INNOVATIVE DEVELOPMENTS IN FLIGHT TRAINING SYSTEMS: THE NEED AND IMPORTANCE OF INNOVATIONS IN PILOT TRAINING

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Abstract— The aim of this study is to examine the effects of innovative thinking and further more innovations and to discover how much they are important in flight training systems. From that point along the invention of aircrafts in the history of aviation, the innovative strategies that are recently progressing at certain stages are evaluated. In this context, carried out new generation flight programs, simulation systems, aircraft models that are used especially in Turkish Air Force Flight School are mainly ,the innovative strategies in these sections are revised and their importance and effect on flight training systems are explained. Also the study includes re-creations of flight training concepts depending on the evolution of aviation industry, technological developments, increasing importance of air superiority and the difficulties pilots have to face. In the study, as a single concept, importance of innovation in aviation firstly described, and then by emphasizing the evolution of aircrafts, the changes in flight trainings are clarified. In this way, as well as other disciplines, the importance and need of innovations emphasized in flight training systems and the positive effects of innovations are determined very clearly.

Keywords— Pilotage, Flight Training, Innovations, Aviation and Technology, Flight Simulators.

I. INTRODUCTION

The training and education of pilots establish the basis of aviation and eventually air superiority. In order to sustain this basis, firstly it must be well designed and guaranteed then must be improved, qualified and reinforced to become capable of responding to different situations, events and complexities of the age. The aviators form that basis whether teacher or students can maintain the air superiority by just being open to innovations and developments thanks to their technical expertise and qualified training .

"The story of the Air Force is a story of innovation"(Mission Innovation, 2013). To solve todays international security problems in efficient and intelligent ways we need airmen that essentially integrated with innovative thinking. And of course, the aviators using always the newest technologically advanced systems and methods are the ones substantially conceived innovative thinking. The pilots who are not capable of meeting and responding to theproblems and obligations occurring in our age and who have not enough skills to carry on their tasks in airspace getting more complicated each passing day will cause failures and flaws in their performances and missions. For that reason in order to train pilots capable of meeting today's defense problems, improvements and R & D activities keep going under the wings of innovative breakthroughs continuing to rise each other.

Through the innovative enterprises, solutions that can respond to needs formed in our age in pilot training grow out each other day and this process keeps going very quickly. Technological developments, along with change demands both reveal new circumstances and these two factors always boost each other. Always using new systems and attaching importance to the R & D works aviation industry is leading to these developments and strategies. And so the pilots whom we can address as the heart of aviation industry must be always open to innovations and be readily adapted to changes and improvements arising from innovations and sustain them to transfer to next generations, and thus they have to maintain and save the previously formed accumulation of information, change and technology. In order to train pilots who are ready for all obstacles may be encountered in future, comprehend necessary modern war strategies and whom pilotage capabilities reached a professional level, the indispensable elements are innovations. in science and technology.

What is "Innovation"?

When the term innovation mentioned, always the same meaning comes to the minds in the science and technology world:"renewal". If we define this concept like so, we will not only incomplete it but also let misunderstandings. Innovation is derived from "innovare" a Latin word means to do something different. So to make an appropriate definition we can describe innovation as a " recreation of science and technology providing economic and social benefits". If we look at the definition we can somewhat take innovations as short and long term objectives of science and technology policies. Because in there the common aim is the benefits of society.

On the other hand there is an event comes to minds that innovations seen as a kind of invention and discovery. If it does not carry the meaning of renewal as we know, it should not be perceived as like a discovery. One of the best examples explaining this situation is given by Turkish Technology Foundation:

"Singer. Yes, contrary to your forecast Isaac Singer is not the one who invented the sewing machine and so named after him. The sewing machine is invented by Elias Howe in 1846 in Boston. But unfortunately he lost the chance of earn billions of dollars and give his name by failing to convert his invention to an innovation. Singer the one succeeding this, becomes the name and the brand when the sewing machine is mentioned all over the world. There is an important tip for our industrialists: Singer took advantages of the patent for Howe's sewing machine. Patents includes great tips and by developing product management and new products constantly, monitoring and investigation of the patents in their fields provide great benefits to the entrepreneurs whose aim is to protect competition power. Inventions and patents contains great opportunities for innovations but it is not expected from the entrepreneurs to invent but innovate. Because only this way they can increase the competitiveness and profitability by increasing the market share"(Yamaç, 2001).

