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RULES OF EDUCATIONS AND TRAININGS IN THE AREA OF SAFETY OF AIR TRANSPORT AND GENERAL AVIATION

Abstract. The system of air education and trainings functioning currently in countries organized in ICAO association was presented in this work Authors payed attention to the fact, that specialistic air-trainings are entered into existing national educational systems. The security of passengers and crews of aerodynes is a most important matter in the air transport. Not only practical trainings, but also theoretical trainings and the background knowledge of the candidate on the flying staffer there have the essential influence on the security level. This fact was illustrated in the article with several examples, which illustrate typical, though often underestimated, aspects of the organization of educational systems and trainings, especially theoretical trainings. In spite of intensive searching authors of the article did not manage to reach a case study from the range of the methodology of air-trainings , understood as a multistage process, which lasts practically through the entire life of the airman. Maybe this results from the fact that that an aviation is created by technicians, and the theory of the education is a domain of humanists who do not understand the world of the technique. Presented work can be therefore treated as the invitation to the assumption of common interdisciplinary research.
Keywords: education for aviation, safety in general aviation, safety in line aviation, human factor, education systems, education for safety

ZASADY PROWADZENIA EDUKACJI I SZKOLEŃ W OBSZARZE BEZPIECZEŃSTWA LOTNICTWA OGÓLNEGO I TRANSPORTU LOTNICZEGO

Streszczenie. Od zarania dziejów człowiek próbuje przeciwdziałać zagrażającym mu niebezpieczeństwom i opanować wrogie sobie żywioły. Źródłem sukcesów w tej walce jest

wiedza zbierana przez pokolenia. Jest ona przekazywana działającym w warunkach zagrożenia osobom przez systemy edukacji i szkoleń, które są jednak niedoskonałe. Dlatego, zdaniem autorów, ludzie wykonujący konkretne zadania i podejmujący związane z tym decyzje popełniają błędy, prowadzące do zdarzeń niebezpiecznych, wypadków i katastrof, których teoretycznie można byłoby uniknąć. Od wielu lat, a nawet od wielu wieków prowadzone są poszukiwania najlepszego systemu instrukcji edukacji i szkoleń osób odpowiedzialnych za bezpieczeństwo. Stworzono wiele systemów dedykowanych do każdego obszaru działania. Pracują one dobrze, ale mogłyby pracować lepiej. Jednym z powodów tego stanu rzeczy jest brak współpracy specjalistów z zakresu bezpieczeństwa różnych obszarów , brak transferu wiedzy oraz niedocenianie szczególnej roli ogólnego wykształcenia technicznego. Autorzy niniejszej pracy przedstawiają różne systemy edukacji wykorzystywane w inżynierii bezpieczeństwa, opisują ich wady i zalety i proponują zmiany wiodące do poprawy efektywności. Przedstawiona opinia jest wynikiem analizy wielu zdarzeń i incydentów wypadkowych oraz zawodowych doświadczeń autorów pracujących jako nauczyciele akademiccy i inżynierowie bezpieczeństwa.
Słowa kluczowe: szkolenia lotnicze, lotnictwo ogólne, bezpieczeństwo lotów, czynnik ludzki, systemy edukacji, edukacja dla bezpieczeństwa.

Introduction

From the daybreak of history the man tries to master strange foreign and unfriendly elements. Basic source of successes in this fight is delivered the knowledge gathered by generations. This knowledge is delivered to following daredevils by use systems of the education and the instruction. These systems are however very imperfect. As result of this people undertaking concrete decisions making mistakes, leading to events and disasters whose theoretically one could avoid. For many years now, and even from many ages lasts research of the best system of the instruction of persons responsible for the safety. One created many educational systems dedicated to each effective range. These systems work well, but would be able to work better. The author of this work presents different educational systems used in the engineering of the safety, evidences their advantages and disadvantages and proposes changes leading to the improvement of the their efficiency. Presented opinion are the result of the analysis of many events connected with the resultant risk of disaster or accidents. They are also greatly determined by personal experiences of the author who is an academic and the engineer working the area of the technical safety.

Risk Factors

The risk is relative to many factors. Their analysis is a key to the understanding of the part of errors committed by the man. The set of the risk factors (danger factors) we divide usually on four subsets called:

- human factor,
- technical factor,
- law factor,
- random factor.

