New Technologies in the Global Aero - Space Engineering Education

Marek Foriash
Polish-Ukrainian Research Institute, Poland

Volodymyr Kharchenko, Dmytro Bugayko
National Aviation University, Ukraine

New technologies in the global aero - space engineering education are considered. The paper paid special attention to the civil aviation hazards and risks in the context of global aviation development trends. The paper deals with challenges of new aviation specialties creation, including features of 1, 2 and 3 education cycles. The paper introduces practical experience of the National Aviation University according to the new technologies in the aero - space engineering education implementation.

Keywords: technologies, global aero - space engineering education, cycles of education, hazards, risks, unmanned aerial vehicles.

1. INTRODUCTION

Training of highly qualified specialists is the key element for the development of global aerospace system. In this regard we have divided our paper into the following main parts:

Firstly, we will have a look at Global Approaches to Civil Aviation Activity Regulation Framework.

Secondly, we want to introduce features of Aero – Space Engineering Learning (three educational cycles) at the National Aviation University (NAU).

Then we will speak about our New Educational Technologies, which we developed and which we are implementing today.

Finally, we will offer some solutions regarding the ways of Aviation Personnel Global Training Development.

2. GLOBAL APPROACHES TO CIVIL AVIATION ACTIVITY REGULATION FRAMEWORK

Progress of humankind is very much sensitive to modern global challenges. Today global challenges have different aspects. Global challenges are closely connected to technologies and both these components identify specific features of science and education. They are based on new knowledge. In our opinion a lot depends on the development of socio-technical systems such as airspace industry, transport, nuclear power engineering, chemical industry etc. To meet the global challenges in the future we will need a new generation, which will be competitive and highly professional (see Fig.1).

New technologies in education provide training of highly qualified engineers for aviation and space industries. The technologies should be viewed and designed to meet three main requirements specific for these areas:

- incorporation of strong regulations and rules adopted in aviation and space industries;
- consideration of quick progress in airspace technologies development;
- competitiveness of today's and tomorrow's graduates on the national and international labour market.

In this regard didactic approaches to aerospace specialists teaching are as follows:

- To provide future engineers with knowledge on the regulations applied to their future profession.
- To develop their practical skills through training in modern laboratories equipped with the latest research products.

