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OBJECTIVE EVALUATION OF IFR TRAINING FLIGHTS

OBJEKTÍVNE HODNOTENIE VÝCVIKOVÝCH LETOV IFR

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Abstract

We are living, working, and most importantly, flying in the 21st century, but in many areas still stick to old customs from the pre-millennial times. I have decided to attempt to improve the quality of flight instruction by implementing modern evaluation and debriefing methods to training flights performed in a flight school where I currently perform the role of a flight instructor. In my paper, I am explaining the way the training course is done in our conditions, how it is already different from other schools, what aircraft we use for training and how I evaluate the results of training flights. My research is about the effects of applying modern debriefing methods in our already modern instrument rating courses.

Keywords

Flight Instructor, Aircraft, Flight Training, Evaluation, Student, Methods, Debriefing

1. Foreword

Since the early days of aviation at the beginning of the 20th century, brave men and women carved out paths to modern, safe industry, as we know it today. Though technology has advanced dramatically, the pilot is still the key element and risk factor in flying. The best way to mitigate the risk of human errors is proper training. To make the training as efficient as possible, students should be made well aware of their conduct, be it positive or negative. Such debriefing shall be provided by their Flight Instructor, based solely on students' performance, with regards to piloting technique, safe aircraft operation, and much more data. However, sometimes other factors come to play. Since we are all humans, we are not always 100% objective with our opinions on other people. Subjective inputs might inadvertently distort valuable debriefing feedback.

What if we could eliminate the subjective, human factor from training flight evaluation? Especially when it comes to IFR flying, grading takes into count the pilot's ability to fly as precisely as possible, with only minimal deviations from the desired flight path. Apart from general situational awareness, emphasis is also given to following published procedures. All of this could be monitored using a GNS logging device, evaluated by computer software, and the 100% objective feedback provided to the student efficiently.

Could such a method make a difference for student pilots? Would it be practical to use and sustainable? Being currently stationed as a Flight Instructor at a state-of-the-art flight school in the Czech Republic, For the purposes of this paper, I am about to compare the effects of proper, objective, high-tech debriefing methods to conventional methods currently used on our students.

2. Background and state of the art

Flight schools are businesses like many others. The main goal of every business is obviously to make a profit. Generally speaking, the majority of flight training institutions are more profit-oriented than they should be. However, raising a new generation of pilots is not all just about business. It is a real mission. A mission, to make the aviation industry safer for everyone involved.

Living in the 21st century brought us undeniable technological advancements. The military and aerospace industry was responsible for the most of technical research applicable to nowaday's civil aviation sector. The greatest use for us comes from the invention of satellite-based navigation systems. Combined with tracking tools, memory devices and data processing software, this creates and opportunity for applying modern sollutions to training flight debriefing, which is undeniably a key element of the entire teaching and learning process in aviation.

To harvest the greatest amount of valuable data straight from aircraft's Air Data Computer and Attitude and Heading Reference System, or in short, ADC and AHRS, I would highly recommend plugging an SD card into the port located on the frame of Garmin's G1000 Perspective+ avionics suite, specially designed for this purpose. All of the flights within my research have been performed on airplanes of a single operator, who enforces very high safety standards, where SD cards are standard for logging flight data as a part of their safety program. With their approval, I used this data also for debriefing purposes with my students. The entire process of transferring these figures from the aircraft to the TV in our briefing room takes on average about 10 minutes

After exporting flight data from the SD card inserted into the frame of Garmin's G1000 Perspective+ Avionics Suite for the duration of the entire flight and obtaining a sheet full of raw data, it is of great significance to choose the correct and the most efficient way to work with this information. The most suitable solution appears to be purchasing a commercially available software, instead of developing an own one, since software development would have to be delegated to a dedicated team. Out of many companies providing such software for public use, there seems to be a single winner. Yet again, selecting a software provider is not the subject of my main research and there was legally no need for public procurement, as the subscription has been purchased utilizing private funds.