Almost all events and disasters are result of errors. Errors can be divided on:

- final errors,
- accumulated errors,
- hidden errors.

In the law literature and literature the connected with sciences of safety the human factor is associated usually with the final error. Simultaneously circumstances having the influence on the coming this error into being are ignored or analysed very superficial. As a result of this elimination of many kinds of the final error is not possible. It would be better to treat the final error as the result of well-known or unknown circumstances and conditionings, which could be independent on the person who is accused of causing of the disaster or the event. The manner of education and instruction is an example of such just circumstances. The after-mentioned example is illustrating such just the situation

The example 1

One businessman, having the opinion of the superb pilot, bought the new plane and with the group of friends flew on the mountainous airfield. Approaching to the landing suddenly he changed the decision trying to leave on the second circle. The plane crashed on the mountains slope. At first the personal the pilot error you given the ace the reason of the disaster. Why the experienced pilot committed so fatal error? The first answer he this question was: the bravado and the slight of the danger. This is however not the correct answer. I knew the pilot and I know that without the need never he would expose its own life. All the more he would not expose lives of passengers. In the fatal day reigned the very non-typical weather. It was very warmly and appeared fohn occurrences. Calibrated he other thickness of the atmosphere the altimeter showed the false altitude QNH. The instrument error could reach even to 50 m. Because air density was low and the plane was the strongly laden flight was performed on large angles of attack. This caused the optical illusion leading to wrong marking of the height. Wrong indications of the instrument (altimeter) were confirmed by wrong optical estimation of the height. Entering in ATZ the pilot asked of circumstances conditions for the landing. Unfortunately, the person being found on the tower of the airfield feared to give information, because

did not have the formal permission on the job as flight controller on this aerodrom. He didn't know that acting in the interest of the safety of flights in not typical situation (weather conditions) was not subjected to the legal responsibility for the break of regulations about the employment. One can so ascertain that a original reason committed by the pilot of errors was the lack of the proper education and the proper instruction. Particularly:

- the insufficient acquaintance of rules of the corection of indications of pilotage instruments,
- the lack acquaintances of the mechanism of the occurrence of optical illusions,
- the lack of the proper instruction in mountainous flights,
- the lack skills of the quick estimation of limitations due by high temperature of the air,
- the low of the education in the legal area of person fulfilled the turn of duty on the tower of the airfield.

The elimination of only one of mentioned higher education errors probably would suffice avoidably of the disaster. There it is proper to remind the old Roman rule "Minus saepe pecces si scias quidnescias". Both the pilot, how and the collector surely would supplement their own qualifications, if they would know, what should learn. People for the safety of flights responsible must possess the very spacious knowledge and will turn over many examinations {tests}. One cannot extend the area of the instruction indefinitely. The problem consists in these that one teach often unnecessary things and the teacher has not time for delivering the information which can decide about somebody's life.

Errors reckoned to groups "technical factor" are connected usually with the excessive specialization or with the excessive attention concentration on one unit. The basic educational error is providing of technicians into the very wide and detailed knowledge, which is however only a formal knowledge. The part of the intuition is underestimated. In the effect are committed primitive errors, called also the rough errors. The typical situation is desribed belov.

The example 2

Small, but having the large experience in the production of composite constructions the air-firm starts the production of ultralight planes. One applied the shell construction of the wing. The shell was designed with the use of latest programs FEM. She possessed the optimum- aerodynamic section and the very high static durability. Constructors forgot however to check the construction on the shell-buckling. During the tentative flight the wing lost the sedateness and has broken. The group of high educated specialists aided by the very good, professional ADP system made mistake which should not commit the sophomore of the engineering college.

In given example the education and training programme guilt for the disaster carries. Constructors of ultralight were splendidly educated to making very complicated calculations, but did not possess elementary engineer intuitions.

The low factor must be considered in two aspects:

- the not practice of the law,
- defective determining of the law.

The first aspect is usually exhibited in postresultant reports because the offence of the definite rule is easily to notice and to prove. Errors committed in this area belong to proximate causes of the event. Errors classified as "not practice of the law" determine approx. 30% statistically registered reasons of events. However statistics not always speak truths. In many cases the law is not performed, because is unrealisable. Many times a true culprit is not this, who breaks the legal provision, but this who created the defective rule.