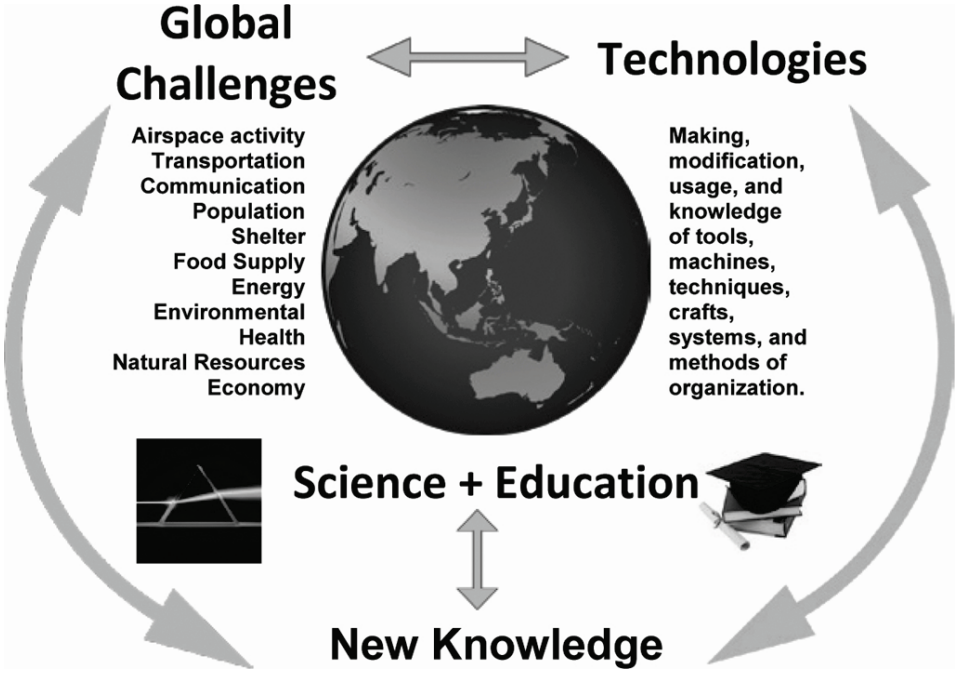

Fig. 1. Approach to Modern Science an Education.

According to Global Civil Aviation Regulation Framework the Aviation Personnel Training is regulated on three hierarchical levels - Global, Regional and National [1].

The Global level (provided by International Civil Aviation Organization (ICAO) consists of international training standards (based on *Standards and Recommended Practices* (SARPS)), co-ordination of activities and sharing best practices, etc). ICAO Safety Management System is grounded on management commitment and consists of three main directions of civil aviation development – safety, effectiveness and efficiency. All this directions depend on hazards and risks. Safety is the state in which the risk of harm to persons or property damage is reduced to, and maintained at or below, an acceptable level through a continuing process of hazard identification and risk management. Hazard – condition, object or activity with the potential of causing injuries to personnel, damage to equipment or structures, loss of material, or reduction of ability to perform a prescribed function. Hazard – Condition, object or activity with the potential of causing injuries to personnel, damage to equipment or structures, loss of material, or reduction of ability to perform a prescribed function. Risk – The chance of a loss or injury, measured in terms of severity and probability. The chance that something is going to happen, and the consequences if it does [2].

By ICAO main 3 risks defences within Global Safety Management System are: regulations; training and technologies.

The Regional level (Regional aviation organizations, such as EUROCONTROL, European Civil Aviation Conference (ECAC), European Aviation Safety Agency (EASA), etc.) adapts training standards to regional features and requirements.

The National level (National aviation organizations, such as National Supervisory Authorities (NSA), Civil Aviation Authorities (CAA), State Aviation Administration (SAA) and national training centres, such as National Aviation University, Kyiv, Ukraine, International University of Logistics and Transport in Wroclaw, Poland, Polish-Ukrainian Research Institute) . At this level implementation of training standards is provided. It should be underlined that higher education and research institutions play a significant role in the development of training programmes, technology, and regulations. National Aviation University, International University of Logistics and Transport in Wroclaw, Polish-Ukrainian Research Institute are among them.

Global, regional and national levels are hierarchically interconnected and mutually consistent.

3. FEATURES OF AERO - SPACE ENGINEERING LEARNING (1, 2 AND 3 EDUCATIONAL CYCLES) AT THE NATIONAL AVIATION UNIVERSITY, UKRAINE.

National Aviation University (NAU) is a large higher educational establishment well-known both in Ukraine and far abroad. For the years of its existence the University has trained over 150 thousand Specialists and Masters and over 5 thousand Candidates and Doctors of Science in many fields of country's economics, science and technology. The University has also trained thousands of specialists in advanced areas for 126 countries of the world. Nowadays more than 50 thousand students study at all University's structural departments accounting for 1200 foreign students from 44 countries.

Educational courses include practical recommendations and are based on documents of European Civil Aviation Conference (ECAC), European Aviation Safety Agency (EASA) and EUROCONTROL. The University has been successfully collaborating with the International Civil Aviation Organization (ICAO). It is also a place for two ICAO European Regional Training Centres which provide training and retraining for personnel of aviation companies of Ukraine and other countries of the world. Both centres use the generally-acknowledged TRAINAIR methods based on ICAO Standards and Recommended Practices.

The National Aviation University takes an active part in many international programs with foreign universities, training centres, associations and companies. NAU co-operates with more than 100 foreign scientific and training institutions of Russia, Germany, France, Poland, Spain, Azerbaijan, Belorussia, Lithuania, Latvia, Italy, Georgia, Vietnam, South Korea, India, China, Turkey and other countries.

