training in simulators but generally, the use of simulation in general aviation training is mostly restricted to instrument training in the training of private and commercial pilots.

➤ **Engineering Flight Simulators**

For the aircraft designer, the development, installation and testing of complex aircraft systems can require many hours of airborne flight tests, which, depending on the equipment can be expensive and dangerous, for example, in developing a military terrain following system.

By providing an engineering flight simulator, the system designer can install, integrate and evaluate aircraft equipment in the simulator. The simulator is still flown with the same exercises as the actual flight trials aircraft.

The major gain is that design faults are easier to detect in the simulator and more importantly, that early detection of a fault in a program can reduce the life cycle costs significantly.

➤ **Aptitude testing flight simulators (device)**

The qualities needed for a pilot include hand-eye coordination, motor skills, spatial awareness, interpersonal communication skills and judgment and management skills. Many training programs are expensive and consequently, there are considerable benefits in detecting potential deficiency in pilot skills prior to the commencement of any training. Aptitude testing equipment has been developed to isolate these skills and identify areas where a trainee pilot is likely to encounter learning difficulties. In programs where there is a surfeit of applicants, failure in aptitude tests can result in an immediate rejection from the course.

In other programs, it may identify possible training problems leading to alternative training routes. The overall aim is to use low-cost aptitude testing to detect faults well before they would be identified in a training program.

➤ **Flight simulators providing the Computer-Based Training (CBT)**

With the availability of high performance computers in flight training, it is not clear how the training syllabus is best presented.

Traditionally pilots have been trained by a combination of ground school and airborne training. The flight simulator provides a link between these two elements of training; a pilot is able to undertake training in a simulator to replace training in an aircraft. CBT extends this concept into the ground school training.

CBT now extends to all phases of flight training for both civil and military organizations, covering engine systems, cockpit drills, navigation systems, radio panel operation and FMS training.

➤ **Using of flight simulators for maintenance training**

Rather than dismantle a complete gas turbine engine, the student can interact with images of the engine, selecting a bolt or hose to remove. Inspection of a filter can show evidence of contamination requiring further disassembly. The order and sequence of removal and installations is presented in a logical sequence and fault finding methods are monitored to check on the student's fault diagnosis. The student's progress in failure detection and repair can be monitored by the computer system and provide a record of progress for the instructor.

With modern aircraft, these concepts of maintenance accord with the aircraft systems found on the aircraft, where faults are recorded in flight and downloaded by maintenance crews who undertake fault detection and correction at the board level to facilitate a fast turnaround of the aircraft.

4.2 Flight simulators categorisation according to training purpose

From the training purpose point of view we can divide the flight simulators on the following categories: [1], [2]

- *Cockpit Procedures Trainer (CPT)* – is used to practice basic cockpit procedures, such as processing emergency checklists, and for cockpit familiarization.
- *Aviation Training Device (ATD)* – is used for basic training of flight concepts and procedures.
- *Basic Instrument Training Device (BITD)* – a basic training device primarily focused on generic instrument flight procedures.

- *Flight and Navigation Procedures Trainer (FNPT)* – is used for generic flight training. A generic, but comprehensive flight model is required, and many systems and environmental effects must be provided.
- *Integrated Procedures Trainer (IPT)* – provides a fully simulated cockpit in a 3D spatial cockpit environment that combines the use of multiple touch-sensitive screens that display simulated panels in the same size as the actual aircraft panels with hardware replica panels.
- *Flight Training Device (FTD)* – is used for either generic or aircraft-specific flight training. Comprehensive flight, systems, and environmental models are required. High level FTDs require visual systems but not the characteristics of a Full Flight Simulator (FFS).
- *Full Flight Simulator (FFS)* (Fig. 4) – is used for aircraft-specific flight training under rules of the appropriate national civil aviation regulatory authority. Under these rules, relevant aircraft systems must be fully simulated, and a comprehensive aerodynamic model is required.
- *Full Mission Simulator (FMS)* – Used by the military to denote a simulator capable of training all aspects of an operational mission in the aircraft concerned.



Fig. 4 Airbus A320-200 Full Flight Simulator [7]

4.3 Flight simulators categorisation according to ICAO qualification levels

The principal ICAO document regarding the issue of qualification of Flight Simulation Training Devices (FSTDs) is mentioned ICAO Doc.9625 “*Manual of Criteria for the Qualification of Flight Simulation Training Devices*”.

This manual addresses the use of FSTDs representing aeroplanes (Volume I - Manual of Criteria for the Qualification of FSTDs - Aeroplanes) and helicopters (Volume II - Manual of Criteria for the Qualification of FSTDs - Helicopters).

The methods, procedures and testing standards contained in this manual are the result of the experience and expertise provided by National Aviation Authorities (NAA) and FSTD operators and manufacturers.

Each volume of document containing three Parts as follows:

- Part I - Training Task Derived Flight Simulation Requirements
- Part II - Flight Simulation Training Device Criteria
- Part III - Flight Simulation Feature and Fidelity Level Criteria.