The example 3

The greatest disaster in history of the aviation happened in the year 56 on Tenerife. At least three from among major causes of the accident were tied with defective determining of the law. The incorrect air-phraseology allowed on usage the word START in different meaning. This led to the wrong understanding the permissions given by the flight control. The lack of operating procedures available to crews in the trafic situation, which reigned on this airport in the fatal day was the second from major causes of the disaster. Newly introduced provisions regulating in the very rigid way a working period of the flight crew were third from legal-organizational factors causing the threat resultants. The Dutch crew decided on taking off of their plane conditioned the incertitude regarding the security of this operation, because the further stayover on earth threatened with the break of mentioned provisions and with official serious consequences.

Defective determining of the law is in opinion of author of this paper one of major causes of events. She appears more often than personal errors reckoned to the group called "human factor". Unfortunately, this is the reason visible only during the analysis of many similar events and incidents. Her detection demands simultaneously acquaintances of bases of the law and of the area, which this law has to regulate. This is difficult to the realization because is lacking experts who possess the knowledge and the experience in both mentioned higher areas. In countries of the western democracy rules of law are created by politicians, lawyer's economists and financiers. None of these professional groups is instructed in the area of the safety engineering. Es a result of this created legislative solutions are often a hidden source of the safety and security threat. Rules of the democracy we will not change. However it is possible and advisable creation of the instruction and education systems for mentioned persons. We need not deliver the full knowledge from the area of the safety engi-

neering. It will be enough if creators of the law will have a consciousness of their own ignorance.

Random factor is sometimes called as a coefficient of our ignorance. This is not the coefficient of the ignorance, but the coefficient of our ignorance. This means that area of activity of this factor one can be evidently diminish by the education. One cannot however teach all of all. It is necessary to decide, which knowledge is really indispensable for definite people.

The example 4

The schoolboy X was a top boy of the instruction on a glider pilot. In the fatal day he came on the airfield after the car travel lasting the all night. The ambition did not permit him to admit to the fatigue. Probably as the result of the pre-flight excitement it seemed to him that was sufficiently efficient for making of following exercises in air. Air seemed to be clean and quiet. Single cumulus wandered on the blue sky. This was however the apparent calm. Weather forecasts informed about the threat of the very rare phenomenon called a turbulence of the clean sky. In the moment of the flight on the large (to large) angle of attack the glider unexpectedly fell in the area of the turbulence. The tired schoolboy did not react sufficiently quickly, to prevent to the entry into the autorotation. Autorotation on low high marks the death. The glider became broken, the schoolboy was killed. Reasons of the event one reckoned in to two groups: human factor and random factor.

In the given example the insufficient level of the training in the area of subject "Human Factors & Pilot Performance" and "Meteorology" was an original reason of the accident . In educational programmes of the subject "Human Factors & Pilot Performance" the encyclopaedic information are given instead of the knowledge from the range of the physiology and the air-hygiene. The meteorology is presented in the so hermetic way that the greater great deal of students, and even many instructors calls her a cabala. This makes difficult the proper interpretation of the information meteo from Internet and interpretation of observed symptoms of threats. The way of publishing of official meteorological forecasts is archaic and unfriendly for the recipient. They are coded with special code, coming from times of the Mors telegraphy. This makes difficult, and sometimes even makes impossible the precise description of atypical phenomena and causes also essential difficulties in reading of the non-standard communication. In given example the official (coded) forecast did not contain the warning before the the clean sky turbulence. Instructors leading the activities on this day did not have the duty of making acquaintance with all potentially available forecasts and comments of meteorologists person.

Given example illustrates the phenomenon of the simultaneous occurrence of the accumulated error and the hidden error. The sum of seemingly small errors, committed by many people led to the disaster. These errors are

simultaneously errors hidden, because their relationship with the final result is not obvious. However one would be able to avoid disasters, if all actors of the theatre of events had the knowledge enabling the detection of symptoms of threats.

Systems for instruction and education

The restriction of the negative impact of risk factors on the safety takes place across:

- the creation of legal systems and the legal education,
- the general education,
- trainings and the education oriented on matters related to the aviation.