National Aviation University focuses on opening of new specialties, which can meet the tendencies of global aviation development in future. For example, in 2014 a new specialty appeared at University aimed at training of Unmanned Aerial Vehicles (UAV) Ground Control Operators. The students, who choose this qualification, in addition to professional training on technology project design and use of unmanned aircraft systems get wider IT skills: programming skills, administration of computer systems and research engineer computer systems. The period of for getting the Bachelor degree is 4 years, the Master degree - one and a half year (see Fig.2).

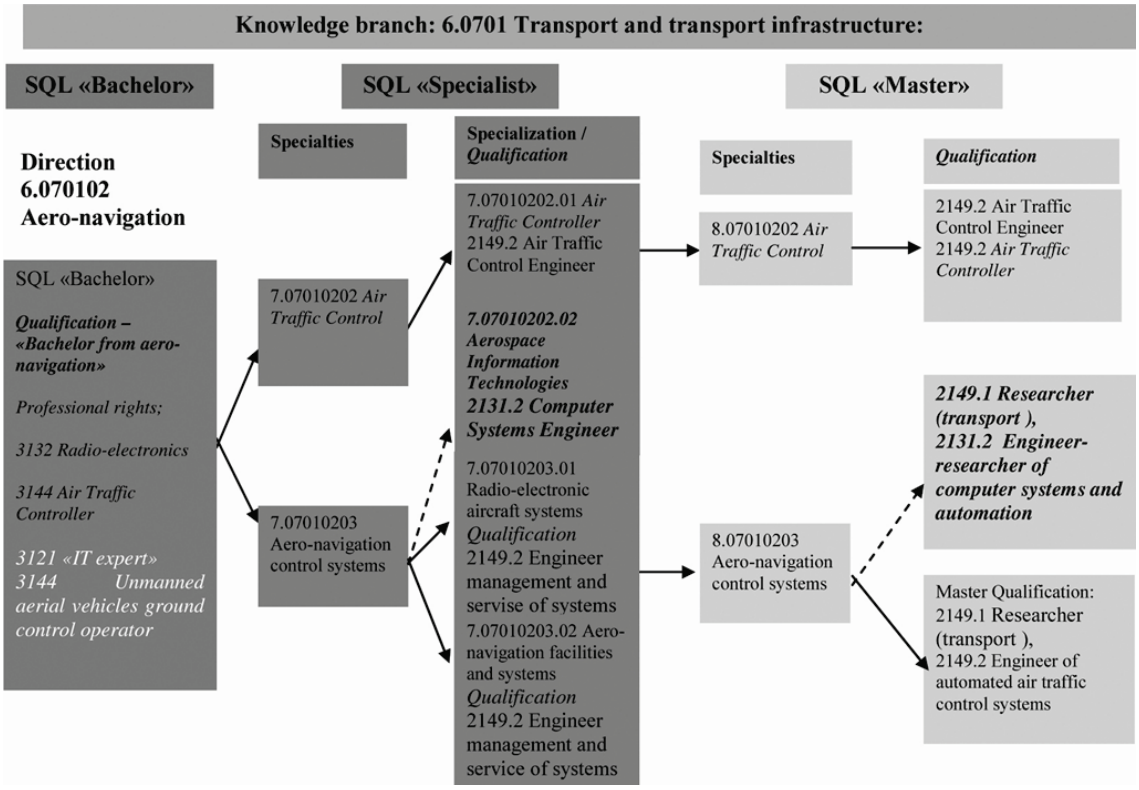

Fig. 2. Features of Aero - Space Engineering Learning (1, 2 educational cycles) at the National Aviation University.

