

## **Flight simulators for general aviation**

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### ***Abstract:***

The article is devoted to the flight simulators issues, primarily the simulators intended for general aviation. This article presents the areas currently using the flight simulators, their importance in the aviation transport safety and development trends of this industry. The aim of the article is to offer an overview of the most important flight simulation manufacturers for general aviation and a basic description these training simulation devices.

### ***Keywords:***

general aviation; simulator; safety; pilot's training

## **INTRODUCTION**

In aviation industry, simulators are used for the same purpose as in the design process of new aircrafts, in behaviour and operating lifetime examination and in training people to operate the aircraft without actually having to fly one, etc. Therefore, flight light simulators can be divided to development simulations (designated for developers) and flight simulations (intended for the aircraft simulation flight, the aircraft behaviour and mainly for pilot's training). Development simulations are used in the following : in the design process for new aircraft or its individual parts, tuning and verifying flight characteristics in all phases of flight, verification of stiffness of the constructure or verifying lifetime for different types of stress. This ultimately determines aircraft limits during operation both in the short and long term. This simplifies the work of developers, designers and technologists. Flight simulations have been used since the very

beginning of the Air Force itself. While in the past there was a need to prepare pilots for a new working environment, today the main focus is to reduce the risk of accidents and an economic factor. This, on the contrary, increases the training requirements, verification of crew and operator's skills, regularly gaining experience at the lowest possible cost.

## 1. FLIGHT SIMULATORS FOR COMMERCIAL AIR TRANSPORT

It is possible, to express the movement of an aircraft, its characteristics and to simulate its movement in the virtual environment through a set of differential equations. The complexity of mathematical relationships depends on the amount of variables considered that will be, for the sake of calculation, taken into account. This complexity then generates simulator computational power requirements. For simplicity, we divide the flight simulator into the hardware part and the software part.

The hardware part includes cabin controls, visual units, computer technology and platform for simulation of movement. The software part is responsible for the movement of the aircraft in space, performance of its quality and his impact on meteorological events. The software constantly uses the performance of computers and calculates the differential equations of the aircraft's position and motion.



**Fig.1** Flight simulators

The results, obtained by visualisation and audio system display demonstrate steering force, platform motion and data changes in the crew cabin. The more input data the software processes, the more realistic the output is.

Of course, there is a strong mutual-connection between software and hardware. These two parts must be maximally tuned in performance and function.



**Fig.2** Products of the world-known flight simulators manufacturers, FFS company

A detailed examination of the aviation industry clearly shows that the greatest need for simulators is generated by commercial air aviation. Commercial air aviation transports a large number of passengers and flights, hence it represents the greatest number of take-offs, landings and flight hours [1].

**Table 1** Number and placement of FFS flight simulators series in the world in 2011.

<b>Number of simulators</b>	<b>Users by Country</b>	<b>Share in the world [%]</b>
561	USA	42,7
86	UK	6,5
79	China	6,0
51	France	3,9
43	Canada	3,3
41	Germany	3,1
32	Japan	2,4
30	Australia	2,3
27	Netherlands	2,1
26	UAE	2,0
19	Russia	1,4
18	Italy	1,4
16	Spain	1,2
16	Brazil	1,2
16	Singapore	1,2
16	S. Africa	1,2
16	S. Korea	1,2
15	Malaysia	1,1
14	Turkey	1,1
13	Sweden	1,0
12	India	0,9
12	Indonesia	0,9
11	Saudi Arabia	0,8
10	Taiwan	0,8
136	37 others	10,3
1318	In total	<b>100,0</b>

Source: [2]

The acquisition cost and operating costs of aircrafts used for air transport is high. For that reason, commercial aviation owners are forced to use these aircrafts to be maximally efficient or business, and not for crew training. This would only increase their total operational costs.

Therefore, in order to maintain a high level of flight safety, flight crews practice on flight simulators. Airline companies own or outsource such services from someone else who owns simulators. Availability of the most realistic simulators is requested at most.

**Table 2** Manufacturers of FFS flight simulators series in the world in 2011.

<b>Number of simulators</b>	<b>Manufacturer</b>	<b>Market share [%]</b>
579	CAE	44,0
325	FSI	24,7
282	Thales	21,4
33	Link	2,5
22	Mechtronix	1,7
17	Sim-Industries	1,3
15	Opinicus	1,1
7	Rockwell Collins	0,5
7	Transas	0,5
35	14 others	2,7
<b>1315</b>	<b>In total</b>	<b>100,0</b>

Source: [2]

The full flight simulator (FFS) or flight training device (FTD), with the advanced visual projections and audio systems, both are typically used within this industry. In 2011, 1318 flight simulators of the FFS category were used in the world.