In general educational systems it is necessary to discriminate following stages:

- the initial stage,
- the preliminary education,
- the basic education,
- the professional training.
- the advanced professional training

The oriented educational systems can divide on:

- the academic model,
- the teaching model,
- systems of the self-education.

Every from European countries has his own specific education and instruction system. These systems are tied however with themselves across conventions and international treaties and agreements concerning of the mutual recognition of certificates. In the area of air-trainings of the decision of the Chicago convention and detailed provisions given by ICAO are in force all over the world. Additionally in Europe provisions Eurocontrol are in force.

The academic profile of the education for the safety

There is no one academic model. Existing solutions can be divided due to effective ranges and manners of the action. Different area paths leading to the same purpose – improvements of the securities of air operations – one showed in fig. 1.

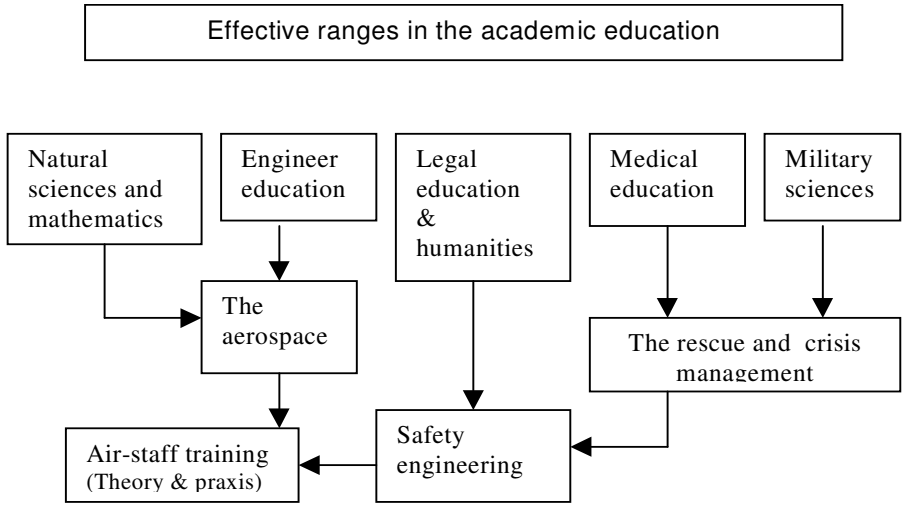

Fig. 1. The position of the safety engineering and air-trainings in the academic training programme

Depending on the point of departure achieved effects can be different. However the discussion on of this which from ways leading to the improvement of the safety is by definition better – does not make meaning. Tasks performed by crews of air ships are strongly differentiated. Conditions of the realization of these tasks are different. It is not allowed also to forget about the differentiation of personal features of air-crews members and of candidates to trainings. Therefore necessary is the assertion of the large diversity both contents and forms of the education is necessary. The division of training programmes realized within the framework of the academic model one showed on fig. 2.

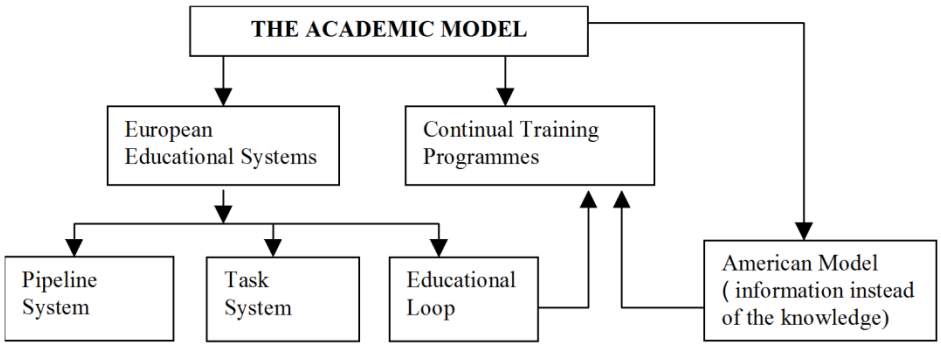

Fig. 2. Manners of the realization of the academic model for the education and air-trainings

The academic model has its roots in university-traditions of Europe. The Mediterranean tradition and the Eastern European tradition prefer the educational variant, relying on the transfer of the knowledge instead of the information. To teach thinkings (in this the mathematical thinking) is a basic task of European educational systems. They appear in three basic variants: pipelined, strangulated and of task.