The training of UAV ground control operator provides the following qualifications:

- IT Expert**.**
- ATC/Pilot PPL – Experts acquire knowledge and skills in the theory and practice of organization and control of air traffic. Studding the construction of modern air navigation systems, new concepts of air traffic management, flexible usage of airspace and procedures of air traffic services.
- UAV ground control operators - Experts can use, and maintain unmanned aeronautical systems and their components to be experts in management of unmanned aerial vehicles, equipment and personnel.
- Researcher of computer system and Automation/Computer system Engineer - Experts can use to create, develop and maintain air navigation systems and their components to be experts and managers, organizers of certification systems, equipment and personnel (See Fig.3) [3, 4].

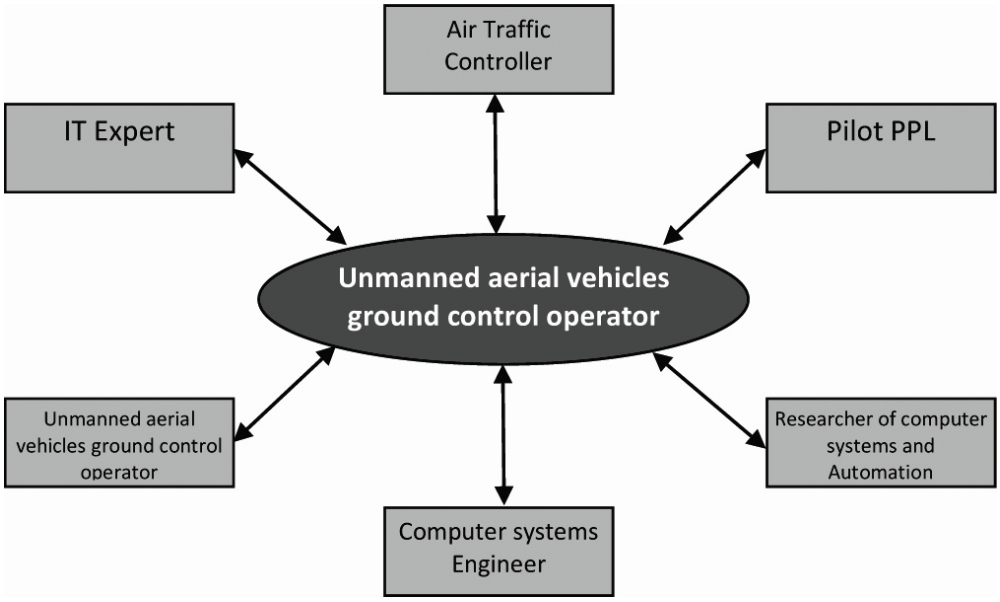

Fig. 3. Requirements of UAV Expert.

The new strategy for the training of highly qualified scientific personnel at the National Aviation University is provided within the framework of the International Tempus-Project "New Model of the Third Cycle in Engineering Education due to Bologna Process" (NETCENG), which is planned for years of 2014-2016. The Consortium of the TEMPUS Project consists of 22 institutions from 6 countries, including 14 universities. The Project Objective is the development and implementation of an experimental model of doctoral programs in the field of engineering and aerospace technology according to the Bologna Process, and 10 principles of Salzburg and Bucharest Forum, aimed to address the needs of economic development. Specific Project Objectives are:

- to develop, implement and accredit new core and transferable curricula including ECTS;
- to establish new structured doctoral programs in target area according to requirements of labour market;
- to develop innovative teaching/learning environment for doctoral programs;
- bring the higher education institutions of PCs closer to the labour market.

High-quality training of aerospace specialists, which is based on author programs of 1,2,3 educational cycles, gives to the university significant competitive advantages on the global educational market.

4. NEW TECHNOLOGIES AT THE NAU AERO - SPACE ENGINEERING LEARNING

It is not possible to provide modern educational process of higher technical institutions without a large-scale use of new technologies in training practical skills of future specialists.