Another good example of innovative success beside Singer's comes from a British entrepreneur and a merchant Richard Blechynden who is known as the inventor of iced tea but actually not the real inventor by just doing convert invention to innovation as we stated. In 1904 at the world's Fair holding in St. Louis, Blechynden was working at the East Indian Mansion. He was selling hot tea to the people but by his chance he could not sell to anyone because of the hot weather. Then he realized the reason why he could not sell tea, the innovative idea which will be a breakthrough in the future came to his innovatively sophisticated mind. He gathered his team and put the brewed Indian tea in bottles and then pass through it ice-cooled pipes. Thus they offered to their customer this ice-cooled brewed tea. Their iced-free cooled tea incredibly accepted by the exhibition visitors and achieved a great success. After the fair they took the new iced-pipe system to New York City and introduced it to the people in there and they finally made even more popular summers loved beverage iced tea. By giving right decisions at the right time and using his innovative thinking ability Blechynden is taken his place in the history and gave us a really good example to understand how important innovations are.

By examining the relevance of the concepts mentioned we can describe inventions as "a very first idea on a product or a process" and innovations as " the very first attempt to apply this processes or products into real life." In other words, inventions are "products", innovations are "values" (Szmytkowski, 2005). Consequently innovations are not separate activities, events or actions different from others. So they includes the scientific and technological processes. But it is expected from innovations that the innovative ideas in science and technology activities must turn into credible benefits in terms of actions and results and on the other hand this benefits must be come with concrete results.

So, is it possible to have applications of innovations that we most give in commercial disciplines, in educational systems?

The Place Of Innovations In Education And Training

If we mention innovations as renewals of course we can conclude they can exist in educational systems. But innovations here must not be addressed as marketing and commercial benefits of inventions and re-creations but conceptual changes, reforms and utility provisions to be more accurate. The main resources of reforms and restorations of education are the training models which are based on creativity and self-confidence, reached a sufficient level to free thoughts and open to ideas and non-rote. The student grow out of these education models will be productive, self-reliant individuals can establish a relationship with the environment, have a team approach and spirit, exchange their informations consistently , tend to use information technologies and have the skills to use them, speak foreign languages (EU's future target is at least 2 foreign languages).

It is possible to find examples including definite success of innovations and expressing their importance in education systems. In a research applied on elementary students by Mersin University Faculty of Education the department of education programing and institution two group compared. While first group has to create innovation projects different from the usual curriculum, the other is not and is applied usual curriculum. And it is found that there is significant differences in academic self-post test scores between two groups. In the study it is reached that innovation project groups which includes processes of responsibility, careful thinking, problem solving, using information technology, integrating information to life and logical thinking were more successful rather than the usual curriculum applied group and they were contributed positive results to their academic identity and learned lessons better than before.

As a result more than mentioning existence of innovations in education systems, we can conclude that innovative ideas and strategies contribute education systems, enriching informations of students and educational models while modernizing them. Based on these factors that ongoing innovative strategies of education and training systems, we can examine how they are applied to flight education and training systems in the same way. Innovation as have different meaning and importance in education systems, they have also specific and unique meaning in flight training systems. For aviators the term of innovation has a credible meaning that distinguishes from simplicity, it becomes a concept we can define

as a management process an solutions of changes that are brought by problems and by taking the essential technological steps to reach desired results.

Technological Developments In Aircraft

Innovative strategies and progresses carried out by aviation industry along with aerial vehicles let changes and innovations in flight training systems. The flight training concepts used today, owe advances in their formations to the accumulation of experience, knowledge and education. Indeed, to conceive deeper meaning of "The story of the Air Force is a story of innovation"(Mission Innovation, 2013) and to better understand the origins of innovations that we take for granted firstly we must listen the "Story of Aviation".