In the pipeline system the information forming the logical corpus are transferred only once. The expanded tests systems and examinations serves for cohesion of this system. Through to tests the listener is forced to the self-contained repetition of gained information.

The educational loop relies on the repetition of the same basic information sets and to the discussion them in different contexts. This enables the better understanding and the memorization of displayed material and **eliminates the necessity of incessant examining**. The system of repetitions realized in the educational loop is an educational model which acts much more effectively from the pipelined model. The correct working of this system is possible however only in case of a very good coordination of turn-down contents and led exercises. He requires employments of teachers about highest qualifications and the careful selection of candidates taught or trained according to the determined profile.

The task system relies on the knowledge acquisition at by students and pupils in the way almost independent. This is the typical study, requiring of the free access to instructional material and the large number of individual consultations. He teaches independences, but creates simultaneously the danger of the uprising of unacceptable gaps in the area of the basic knowledge.

Large controversies wakes the initiation in Europe an American model which is based on the teaching of procedures without the understanding of sense of them by the pupil. Such system takes an exam in case of, when the number of procedures is small and they are memorable. At the greater number of the information not constituting the logically well ordered theory follows the process of random lapses of memory. Can then appear informational gaps directly leading to committing to critical errors . There can appear also other dangerous phenomenon - the lack of the skill of the use of the possessed knowledge, caused with the habit to the use a ready solutions given in instructions. This illustrates the after-mentioned example.

The example 5

In the year 2013 happened on the airport EPRU the accident in which died many young people. The plane carrying out of parachutists started at the temperature of air above 400C. From elementary thermodynamic calculations results, that the relation of the thermodynamic efficiency of engines to the rated efficiency was equal

$$\eta_1 = \frac{T_2 - T_0}{T_2 - T_s} \approx 0.97 \qquad (1)$$

where

T_2 – the permissible highest temperature in the cylinder of the engine, $T_2 \approx 1300^0$C

T_0 – the ambient temperature T_0=40

T_s – the temperature for which one means the rated engine power $T_s = 15^0$C

The proportional fall of the capacity of wings caused with the change of the air density was equal

$$\eta_2 = \frac{T_s}{T_0} \approx 0.92 \qquad (2)$$

The therefore maximum starting mass should to be reduced about at least[1] $(1-\eta_1\eta_2) \approx 11\%$. The plane took off with the rated load given in the instruction for standard atmosphere. Engines became in the perceptible way overloaded. This became one of reasons of the failure of one of them in the critical flight phase and the disaster tragic in results. The pilot undoubtedly had the knowledge nessesary for the supplement of the informational gap in the manual of the plane. He could not however correctly use this knowledge.

The practical profile

The practical profile in education, called is also as the teaching model is typical for countries of the culture Germanic and Anglo-Saxon. He prepares quickly and effectively for the undertaking of the regular professional work or performing of the determined function in the crew realizing typical tasks, but it makes difficult, and sometimes even makes impossible the creative work and the correct action in atypical conditions. It is not fitted for the training of commanders of the higher grade.

The practical training preceded with the theoretical training

This system is applied both in the academic model, and in the teaching model. In this system are led air-trainings PPL in Poland. Basic and practically only his advantages are: the low cost and the comfort of the organization. Every stage of the theoretical training ends with the written examination or with the

[1] In the calculation one did not take into account the fall of the efficiency of the propeller. One did not take either under the attention so called density height of the airport, which caused the additional fall of the capacity several percent.

computer test. The test-examination the overall of displayed material is led on the final. The practical training is led exclusively in the teaching mode. It is divided into several dozen practical tasks which the pupil performs under supervision of the instructor. The nadir of the practical training foresees three internal practical examinations in the training centre and The state examination. The winning of following air-authorizations is tied with the holding of the similar cycle. z tym, For the obtainment of some authorizations wymagany jest it is required additionally the execution of the specific amount of independent flights or other kind the air-practice.