Without further ado, I would like to introduce key features of CloudAhoy – debriefing for pilots. As mentioned, the key feature of the software is the ability to track flights. However, there are many add-on valuable tools, that not using them would be a waste of resources. As an example, the flight segmentation. I would definitely consider this an extremely valuable tool for flight instructors. To avoid having to scroll through the entire flight log in order to be able to review the desired maneuver, for example, approach and landing, which tends to be located at the very end of the flight log. Flight segmentation divides the log into segments, while each maneuver or change in flight profile is logged with a separate tag. The flight instructor is then able to skip through the flight log and show only those parts, which are desired for debriefing purposes, be it because these were problematic or simply require further attention. Flight segmentation can either be achieved automatically by the software's built-in technology, which can recognize maneuvers such as turns, climbs, descends, stalls and instrument approaches. This ability can be considered crucial for debriefing flights following instrument flight rules. Furthermore, the software works with a built-in database of instrument approach procedures and is therefore capable of comparing the actual – recorded flight path to the desired flight path according to the aforementioned database. The system is capable of analyzing the accuracy of the pilot's performance and eventually provides objective evaluation. More on that later. Shall the automatic segmentation feature malfunction or shall the crew perform a non-standard maneuver, which they desire to be logged as a separate segment, there is an option to divide segments manually.

The aforementioned scoring system is one of the best tools for flight instructors on the market to this date, according to my independent opinion. Being able to reduce flight instructor's workload by eliminating the need for constant monitoring and noting of flight profile deviations, opens up mental capacity for other tasks. The student will receive an automatically determined score for each maneuver [ref. Figure 1], as well as for the entire flight, based solely on his or her piloting technique. Obtaining feedback on this level of machine objectiveness with no influence of subjective human interactions might be beneficial for the student pilot's self-criticism, ability to prepare more efficiently for the upcoming lessons, and therefore general progress in their training. The scoring system is based on a zero to one hundred points scale, taking into account parameters such as correct altitude, speed, track, descend angle, etc.

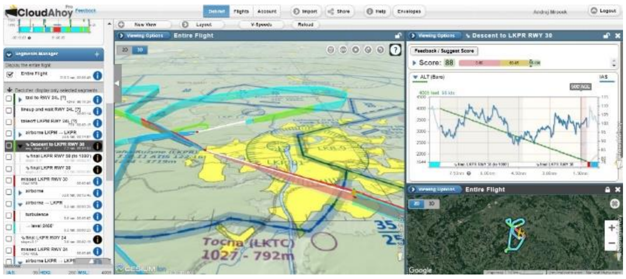

Figure 1: Maneuver scoring. Source: Authors.

3. Research Methods

Due to the currently ongoing global situation with pandemics and lockdowns all around the world, I accept the fact that I have to work with limited resources. Therefore the research can only be performed on a rather small scale, which would hopefully still provide some answers to the question regarding the effect of modern debriefing methods on students' performance in flight training.

I managed to gather six testing subjects. As a part of my studies at the University of Žilina, I am undergoing on-the-job experience at an American aircraft manufacturer's authorized dealer and training center just out of Prague, Czech Republic. There I am tasked with performing the duties of corporate pilot and flight instructor for the company's clients. My six subjects for this research are in fact clients who decided to undergo a training program to obtain an instrument rating on a high-tech, premium category airplane.

The aforementioned six subjects, we shall refer to them as students, would be divided into two groups of three students. Group 1 would be introduced to debriefings using advanced technology including CloudAhoy software. Group 2 would be considered a control group, which would undergo the same set of lessons, with the exception that only standard, proven ways of debriefing would be applied. Their lesson to lesson progress would be monitored as well. The product of this research will be a set of data comparing the lesson-to-lesson progress of my students' performance. The core comparing element will be the number of flights required to successfully meet the standards required to pass the given lesson.