The aerial vehicles that got ahead and got serious developments from the beginning of the 20th century faced with various challenges like wars, catasrophes and difficulties through this process brought fund of knowledge and new technologies. During this development processes and the rapid developments of aerial vehicles pilots are to get used to new qualities and education programmes in order to adapt themselves to the changes and to complete the mission with success. The education pragrammes that the pilots have been revised in respect to new scenerios and new threaths. Behind this revision it lays the logic that the advancement of technology resulted from the cutting edges in aviation through the historical developments of aerial vehicles.

A Quick Review On The History Of Airplanes

The passion to fly is existing since human beings watching the flying creatures and it goes back to 2 000 years ago. No matter how it is told as a legend and a mythology, it is also mentioned in the historical sources referring to different ways of first fly attempts. Primitive aviators that we can call so are the first humans trying to fly using goose feathers and clothes by just doing no more than imitating birds. By time passing different vehicles invented like airships, balloons, gliders and eventually airplanes and advanced aerial vehicles formed today's aviation industry.

When designing aircrafts the important and featuring basics for the aircrafts are to get more altitude, to be easily controlled, to move faster, to achieve tough maneuvers and to have great distances. Aircraft engines become more efficient gradually. At first times aircrafts had steam engines then piston engines and after then jet and rocket engines. The materials used in the construction of aircrafts is made of lighter materials and more durable outfits over time. At first aircrafts were made from wood and canvas, then steel pipes and vanished fabrics and subsequently with the World War II broke out, aluminum monocoque came into widespread use. Today more durable and lighter carbon fiber and composite materials which are also more easily be formed are in use. At the same time aircraft command and control systems are continuing to evolve. First times, the gliders was controlling almost using whole body of the pilots, left their places to advanced avionic systems commanding and controlling by computers and electronic devices would be invented in the future. In modern warfare aircrafts, advanced avionic systems and flight computer are in use to have balanced flights to achieve maneuvers that aircrafts have to meet to the manners developed by war conditions.

With the rapid advancements in technology, simultaneously developed and made flight training high efficient and low cost simulation devices are one of the most important innovative breakthroughs in flight training systems.

Evolution Of Flight Simulators

Flight training especially training of a jet pilot is one of the most expensive, long-lasting and risky trainings in the World. Flight simulators are invented to decrease the high-costand long time, while also prevent death risks in the air. By applications of technologicaldevelopments in flight simulators, they have become much more realistic and provide highfidelity and flatness as the real aircrafts. And also using these flight simulators effectuate high fidelity ensure better training opportunities in many ways such as emergency procedures,repetition frequency, preparing difficult and risky conditions rather than real air-craft trainings (Çevik, 2014). Flight simulation devices has been existing since 1920. In the first period they were devices consisted of engine removed planes and were thought to be helpful and effective to the pilot training. By technological advances simple devices left their places to all-round simulations which were computer-aided and had much more complex systems. As computer technologies continued to evolve, simulation technologies evolved simultaneously. Aircraft control and command simulation devices also was developing along with visual streaming technologies at the same time. One of the first visual monitoring system trials is "cyclorama" provided external view enabling pilots to scene sighting by a circular curtain or a wall about the simulator. With the invention and use of televisions the visual scenes got much more realistic field modelings. As time progresses with the development in televisions using numerous giant television monitors around the simulators approached reality and provided pilots to sight much more detailed and realistic scenes.

The first simulator which enabled flight simulators widespread and can be accepted milestone in simulation industry is "Link Trainer" or "Blue box" invented and named after by Edwin A. Link. Widely used in World War II, Link trainers has played a crucial role in training about 500 000 pilots in war. It provided saving time in pilot training and prevent threats and hazards that might would be occurred in the sky by enabling ground flight trainings. Link

simulators both used to train pilot candidates in basic training and develop existing skills of professional pilots and let them to try different maneuvers.
Over 90 percent of the experimental comparisons dealing with flight simulators reached results showing us along with aircraft, simulator trained pilots became much more successful rather than only aircraft trained pilots (Jacobs, Prince, Hays & Salas, 1990). Flight simulators even have extra abilities than actual aircrafts. For example, numerous trainings can be given in a short time, they enables to startover the training whenever and wherever desired, they have advanced debriefing and playback systems, they have low cost and about no risks at all. These are some of the dominant sides of simulations. In addition to that like network linking simulators with each other and realizing operational environments attending numerous candidates, the skills that we need to focus on in terms of training efficiency will be emerged in the new simulators (Çevik, 2014).