The parallel leading of the theoretical and practical training

In this system basic air-trainings in Czech Republic are led. A basic advantage of the system is the large motivation resulting from the direct relationship of turn-down material with practical tasks. Formal partial examinations are not there, but every instructor of the hands-on training before the accession to the following task checks the level of the capture of theoretical messages related to this task. A defect of the system is the omission in the process the training of the information not directly related to situations appearing during the practical training. There is in him also no place for the general knowledge. Podstawową zaletą systemu jest bardzo The good contact of trained person with the instructor who bears the full responsibility for results of the training is a basic advantage of this system.

The simulation and simulators

Basic trainings on simulators one initially led exclusively in the air force. Currently more and more civil schools of flying introduces simulators as the supplement of the theoretical and practical training.

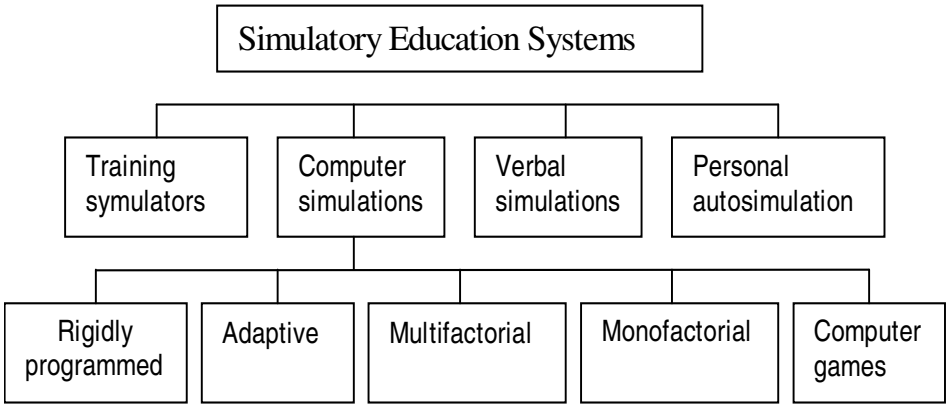

Fig. 3. The classification of systems of the simulation of flights

Simulation models can be divided on three groups:

- models attends to the transfer of the knowledge,
- models attends to the transfer of the knowledge,
- models agrees to the coaching so called habits (conditioned reflexes).

Computer models dominate in the first from mentione groups. Models with arigid software and computer games are here most popular [7]. However adaptive models, used tools of the artificial intelligence are more effective. Adaptive computer programmes adapt themselves to the pupil and provide reaching the optimum-tempo of the education. Unfortunately the most of they gives only the possibility of the thoughtless coaching of the memory. Additionally, the long time of the creation of the software causes that in the moment of his practical use offered knowledge is already out-of-date. The high cost of the intelligent software causes that it is not dedicated to specific instruction needs, but realizes the nearer undefined general education, overloaded with the unnecessary information [8].

Educational one-factor models deliver the easily assimilable information whose using depends on the intelligence and the ingenuity of the pupil and his teacher. Related computer programmes can be cheap and very effective. The active map on which one can coach the navigation is a typical example of the one-factor model.

Training simulators serve to the education of suitable reflexes. The chamber filled burning materials is an example of a very effective training simulator applied through the fire brigade. Entering to her the pupil has such themselves conditions, as in the real fire: the smokiness, the high temperature, flames, obstacles making difficult the movement, shouting of burning people.

The verbal simulation is simplest, and an at the same time most effective way of teaching of procedures. Polega ona na tym, że She relies on this that the instructor leading of the exercise discusses the situation helping himself with simple tools, such as large-scale illustrations and models , slides, audio-recordings and films. Sitting opposite the pupil answers what in a given situation does or should do. Nothing disperses his attention. Important are only procedures and the time. Exercises can also be led with the participation of the group of pupils or groups of instructors. In the aviation described method is called “on foot flying”. She is very effective, She is very effective, first of all due to the ease of arranging of instruction situations and the precise adjustment of them to needs.