As noted, the creation of unmanned aircraft systems is one of the priorities of the global civil aviation. In this regard, the National Aviation University conducted a perennial work on the

principles of design and creation of experimental remotely piloted aircraft systems. In the research and production centre of unmanned aviation "Virage" of National Aviation University the line of UAVs have been developed: one -engine M-3 "Border", M-6 "Skylark"; two-engine M -7, M-7D, M-7V5 "Sky Patrol", drones (the UAV) and UAV with an electric motor "Eye" (see Fig.4). These types of UAVs are used for aviation specialists training purposes.

Thus the ways to solve the problem of integration, search, recognition and processing of satellite tracking, navigation and UAV-onboard avionics. Together with researchers of the Ukrainian-Polish Research Institute in Wroclaw and the International University of Logistics and Transport in Wroclaw, Poland conducted comprehensive work on assessing capacity and effectiveness of RPAS to solve logistical problems of territorial infrastructure [5]. At the same time ways addressing the problems of integration, search, recognition and processing of satellite systems data, navigation and UAV onboard avionics are also developed at our university [6].

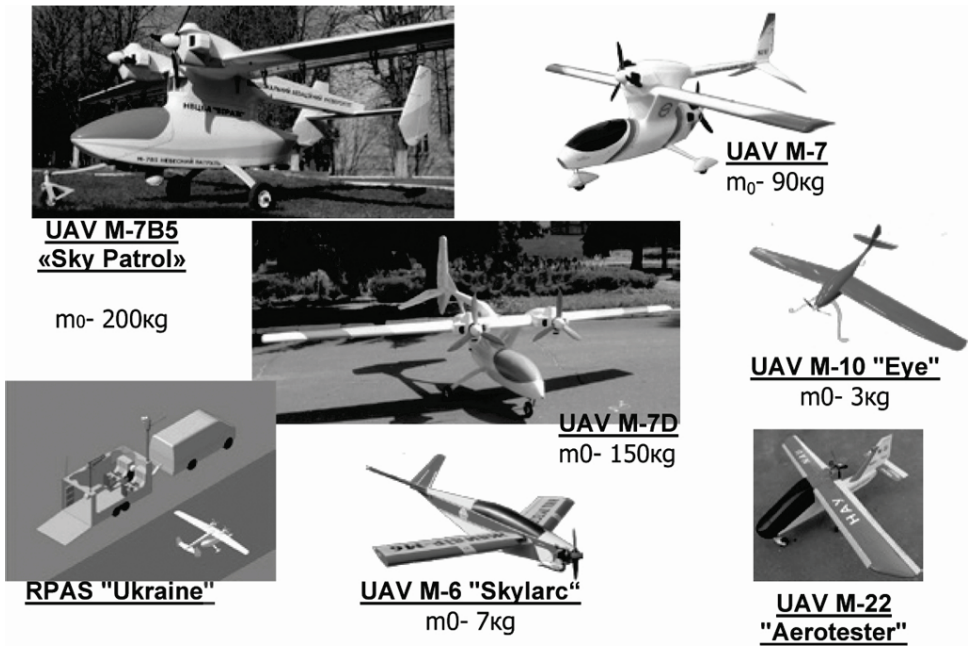

Fig. 4. Multi Propose UAVs of NAU.

Learning of aerospace specialists requires study of modern satellite technology. Scientific and Education Centre "Aerospace Centre" has been established at NAU to conduct fundamental, applied, experimental research projects and training courses. The Centre's activity is aimed at implementation of priority areas of science, engineering and technology-based global navigation satellite system and information technology (see Fig.5).