Flight Educations From Past To Present

The basic flight education which is also called pilotage consist of difficult, complex and long processes. It occurs in several different and rigorous stages are pursued for especially war pilots. While pilot candidates trying to pass some theoretical and practical exams,they gradually get professional levels. Pilotage education has not only one long term, it should take throughout lifelong education because war pilots have to get themselves ready practical and theoretical against any situations that happen in anytime(Dağlı,2014). Before introducing innovations that are held, it will be necessary to review the process of the basic flight trainings.

The Evolution Of The Flight Trainings

The history of flight trainings can be divided in 4 categories. Every category add new features instead of changing it. First one is the apprenticeship stage(1903-1929) consisting of the time that teacher pilots transpose their experiences, skills and knowledge to candidates, second is the simulation stage(1929-1979) providing pilot candidates to practice in an artificial flight environment, third is the security stage(1979-present) including the human factors in the curriculum and fourth and final is the customized education stage trying to make pilot candidates serviced in the most beneficial place and represent the future flight education by bringing their abilities to the top level. The flight trainings that are given by the military and civilian institutions have a brief model of education and plane. Although these institutions have same features, the military institutions have to be more successful and adapted to difficulties because military pilots will work in more dangerous and complex situations so it will be expected high discipline and studies and special skills from them. For example military pilots are required to endure high G tolerance, a to be more careful and precise in emergency situations, to flight in formation with others, a to perform landing and take-off in formations and to show the maximum precision and punctuality in the flight. These are skills that the military pilots must have different from civilian or commercial pilot skills need to have. The flight training given by the military start with basic flight training or pilotage, then continue with combat pilot training. This article examines innovations carried out in Turkish Air Force flight training stages.

The Innovations Recently Carried Out In Turkish Air Forces Flight School

Constantly developing technologies and coming off defense needs result changes and innovations in flight training systems where innovative breakthroughs continue to increase rapidly. To clarify those kinds of breakthroughs , the innovations achieved by the Turkish Air Force 2nd Main Jet Base in Çiğli-İzmir are the really crucial ones that makes us realize and conceive thoroughly how important innovations in pilot training. Innovations that this article examines are e-learning system integrations in pilot training, Modernized T-38M Advanced Trainer project (ARI), Multiple Intelligence Application on Pilot – Teacher Combinatorial Assignment and KT-1T trainer and re-build of education acquisition strategies.

Modernized T-38M Advanced Trainer Project (ARI)

Consistently changing war environment, along with changing older generations operational approaches, changes weapon and warfare systems and the training concepts of the personals to use them. Thus needed updates and renewal of concepts in training systems will gain personals necessary skills to use mentioned vehicles and weapons effectively and professionally and let more efficient training. In this context, within the modernization T-38M project, 55 T-38A aircrafts modernized with different advanced avionic devices. Supplied from both national and foreign firms the systems are integrated with all in national softwares. After the modernization newly created training curriculum it is planned to save 20% of the sorties. In addition to that in combat pilot training T-38Ms are decided use and planned to save 55% of the sorties regarding to outdated flight programs.

As a result of the project it is ensured that continuity in pilot training and time and cost efficient structure has been created. Besides the modernization of the aircrafts there have been carried out projects which are new simulators (ARISİM) and computer based training (CBT) to provide more efficient, standard and appropriate training meets the requirements of modern flight training. In this way pilots can be trained with the desired pilotage skills. By ensuring pilots situational recognitions at the top level in terms of safety it becomes more efficient with the modern avionics and early warning systems T-38Ms

acquired. And also situational recognizing will bring pilots self-confidence (Yılmaz, 2012).