Personal autosimulation attend to holding of the skill and habits. It cannot be applied in the basic training. The application of this method relies on this that the coaching person already remembers the experienced earlier situation repeats binding procedures or describes necessary to the execution of the activity or imagines their exercise. At some level of the imagination one can arrange new situations. The autosimulation is often applied by acrobatic pilots. On receipt of

tasks they imagine every activity which they will have to perform. Thanks to this, later acting in the deficit of the time they can perform the same activities more quickly and more sensitively. Autosimulation is a kind of the meditation. Therefore applied too often or in the wrong way can lead not only to producing of incorrect habits, but can even lead to abalienations. Therefore the correct exercise of the autosimulation one ought to teach. Is not allowed to admit to producing the situation called "the improvement in error" which relies on the repetition of incorrect activities.

Systems of the continual training

System of the continual training is a form of the realization of the old Roman maxim "Repetitio mater studiorum est" and of the educational loop. Seemingly he seems most effective. Unfortunately, for the effectiveness of his action they are required: the continuous update of programmes and the personal touch to every pupil. From financial reasons, and often either organizational these requirements cannot be fulfilled in general aviation (GA). This leads to badly organized actions, bringing more damage than the advantage. However some forms of the continuing education prove correct also in GA. They belong to them:

- handbooks dedicated to individual bands sentient the need for the improvement of its qualifications,
- so called conferences of the security ,
- some forms of the online education.

Quite differently looks the situation in airlines which or organize periodic trainings for their workers, or require from them certificates of the completion following of certifield courses. In the combat aviation it takes no place or time on the self-education.

Conferences of the safety

In every from European countries the responsible office for the safety of the air traffic organizes trainings on the central level. All heads of the air-training train of air, flying clubs and commercial companies are supposed the duty in them to participate. Privat airmen can also participate in these trainings. Of course the participation of private persons is limited. Persons trained centrally organize conferences of the safety on airports or in instruction centres directed through him. Events, which happened in the last year are discussed on this conferences. Preventive recommendations are transferred also.

The online education

The online education is realized in two variants:

- commercial education,
- free education.

The commercial education, is available only to persons who paid behind her and limits itself usually to the coaching to the state examination on the following degree of air-authorizations. She does not have the greater influence on the safety. The free education is led by State-institutions, air-associations and private persons. Usually this are trainings led on the very essential high level. The participation in them has an essential influence on the security of flights. It is necessary that to underlinethe important part of instructional material is elaborated by persons who receive from this title of no salary and no achieve other profits. This is the typical activity "no the profit" testifying about the solidarity and the ethical high level of airman-environments.

Trainings led in airlines

Airlines have usually the own instruction hinterland, which enables both the education of candidates on members of crews as and periodic trainings for persons already fulfilling determined duties. However more and more often workers are delegated to central sites, related to the determined producer of air liners. Thanks to the centralization drops the cost of trainings and raises their quality. This is particularly important in case of the necessity of the use from flight simulators. Unfortunately small lines and lines low-of cost apply sometimes unethical practices relying on the requirement from members of crews of the organization of their training. This causes numerous pathologies, leading to safety threats.

Conclusions

Educational and trainings systems applied in the general aviation and in the line-aviation are characterized with the considerable differentiation of forms and with the high level of the effectiveness. One ought however to notice that greatly they base on earlier forms of the school-education which in many areas is led badly. Courseware GA is tied with the obtaining of following air-authorizations and are coordinated by state authorities. They have a character of closed trainings and short courses realized by the specialized training centres. The line-aviation worked out its own forms educations, relying mainly on the mental restraint of large and detailed descriptions of procedures and on practical exercises with use of different forms of the simulation of real situations. The most of airlines does not lead trainings on basic level, and employs the cadre educated and brought up through the general aviation. Described process of the competence transfer gives essential economic savings, but strengthens the threat of the occurrence of hidden and cumulative errors. Reasons of many irrational behaviours of members of air-crews lie in the wrong organization of the air-training on the lovest level, and in improperly led of school-education. The chain of errors is then overlong, so that

possible be the obtainment of the significant improvement of the safety exclusively across the initiation of recommendations of postresultant commissions. Commissions have inappreciably small possibilities of detection of the errors committed on early stages of the education. The currently existing system of the prevention of the accidents and sfety incidents has no possibilities of elimination of threats generated by improperly led school-education. Therefore it is necessary the authorized verification of programmes and methods of the education and the school education by to this State-institutions and the achievement of changes necessary for the removal of security threats.

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