The tasks of the "Aerospace Centre" are as follows:

- Monitoring of satellite radio navigation systems field GPS, EGNOS, GLONASS.
- Technology objects protection from means of destruction that are equipped with satellite navigation equipment.
- Integrated information processing systems for aircraft navigation (GPS + EGNOS + GLONASS + inertial + LORAN).
- Differential satellite navigation system.
- Precision trajectory measurements in real time based on the differential satellite positioning systems.
- Prediction availability of satellite navigation systems in flight, takeoff and landing.
- Noise resistance of satellite navigation systems.
- Adaptive antenna systems for noise suppression satellite navigation systems.
- Algorithms of primary and secondary information processing of satellite navigation.
- Autonomous integrity monitoring satellite onboard navigation equipment.
- Monitor and control the movement of vehicles on the airport surface.
- Technological software navigation receivers, control and corrective stations.

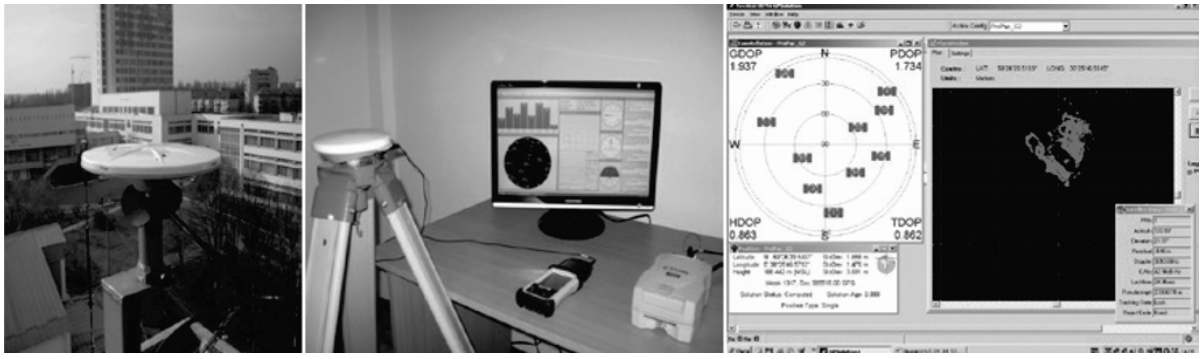

Fig. 5. Aerospace Centre – Experimental Equipment.

One of the most important directions of satellite navigation development is a solution to the problem of space debris. In this regard, the NAU conducted a complex research. The Navigation aids are the main part of service spacecraft for safe docking approach with the object to be utilized. A New approach to complex data processing obtained from different navigation systems is being developed. The ways of satellite navigation systems signals processing in the unstable radio navigation field have been studied. The research on increasing the jamming resistance of satellite radio navigation equipment is in process.

A significant role in the aviation specialists training is assigned to studies on simulators. A complex of Air Traffic Control and Flight Simulators was designed and operated at NAU (see Fig.6).

The ATM simulator consists of the following components:

- air traffic control (ATC) tower simulator;
- flight simulator of UAV;
- flight simulator of airplane Yak-18T.

ATC Tower Simulator provides:

- comprehensive training of ATC tower controllers based on traffic simulation (aircraft and vehicles) in the surveillance area;
- preparation and provision of ATC Tower controller tests in compliance with regulatory requirements;
- testing of ATC tower operation technologies.

The Simulators are designed for:

- air traffic management student and staff training in the real world situations;

