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Igor Zhukov²EQUIPMENT COMPOSITION OPTIMIZATION OF A MULTI-PROFILE TRAINING
COMPLEX BASED ON WIRELESS COMMUNICATION

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E-mails: ¹morzhov@ua.fm; ²zhuia@ukr.net**Abstract**

Purpose: *The problems of the equipment composition optimizing in a multi-profile training center are considered. The structure of such center includes several complex and specialized aircraft simulators of various aircraft types, both civil and military. Operational changes in the composition of equipment allow for the rational structure of the equipment and reconfigurable simulator structure, which is necessary for a pilot training technical support of a certain aircraft type. It has been shown that it is necessary to use the wireless network to complete this task. Using such network as part of simulator complex allows providing wireless transmission of data streams between separate simulators of training complex simulators. Such information transfer organization between separate devices of simulators allows excluding from the equipment of simulators the expensive cables from electrical wires that were previously used to transmit information flows as the electrical signals between separate devices of simulators. Using the wireless network for information flows transmit in flight simulators will significantly increase the efficiency of training equipment use using for aircraft pilots training.*

Keywords: training complex; simulator; equipment; communication; complex; structure; efficiency; flow; crew; multi-profile; optimization

1. Introduction

The main task of the aviation industry of any country in the world that create and maintain the operation of modern aircraft in production conditions is to improve the design, aerodynamic characteristics and on-board automatic control systems as well as ground equipment that accompanies the flight both in normal piloting conditions and in sudden failures of on-board systems, which leads to a corresponding emergency situation.

So, any aircraft piloting is carried out by a trained crew, the safety and quality of the aircraft piloting will be determined in general by the quality of the human-machine "crew-aircraft" system. In view of the foregoing, it follows that the pilot, as an integral part of such system, with his professional level of training should provide the necessary quality of piloting and safety in flights performing.

However, the world aviation statistics is still indicate that about 90% of flight accidents take place solely due to incorrect or improper actions of the

crew, especially in critical situations due to lack of time and the proximity of the land.

In this regard, an extremely important problem appears that must be successfully solved in any aviation organization; it is the aviation specialists' effective training organization both on flight and on technical operation of aircraft and its equipment providing flight safety.

2. The equipment composition of the multi-profile aviation training complex and its tasks in the aviation specialists training

Computerization and informatization, which took place recently in the industrialized countries of the world, made it possible to apply these information technologies in the educational process when training aviation specialists of various specialties.

The computerization of the aviation specialist's professional training makes it possible to intensify the learning process by increasing the activity of specialists, adapting the learning process to the individual characteristics of each person, and the

visibility of the studied information in the subject area. All of that allows us to study what is really needed in the professional activities of a particular employee of an aviation enterprise or an airline company. For this purpose, on the basis of computers and modern information technologies, various technical tools are used that ensure the training process quality for the various aviation specialists training.

All computerized technical tools that are used in specialists training can be divided into two groups:

- computerized technical tools for the aviation specialists theoretical training;
- computerized technical tools for the aviation specialists' practical training.

Such computerized training facilities and periodic training include aviation simulators of various designs that have been widely distributed among aviation organizations for education and training of various specialists.

Modern aviation simulators are complex and expensive high-tech training tools for the aircraft crews training, which guarantee absolute "flying" safety when performing flight tasks of any complexity in ground conditions. Whatever mistakes the pilot makes when piloting on the simulator, this will not lead to the incorrect sensations appearance caused by the impact of even weak physical flight factors, nor to loss of professional health, especially death. This circumstance was the deciding factor for a wide range of different designs simulators usage in the aviation enterprises practice all over the world for the air crews preparation and training. It should be noted that the greatest efficiency of this technical tools usage for pilots training is manifested when developing the interaction of crew members in sudden failures and emergency situations during the aircraft "piloting".

According to the traditional technocratic concept, the quality of simulator preparation is directly proportional to the quality of real flight conditions simulation in terms of the pilots' workplaces layout of a specific aircraft, the aircraft position indication in space, the onboard systems and equipment operation, as well as the visible space outside the cabin, mobility sensations, various noises that accompany the operation of equipment, etc. The requirements for the similarity degree of a particular type simulator various characteristics are presented in the relevant regulatory certification documents.

It is generally accepted that the successful flight task performance on a simulator on technocratic

criteria (maintaining the flight parameters and modes of operation of airborne systems, the correct sequence when interacting with airborne systems, etc.) is one and sufficient criterion that guarantees high flight safety in the failure situation emergence in a real flight.