Following the description of the minimum FSTD requirements for qualifying a device to the agreed international Type as defined in the ICAO Doc.9625 we can divide the FSTD to the seven types (**Table 1**, with simplification of listed characteristics of requirements).

Table 1 Qualification levels of Flight Simulation Training Devices (FSTDs) according to ICAO (own elaboration, according to [4])

Type of FSTD	Characteristics of requirements
I	The first level would be contain an enclosed or perceived cockpit/flight deck, excluding distraction, which will represent that of the aeroplane derived from, and appropriate to class, to support the approved use; lighting environment for panels and instruments should be sufficient for the operation being conducted; modelling of aerodynamics and engines (thrust, temperature, mass); aircraft systems; sound system; visual system. The ATC environment simulation is not required.
II	Meets the same requirements as 1st level, but also to contain the simulation of ATC environment as messages, visual environment, operation on the airport, weather reporting and others.
III	Meets the previous requirements, but also to contain for example the simulation of runway condition, including information on pavement condition (wet, dry). The ATC environment simulation is not required.
IV	This level meets the same requirements as previous levels. It is added for example on ATC environment simulation; sounds of outside environment (weather, meteoric water); voice control.
V	This level meets the same requirements as level IV, but is added for example on runway conditions simulation (dry, wet, icings, water holes); aircraft systems simulation (communication, navigation, warning device); dynamic feeling of control; failure of brakes dynamics and tires; degradation of brakes efficiency.
VI	This level meets the same requirements as level V, but is added for example on ATC extended environment simulation; the motion system includes the acceleration feeling, Buffet in the air due to flap and spoiler/speed brake extension; Buffet due to atmospheric disturbances, e.g. turbulence in three linear axes (isotropic), In-flight vibrations A motion system (force cueing) should produce cues at least equivalent to those of a 6 DOF platform motion system (i.e., pitch, roll, yaw, heave, sway, and surge). Weather environment contains e.g. simulation of turbulence.
VII	The highest approved level. It has to meet all previous requirements with their detail and authentic realization as in the real aircraft.

4.4 Flight simulators categorisation according to JAR-FSTD Regulation

Currently there are many types of flight simulators. Each simulator achieves some technical level. Flight simulators are therefore divided into several types of classes.

The highest category of flight simulators, which are fully flexible, is called “Full Flight Simulators” (FFS). These simulators are designed for training in the particular type of aircraft such as Boeing 737, Airbus A320 and others.

This category is divided according to JAR Regulation, which is valid for Europe, into four levels - the A, B, C and D, where **A** represents the basic level and the lowest requirements for system functionality and amenities simulator. Each level is accompanied by additional requirements particularly on motion, visual and sound system. The highest level is **D**, which contains a motion system that works on six degrees of freedom, provides sensations of vibration and shaking, the effects of engine failure or icing, turbulence and many others.

Another category is Flight and Navigation Procedures Trainer (FNPT). This category is divided by the level of FNPT I, FNPT II and FNPT MCC. These are used primarily for flight training, instrument training and multi crew cooperation training (MCC – Multi-Crew Co-

operation). Category of Flight Training Devices (**FTD**) is divided into levels 1 and 2. *The lowest category of simulators* is the Basic Instrument Training Devices (**BITD**). The **Table 2** contains the categorisation of flight simulators to different levels of ratings according to European regulations JAR-FSTD.

Table 2 Categorisation of flight simulator according to JAR (own elaboration, according to [5])

FFS	FTD	FNPT	BITD
A	1	I	
B		II	
C	2	MCC	
D			

The flight simulators can also be used in area that does not serve directly to pilot training, but rather focuses on amateur use in a variety of games. Currently are available many **commercial flight simulators** such as Flight Gear, X-Plane, YS Flight Simulation 2000, Microsoft Flight Simulator Series or Google Earth Flight Simulator. [2]

5. DEVELOPMENT AND MANUFACTURING FLIGHT SIMULATORS IN THE BOTH SLOVAK REPUBLIC AND CZECH REPUBLIC

The Czech Republic and Slovak Republic have more organizations involved in the development and manufacturing of flight simulators.

In the Czech Republic there are organizations such as E-COM s.r.o. in Slavkov u Brna, VR Group a.s. in Prague, ERM Company s.r.o. in Olomouc or SAAB Czech, s.r.o. in Prague. The product portfolio of companies in the flight simulators area focuses on the production of military flight simulators as well as the production of civil flight simulators, whether it be the helicopters or airplanes. Best known flight simulators manufacturer in Slovakia is Virtual Reality Media, a.s. (VRM) company in Trenčín. This company is dealing with design, development and manufactures of modern flight simulators and training system and is offering complete and cost-effective solutions that meets the training requirements. Extensive skills and professional knowledge can be seen by a diverse range of products. VRM provides the most modern and sophisticated products to customers, including qualified training, maintenance and life cycle support. It is renowned supplier for Slovakia and other international customers. VRM has experienced team which provides the installation of their products in Slovakia as well as foreign countries (Fig. 5). [8]