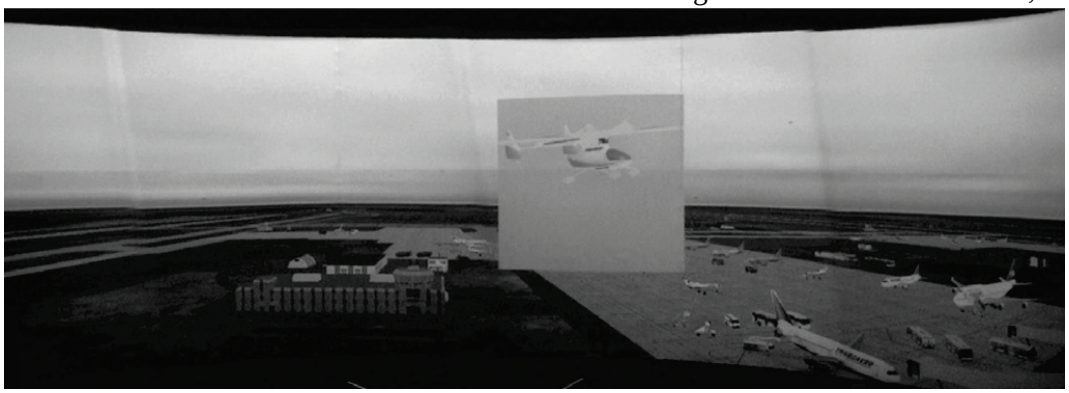

Fig. 6. Airport Tower, Aircraft and UAV Integrated Simulator.

Simulators software with elements of artificial intelligence were jointly developed by scientists and students of NAU. The Simulators were designed for:

- air traffic management (ATM) student and staff training in the real world situations;
- training and qualification testing of both pilots of aircrafts and unmanned aerial vehicles ground control operators.
- training and qualification testing of both Pilots of aircrafts and unmanned aerial vehicles (UAV) ground control operators.

The simulator is being developed as a research platform focused on the simulation of air traffic control systems for research and training purposes. For the software development which is entirely done by NAU researchers, the cross-platform open-source libraries and solutions are used. For

the high-fidelity traffic simulation the nonlinear flight dynamic models based on wind tunnel data are incorporated, while the simulation of pilot-in-the-loop is based on artificial intelligence (AI) approach. The mathematical apparatus and related software implementation has been also developed for aircraft conflict prediction and resolution.

For solving scientific tasks and conducting practical training on aerodynamics, NAU use own Aerodynamic Research Centre (see Fig.7).

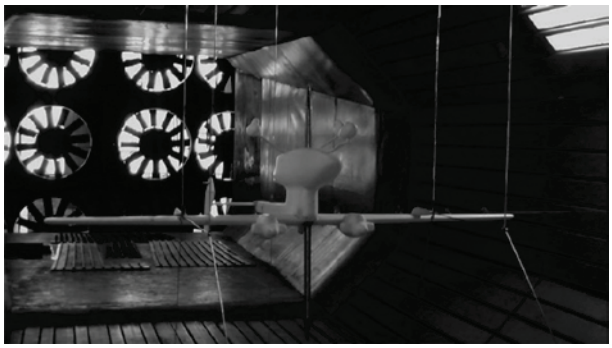

Fig.7. UAV Aerodynamic Test.

- calculation of stability and control characteristics;
- flight dynamics modelling;
- flight vehicle development;
- subsonic wind tunnels development;
- wind tunnel operators training.

In Fig. 8 we can see UAVs Components Durability Complex Test System, which allows researchers and students to design new types of UAVs.

5. CONCLUSION - DEVELOPMENT OF GLOBAL AVIATION PERSONNEL TRAINING

Joint research activity of the National Aviation University (Kyiv, Ukraine) and *the International University of Logistics and Transport in Wroclaw*, in the framework of the *Polish-Ukrainian Research Institute* is very important. Therefore, the National Aviation University, the Polish – Ukrainian Research Institute and the International University of Logistics and Transport in Wroclaw