Generally accepted that successful implementation of the simulator flight task on technocratic criteria (maintaining of flight parameters and on-board systems operation modes, the correct sequence at interacting with on-board systems, etc.) is one and sufficient criterion for guaranteeing high safety flight when failures appear in real flight.

It should be noted that large aviation organizations create special training centers for the training of aviation specialists who operate aviation equipment created by this organization. So at the Antonov company there is a training center for pilots, which provides training for pilots of all aircraft types and their modifications created by this enterprise [2, 3, 4].

3. Wireless local computer network as a component of a multi-profile training complex

The basic principles that underlie the wireless communication development in the computer network of a training complex are based on Wi-Fi technology. Such information flows transmission is provided by Wireless LAN equipment. Wi-Fi is a wireless data transfer protocol that ensures the establishment of a stable connection between various computers of the training complex and integrates them into a local network. Such local computer network structure, which are used high frequency radio waves for communication and data transfer between nodes, rather than cable connections. The installation of Wireless LAN was recommended when the deployment of the cable system was impossible or economically impractical. Currently, many organizations use Wi-Fi, because under certain conditions the network speed is already over 100 Mb/s. Subscribers can move between access points through the territory of the training center.

Notice that the most commonly used today is the IEEE 802.11n protocol, which provides the information flows transmission in a wireless network. If the installation of such systems is impossible or economically impractical, then current mobile Wi-Fi implementations should be used. This will allow us to get a data transfer rate greater than

100 Mb/s, while subscribers can move between access points in the coverage area of the Wi-Fi network using mobile devices that are used, for example, by the instructor of the simulator (smartphones, PSP and laptops) equipped with client Wi-Fi transceivers and with access to the network. Typically, a Wi-Fi network layout contains at least one access point and can be easily scaled.

It is also possible to connect two clients in the point-to-point mode (Ad-hoc), when the access point is not used, and subscribers are connected with the network adapters "directly". The access point transmits its network identifier (SSID) using special signal packets with the rate 0.1 Mb/s every 100 ms. Therefore, 0.1 Mb/s is the lowest data rate for Wi-Fi. Knowing the SSID of the network, the subscriber can determine whether a connection to this access point is possible. If two access points with identical SSIDs fall within the coverage zone, the receiver can choose between them using the data about signal level. Wi-Fi Standard provides user complete freedom in the criteria choice for the connection.

However, the standard does not describe all aspects of the wireless Wi-Fi networks building. Therefore, each equipment manufacturer solves this problem in his own way, applying the approaches that he considers best from one or another point of view. Therefore, it becomes necessary to classify ways to build wireless LANs, as an integral part of the simulator complex, by the method of access points combining into a single system. In general, we can distinguish such methods:

In general, we can distinguish such methods as:

- stand-alone access point (also called as independent, decentralized, intelligent);
- access points that operate under the control of the controller;
- uncontrolled, but not stand-alone (which are controlled without a controller) [4,5].

4. Specialized aviation simulator based on a wireless computer network

The specialized aviation simulator, which is considered, consists of several stands with crew pilots workplaces of a particular aircraft type and a stand with instructors workplaces. At the aircraft crew stands, equipment of a particular aircraft type cabin is displayed, reflecting various information flows during the training of crew pilots. Each stand has its own computer, which provides simulation of the aircraft movement and its systems work. The instructor's stand includes the instructor's workplace

equipment and the computer with which they control the educational process. All the computers of the stands are united in a local area network, with the help of which the information flow control in the simulator is carried out during pilots training.

Notice that during the pilots training with the help of the stand equipment, streams of electrical signals from control elements located on the instrument panels are formed and entered to the communication system with real equipment where various forms of electric signals are transformed into a digital form for processing in a computer.

During the pilot work at the workplace, control signals are changed in the simulator by the control elements, which through the electric cables of the wireless information transmission units entered to the stand computer where the operation of a particular aircraft on-board system is simulated. The simulation results are transmitted via the wireless network to various indicators and instruments located on the instrument panel and reflect the aircraft and the on-board system state at the present time.

Such simulator has a flexible structure that allows you to determine quickly the number of a particular type aircraft stands that belong to the structure of the simulator at the present time.

Specialized aviation simulators that were used in aeronautical training centers had an extremely rigid structure, since the instrument equipment through the network of electric cables and the communication system with real equipment are mechanically connected in a single circuit. This does not ensure the universality and flexibility of the simulator equipment. In this case, the electric cables installation in such simulator takes a long time, does not allow the operative modernization of the simulator equipment according to the cabin modernization. In addition, the high cost of electric cables network significantly affects the cost of the entire simulator equipment. It should be noted that for simulators with a movable cabin, the electric cables network makes it difficult to move the dynamic stand on which the integrated simulator cabin is located, this affects the quality of the congestion simulation in such kind of simulator. The equipment of an analog communication system with real equipment and a computer can be used as part of only one simulator.