Fig. 5 The installation of the FTD Mi-17 CT in Taji, Iraq realized by VRM company [9]

The core product portfolio of VRM company includes: [8]

- Military Simulators - combat and training aircraft (MiG-29, MiG-21, Su-22, Su-25, L-39);
- Helicopters and combat vehicles - helicopters (Mi-17, Mi-171); tanks and combat vehicles (T-72, BMP-2);
- Civil Flight Simulators - Business jets; Cessna Citation FNPT, FNPT II MCC, FTD and FFS levels C, D;
- Other services - 3D modelling, modelling of terrain databases (Geo-typical, Geo-specific), conversion of glazed cabin.

6. USING OF FLIGHT SIMULATORS FOR FLIGHT CREW TRAINING IN THE BOTH SLOVAK REPUBLIC AND CZECH REPUBLIC CONDITIONS

In many professional flight schools, initial training is conducted partially in the aircraft and partially in relatively low-cost training devices such as FNPTs and FTDs.

For many commercial pilots, most aircraft orientation and recurrent training is conducted in high level FTDs or FFS. In comparison to training in an actual aircraft, simulation-based training allows for the training of manoeuvres or situations that may be impractical to perform in the aircraft, while keeping the pilot and instructor in a relatively low-risk environment on the ground. For example, electrical system failures, instrument failures, hydraulic system failures, environmental system failures, and even flight control failures can be simulated without risk to the pilots or aircraft.

Flight simulation also provides an economic advantage over training in an actual aircraft. Once fuel, maintenance, and insurance costs are taken into account, the operating costs of an FSTD are usually substantially lower than the operating costs of a simulated aircraft. For some large transport category airplanes, the operating costs may be several times lower for the FSTD than for the actual aircraft. [2]

The organizations providing the flight training in the both Slovak Republic and Czech Republic know very well on above mentioned matters and advantages of flight simulators using. Of course each country has own specifics, taking into account the quantity of registered air companies, flight schools, interest in flight training and other aspects.

In the Slovak Republic there are a few certified flight simulators, which are used with the flight schools mainly for training of emergency procedures, navigation procedures, IR training and type training. For example The University of Žilina uses the flight simulator FNPT II MCC from company MECHTRONIX for training of students mainly for obtaining qualification for IR training and for training MCC. The University of Žilina also uses a device SEP BITD C172RG and training device BITD Model PI-135 made by ELITE company. These simulators are used mainly for navigation procedures training. The company Seagle Air s.r.o in Trenčín is another organization that is offers the opportunity of flying in flight simulators. Seagle Air s.r.o. uses in flight training the flight simulators such as FNPT II Beech King Air 200, FNPT II L-410 and FFS Cessna Citation Jet C525. These simulators are being used mainly for IR training and for type training on these type of aircraft. In the Czech Republic has been used the flight simulators such as FFS and FNPT II. FFSs is used for type of aircraft B737 (Fig. 6) and A319 and one FNPT II/MCC is used for aircraft ATR 42/72. The company Let's Fly operates the Full Flight Simulator L-410 and FNPT II/MCC for aircraft AN-28. Let's Fly own also FNPT II/MCC for aircraft PA-34 Seneca V and Beechcraft B200. [10]



Fig. 6 Full Flight Simulator B737 used by ČSA [11]

In the Prague - Letňany is FNPT II simulator TL-28. This simulator is suitable for MCC and IR training. This simulator has a motion system but it doesn't have the perfect visualization. Another FFS TL-410 is situated in Ostrava. This simulator is rare, it is type simulator of L-410 UVP. This simulator is older, but the advantage is FFS certification. Both simulators take advantage which is closed cabin. The effects of the external environment such as noise, sounds or voices of persons outside not become diseased the total impression of the simulator.

FNPT II is located in the Benešov. It is the newest certified FNPT in Czech Republic made by Mechtronix. This simulator can simulate two aircraft cockpits, PA-34 Seneca V and Very interesting project that was created in the Czech Republic is the „amateurish“ B737 NG simulator. It is „amateurish“ because this simulator does not have any certification. [10]

7. CONCLUSION

The flight simulators issue is very extensive and deep. The use of flight simulators in both civil aviation and military air force training is commonplace and widely accepted. These simulators allow flight crews to practice needed level of training tasks and potentially life-threatening manoeuvres. The using of simulation technologies for the flight training have the high importance from the training, air safety, financial and other aspects.

The ambition of the authors was to provide some understandable information regarding the flight simulators issue. In this article we were trying to focus on selected information, starting with some general and historical information on this issue, continue through part concerning the main requirements for flight simulators and their categorisation according to relevant criteria and to briefly introduce the Slovak and Czech development and manufacturing organizations in this area, as well as the appropriate information on using these technologies for the flight crew training in the both Slovak Republic and Czech Republic conditions.

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