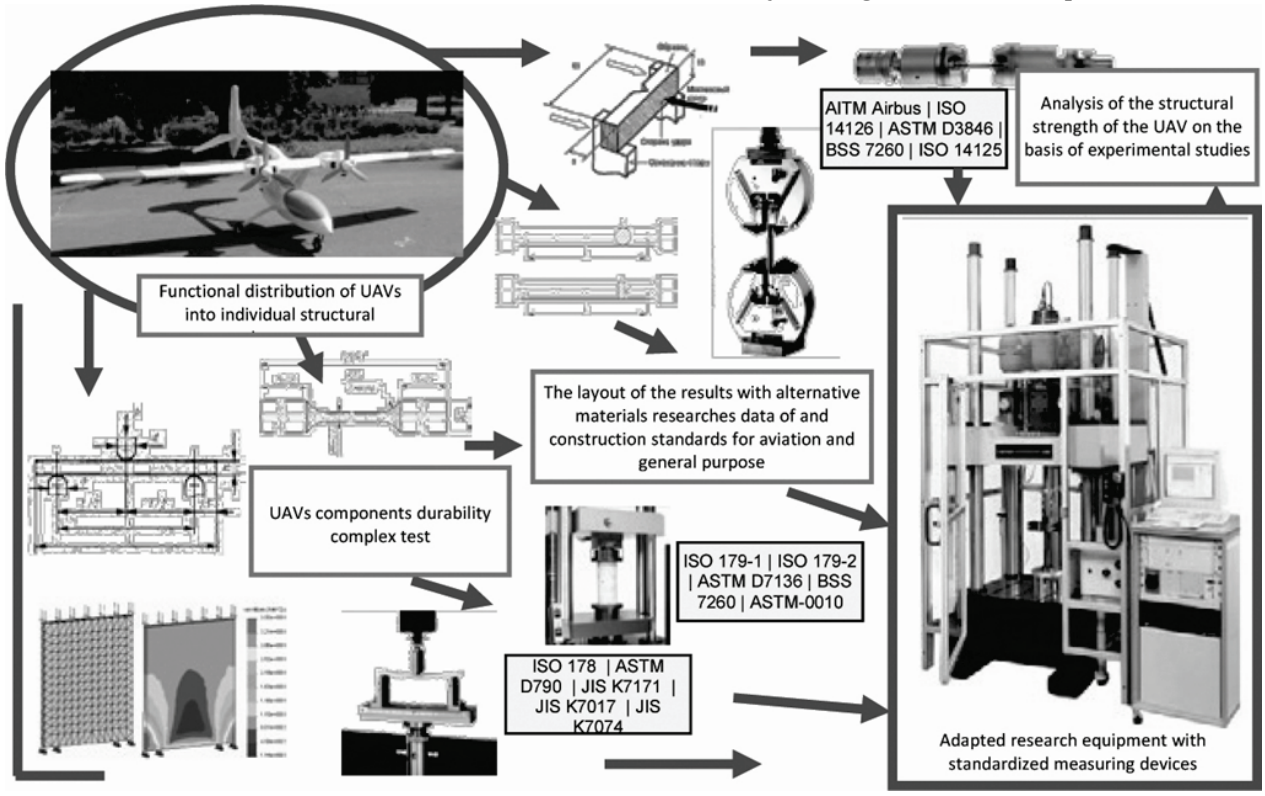

Fig. 8. UAVs Components Durability Complex Test System.

Scientists and students can use next the following services:

- models development and manufacturing;
- sophisticated data analyses and use;

formulated recommendations for three levels of civil aviation regulation on continuous development of the Aero - Space Engineering Educational Process and the application of new technologies (See Fig.9) [7].

Fig. 9. Development of Global Aviation Personnel Training.

For Global Level. Development of International Training Standards (based on *Standards and Recommended Practices* (SARPS) ICAO), Recommendation for Co-ordination of Activities and Sharing Best Practices, etc.

For Regional Level. Recommendation for Adapting of Training Standards to Regional Features and Requirements (for ECAC, EASA, Euro-control, Single European Sky regulations)

For National Level. Development of New Aviation and Transport Training Specialties (first, second and third educational cycles). Implementation of the World and Regional Training Standards.

The complex application of new technologies in the aero - space engineering education is the basis for recent development of aerospace activity.

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Marek Foriash
Polish-Ukrainian Research Institute, Poland
modus@modus-wroclaw.pl

Volodymyr Kharchenko
National Aviation University, Ukraine
kharch@nau.edu.ua

Dmytro Bugayko
National Aviation University, Ukraine
bugaiko@nau.edu.ua