Thus, such analog devices for information input and output in simulators are inexpedient to apply in the modern aviation simulators development, since

they require a large number of electric cables that do not provide flexibility and universality of the training equipment. In addition, the installation or re-installation of the electric cables network requires a lot of time, does not allow making simulator cabin equipment modernization according to the equipment modernization of the real particular type aircraft cabin. It is worth noting the electrical cable network installation is the narrowest element in the process of any type simulator creation. In addition, the high cost of electric cables network significantly affects the cost of the entire simulator equipment. All electrical cables network should be in special channels or boxes and protect them from damage during simulator operation, and the technical staff provides protection against electric shock. All this requires additional material costs.

Thus, the purpose of a wireless local computer network usage is to consider the elimination of the electrical cables network from the equipment used for information input and output. This will achieve the flexibility and universality of simulator equipment. At the same time, it is much easier to modernize the cabin equipment consoles of the simulator according to the consoles modernization in the real aircraft cabin of a particular type. Simulator equipment installation costs are reduced due to lack of electric cables network and boxes.

In this way operative information flows control enables a rational composition of equipment and a reconfigurable structure of the simulator (complex or specialized) that is necessary for a specific training program technical support of crew pilots for a certain aircraft type or its modification.

For this task successful implementation it is necessary to use a local wireless computer network.

Assumed that such local computer network will allow us not only to provide structure flexibility of the training center aircraft simulators that is, to carry out an operational reconfiguration of the integrated simulator structure, depending on the minimum equipment required to perform the training program for the crew of the aircraft. In addition, such network usage as part of the training complex will allow the information flows wireless transmission between individual blocks of the training center simulators. Such information transfer organization between aviation simulators separate blocks allows excluding from the simulators equipment of expensive cables from electrical wires that were previously used for information flows transmission in the form of

electrical signals between separate units or simulator devices.

Here is represented that the usage of a local wireless computer network in the simulators equipment for the information flows transmission and control provides the flexibility of these technical training tools structure and allows optimizing the organization of the computing process in the training complex.

Confirmed that the creation of aviation simulators of various design, using modern information technology of wireless transmission and information flow control on the basis of the local area computer network of *the simulator complex*, allows to provide flexibility in the structure of the simulator of a specific type in aircraft simulators of various design, to significantly reduce the number of electric cables for information flows transmission in the simulator, and also reduces the number of identical equipment, which greatly improves the efficiency of all training center simulators usage, which in turn will lead to an improvement in the reliability of the training complex equipment functioning as a whole and to reduce the cost of pilot training at this institution [6].

5. Conclusions

Thus, as shown in the article, the usage of wireless communication in a simulator for information flows transmitting allows providing structure flexibility not only for one simulator, but also creates conditions for the rational usage of all training equipment in a multi-profile training complex.

All this contributes to a significant increasing of the training equipment usage efficiency and to reduce the cost of one hour of equipment operation in the aircraft pilots' preparation

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Оптимізація складу обладнання багатопрофільного тренажерного комплексу на основі бездротового зв'язку

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Мета: Підвищення ефективності використання тренажерного обладнання різного типу, що використовується в багатопрофільному тренажерному комплексі для професійної підготовки пілотів повітряних суден. Зростання ефективності досягається за рахунок використання в конструкції тренажерів безпроводного зв'язку для забезпечення передачі потоків інформації між окремими імітаторами або блоками. Все це дозволяє суттєво зменшити вартість підготовки кожного пілота або екіпажу повітряного судна конкретного типу, які проходять підготовку в такому тренажерному центрі.

Ключові слова: зв'язок; комплекс; екіпаж; ефективність; обладнання; багатопрофільний; оптимізація; імітатор; структура; тренажер

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Оптимизация состава оборудования многопрофильного тренажерного комплекса на основе беспроводной связи

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Цель: Повышение эффективности использования различного тренажерного оборудования, которое используется в многопрофильном тренажерном комплексе для профессиональной подготовки пилотов воздушных судов. Рост эффективности достигается за счет беспроводной связи в конструкции тренажеров, обеспечивающую передачу потоков информации между отдельными имитаторами или блоками тренажера. Все это позволяет существенно уменьшить стоимость подготовки каждого пилота или экипажа воздушного судна конкретного типа, которые проходят подготовку в таком тренажерном комплексе.

Ключевые слова: связь; комплекс; экипаж; эффективность; оборудование; многопрофильный; оптимизация; имитатор; структура; тренажер

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