Leaders in modeling and simulation technologies such as CAE, FSI, Thales, Link, Sim-Industries, Opinicus, Rockwell-Collins, Transas, Axis, Mechtronix, Sicotec, Simflightronics and FlyPlanes develop and offer these types of simulators.

## 2. FLIGHT SIMULATORS FOR GENERAL AIR AVIATION AND SMALL AIRCRAFT COMPANIES

A large number of professionals is required for commercial aviation [3]. These professionals must undergo high level of preparation. Firstly, aircraft crews must learn how to operate an air transport and then learn to use a particular aircraft type. Afterwards, the skills and habits must be developed and re-tested at deeper level.



**Fig.3** Flight simulators for general aviation

The same is required from aircraft technicians, operators, cabin crew members, and so on. It takes a long time to become a professional in the aviation industry. The journey often starts by joining an areoclub, attending an aviation school, and afterwards, getting experience through small airlines that practice business in aviation. Such companies, aeronautical schools or aero clubs can not, for operational reasons, afford relatively expensive and maximally realistic simulators. Because of the operational reasons, aviation schools and areoclubs can

not afford these relatively expensive and maximally realistic simulators. Companies such as Elite, Red Bird, Alsim, Mechtronics and Frasca etc. aim to develop and manufacture flight simulators for this type of users.

## 2.1 Elite Simulation Solution

ELITE Simulation Solutions (abbreviation of the Electronic IFR Training Environment) is a company providing flying lessons according IFR (instrument flight rules) conditions and ATM (air traffic management). The company was established in 1987 based on the need for simulation technology and the rapid development of computer technology. They focus on the development and production of open and flexible flight training systems for personal education programs and on provision of educational trainings and programs. ELITE Simulation Solutions is based in the United States. Their flight simulators are of the modular type.



Fig.4 ELITE flight simulators

The simulating cabin or helicopter consists of a dashboard, control console, control lever and control pedals. The system is computer-controlled and complemented by a visualization system. It shows the space around the airplane / helicopter cabin. The system may consist of one, three, or more monitors. If applicable, based on the complexity, one or three – point project system with a direct projection can be used as a visual system. Sound system simulating sounds in the cabin is also included. The whole system may include a software instructor workstation, and it is based on the personal computer design. Nowadays, personal computers are affordable, therefore, the cost of such a device starts at a very interesting level and is also available to an individual. Such simulators reach levels of OTD, BITD to FNPT. Elite company also develop their own software that can control this simulation device, or it could also potentially be used for teaching purposes [4].

## 2.2 RedBird Flight Simulations

The company was established in 2006 in order to enable the access of flight simulators to the general public. RedBird Flight Simulations is based in the US and have produced around 300 simulators until now. Simulators are mainly used for flight schools and training organizations. These Flight Simulators can be placed on a movable platform and achieve the category of FTD, according to JAA. According to JAA, they are classified into AATDs (Advanced Aviation Training Devices). The report [5] dated 31.10.2012 states that Beechcraft King Air 350 used their simulator in the range of 80% on type training. The training was accredited by FAA [6].

Focus of activity:

- Aviation schools training and training centres
- Commercial and regional aviation training

Products:

- Basic Training Devices (BITD): TD, TD2
- Advanced Training Devices : LD, SD, FMX, MCX, MX2
- Specialty Devices: XWIND, XWINDSE





Fig.5 Flight simulator MX, RedBird company

### 2.3 Alsim

Alsim Flight Training Solution was established in 1994 as a response to the aviation industry and microcomputers development. Simulators manufactured by Alsim are used from the general aviation up to regional companies. They mainly focus on the production of FNPT Simulators. The latest model should be able to meet the training requirements of the pilots operating different type of aircrafts, from the one-engine aircraft with a piston engine up to medium regional jet airplane. The company is based in France and sell their products in Europe, Africa, Asia and the United States. They have produced more than 170 flight simulators and operate in 36 countries worldwide. In addition to development and production, Alsim also deals with aviation consulting and training programs [7].