KT-1T Trainer And Re-Build Of Education Acquisition Strategies

Turkish Air Forces acquired KT-1T a modern training aircraft which has tandem seat layout, single engine, propeller, although the automatic rudder system reduces deviation, UHF / VHF radio, HUD and MFD pilot training and to meet the needs of today and tomorrow , could form the basis of flight training and fill the gaps when T-37s dismissed. With acquirement of KT-1T the flight training time has been saved and also new realistic simulators let saving in sorties. Pilot using this system, thanks to re-built training curriculum along with aircraft , will reach a higher level of flight qualification in a short time. Using turboprop engines, aircraft consumes 8 time less fuel than previously used aircraft and has lower maintenance and operating costs. Its modernized avionics will reduce and prevent probable emergencies and problems caused by outdated T-37 avionics.

E-Learning System Integrations In Pilot Training

E-learning is a usual acronym for electronically learning. E-learning is emerged from adaptation of learning applications into digital and computer-based doctrines. It helps to transfer knowledge, skills and abilities via devices, processes and applications in digital and electronic environments. E-learning can be applied in different ways such as internet or intranet based learning (, virtual classrooms, computer-based learning, use of audio or video recording, satellite or land-based broadcasts, CD-ROM, DVD, videoconferencing etc. In pilot training usually computer based an intranet based training is used. Along with E-learning additional personnel planning requirements for many lessons are eliminated in Air Force, thanks to interactive lessons pilot candidates learn topics and lessons effectively in less time and by increases their ability on computer technologies so they catch up with their generation in terms of technology and thus their motivation it affected in a positive manner.

The results of the literature review and observation shows us in addition to face to face learning the pilot candidates using e-learning, e-training and mobil learning methods are more successful in their education rather than the ones applied traditional teaching methods. In the light of these conclusions and findings we can conclude that E-learning is an effective and useful tool for pilot candidates need to gain necessary knowledge, experience and skills (Kazancı and Toker, 2014).

Multiple Intelligence Application on Pilot – Teacher Combinatorial Assignment

Instructor pilot and student pilot pairings are based on a lottery system before 2007. This system removed as a result of some research carried out and then a new method applied instead. The main objective of this method is assigning instructors to the students having same intelligence type and improving efficiency and successes in flight training. According to the eight different intelligence groups (linguistic, logical-mathematical, musical, spatial, bodily-kinesthetic, social, internal, natural) pairings made and psychological analysis made on groups after that pairings resulted that having a mentally fitted teacher for students could increase efficiency of flight training. By including all the intelligence types in the process of learning and teaching it is concluded that education efficiency could get to the maximum levels (Abdan and Baş, 2015). Also, thanks to this method it could be determined in which stages pilot candidates will successful or not. It is also examined that test scores of students in cognitive and motor type, able to provide continuous control. By applying to all new pilot candidates Multiple Intelligence Comparison test, it has been determined that students which have the certain type of intelligence could be successful in flight training rather than the others (Abdan and Sağer, 2012). technological developments in the aviation industry is growing rapidly every day.

CONCLUSIONS

Technological developments in the aviation industry is growing rapidly every other day, so the systems which are not adapted into these changing environments unfortunately lose their functionality and puts their users into new pursuits.The training of the pilots whom we can address as the heart of this industry is also affected by these changes and technological progresses and further more needs them.

In order to sustain technological improvements and keep up with the age, discovered strategies and systems compelled us to keep active and spread innovations in flight training systems as well as in other disciplines.

As a result within the provided informations, rapidly changing airspace and thereby new defense needs that formed from new threats creates a necessity of new knowledge and experience accumulations on flight training systems. By using always newest systems in pilot trainings innovations ensure reducing time, efforts and costs, adaptation to the changes come along with the age, solving conceptual and technical problems possible to be encountered. So it is evaluated that innovations are very important for the Air Force and especially for the pilots and particularly to maintain or to win the air superiority whether in war or in peace the pilots trained in systems enhanced with innovations could be addressed as a deterrence factor distinguished from the others.

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