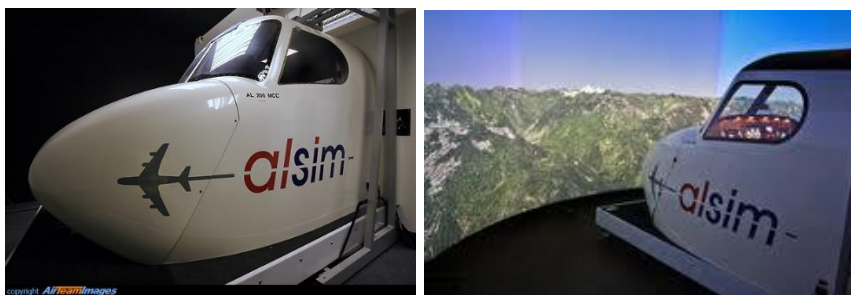


Fig.6 Flight simulator Alsim AL200 MCC

Products:

- ACT G1000, allows training on the glass cockpit.
- G-Sim, allows training of private pilots in compliance of VFR and IFR. The cabin can be re-designed based on the type such as Cessna 152, Piper PA38, Cessna 182, M20J and so on.
- AL50 allows training of beginners and maintenance training of pilots
- AL172 allows training with glass cockpit in small aviation schools. It reproduces the aircraft cabin Cessna 172 NAV III using Garmin G1000.
- AL-200DA42, allows aviation training with glass cockpit. It reproduces the aircraft cabin DA42 using all of the systems.
- AL200 is an advanced model of AL172, allows aviation schools to train the actions
- AL200MCC allows training on one-engine and multi-engine aircrafts and simulation of Beechcraft King Air 200 or Cessna Citation C550. It is suitable for training of
- PPL, CPL, IR and MCC.
- AL300MCC was manufactured with cooperation in Augsburg Airways for Dash 8 aircraft crews. It is used during the type training in the range of 50%
- ALX is a multi-flight model. It allows the preparation of pilots on PPL, CPL, IR, MCC and jet aircrafts

## 2.4 Frasca Flight Simulations

An international company dealing with the development and production of the flight training devices for aviation companies, aviation schools and military organisations worldwide. The company was established in 1958 in the United States and has done business around the world. Frasca Flight Simulations mainly focus on the development and production of flight simulators of single-engine and multi-engine aircrafts, flight simulators of turboprop aircrafts of regional airlines and helicopter flight simulators. These simulators are modular system simulators, easily customizable to meet the customers requirements. The product's reliability is high. Simulators are equipped with their own instructor workplace. The company has built a number of different types of aircraft simulators including Cessna 172, Diamond DA-40 and DA-42, Cirrus, Piper Seminole, Warrior, Archer, Cessna Caravan, Cessna Citation, Beechcraft King Air, Beechcraft 1900,

Pilatus PC 7/ PC 9, Bell 206/ 407/ 412, Eurocopter 120/ 135/ 225/ 350 and many more. [8].

In order to meet the customer requirements, the company is capable to manufacture FFS simulator up to the level D for any type of aircraft or helicopter.



**Fig.7** Flight simulator TruFlite™ Frasca company

### 2.5 Diamond Simulation

Another group of flight simulation manufacturers are aircraft manufacturers themselves, Diamond and others. Development and production are in collaboration with other companies dealing with simulation. Their ambition is to establish a good position in the market by providing package services.



**Fig.8** Flight Simulator - Diamond Simulator D-SIM-40

Diamond simulation is part of the Diamond group, which manufacture aircrafts of the General Air Force. DA20 Katana and DA 40 Diamond Star are both one-engine aircrafts. DA42 Twin Star is two-engine aircraft. These aircrafts are multi-seat, with low running costs and therefore very popular. However, the goal of the company is to sell package services and has therefore created a Diamond simulation. The mission was the production and development of flight simulators of their own aircrafts. Currently, they have produced simulators D-SIM-40 and D-SIM-42. These simulators are known as very realistic to be aircraft cabin as well as control elements. It contains an instructor's workplace with the option of choosing faults of aircraft systems, aircraft position, weather changes and so on [9].



**Fig.9** Flight Simulator - Diamond Simulator D-SIM-42

## **CONCLUSION**

Currently, utilization of flight simulators within the general aviation industry is significantly increasing, or the following main reasons: aviation legislation allows, within the flight training, to take a certain number of hours on flight simulator to obtain a basic pilot licence PPL. Therefore, it is preferable, from the economic point of view, to practice on the flight simulator for both training organisation and students, as an hour spent on the flight simulation is cheaper. A major reason for increased usage of flight simulators is currently also a massive transition from a classic analogue display of flight and navigation data to a glass cockpit display. Navigation and application of glass cockpit display cannot be used during actual flights due to its many functions. The most significant contribution of the use of flight simulators is a significant increase in aviation safety, as simulation flights can be performed outside the allowed restrictions of pilots or aircrafts.

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