4. The training course

Among the latest trends in flight training under EASA, there is a so-called competency-based instrument rating course. Aimed for private pilots, who prefer to only take a simplified battery of tests, compared to traditional instrument rating courses, students have to attend theory lessons and pass written exams in as little as seven subjects. Some key features of competency-based training are inspired by well-established methods from overseas, to be precise, the United States of America and their somewhat less strict FAA regulations. As an example, pilots no longer have to undergo 100% of instrument flying under an approved training organization, commonly referred to as ATO. Instead, there is a possibility to perform some flights with an independent flight instructor first.

The first few lessons consist mostly of observing the flight instructor performing all the duties, explaining what is happening and how to efficiently apply single-pilot resource management in the cockpit of a client's aircraft during instrument flight. This would be typically executed on a rather regular, not significantly interesting business flight from the client's home airport in the Czech Republic to Germany or the Netherlands and back. After getting the idea of what to expect and what it takes to perform an instrument flight, the student would try flying the airplane in the upcoming lesson. He or she would perform the take-off and landing manually, but for the rest of the flight, the autopilot would be engaged. Students would focus on instrument procedures, associated briefings, and checklists, while the flight instructor would handle the radio communication with air traffic control. If the client does not need to travel for business, we would simulate a real mission on an approximately one-hour long flight to an airport with no especially difficult procedures, such as Dresden, Hof-Paulen, or Bratislava. Once the student is comfortable with the single-pilot resource management concept, working flows, checklists and is capable of successfully and safely performing the instrument procedures, they would be handed radio communication as well. This could be challenging at first, but some extent of practice and consistent attitude in-flight instruction will do the trick almost every time. When they manage the radio work at a reasonably proficient level, more hand flying is added to their lessons. The last part of gaining competency for the CB-IR course would usually consist of visiting especially challenging airports and weather conditions, if not practiced already during the client's real missions. The airports we like to visit with advanced students include, but are not limited to, especially those deep in tall mountains, such as the Alps. A typical example would be Samedan near St. Moritz ski resort, Innsbruck in Austria, or Lugano in Italy. Flying to destinations like these often includes facing moderate or severe weather, which could be Foehn winds or thunderstorm buildups in summer. In the meantime, they can attend theory classes at any ATO. I believe it is a great advantage that students can simultaneously gain flying experience and learn relevant theoretical knowledge since the content of ground lectures makes more sense to them and should be easier to understand when they can apply this newly acquired wisdom in an actual flight.

After gaining a sufficient level of competency, applicants seek a flight school, capable of providing training to obtain an instrument rating, usually an ATO. Before commencing the actual training according to the given syllabus, students must meet requirements for minimum flight time and undergo a check flight with a senior instructor or head of training. Depending on demonstrated knowledge and skills, the flight school would propose a training program that the applicant ômust go through before being issued a certificate for completing the training and being able to apply for a skill test with an aeronautical examiner. The aforementioned improvements of the training concepts make instrument rating more accessible to non-professional pilots, hence providing options for increasing skill level to a wide range of pilots, consequently improving general safety in the aviation community. This way of training is not for everyone though, since instrument rating obtained in a competency-based course is valid only for private flying. Therefore, commercial operations are out of the scope for those who have chosen the CB-IR way. Hence it is not a way of choice for university students, who would eventually like to become professional pilots.

5. Aircraft used in the training

The flight school involved in my research uses Cirrus design corporation's series of high-performance, single-engine, piston-powered light aircraft designated as SR20, SR22, and SR22T. All of these models feature state-of-the-art avionics and onboard systems. Students usually complete their entire training, including the course for obtaining the private pilot certificate, in this series of airplanes. Furthermore, there is also a light jet available, designated as SF50 Vision Jet, but we do not use those for training flights in instrument rating courses.

Having the latest up-to-date avionics available in your airplane might make a huge difference compared to flying the same airframe with steam gauges. The earliest Cirrus models were equipped with a traditional analog set of basic instruments, commonly referred to as six-pack. Later on, glass cockpits were introduced into the line production and marketed as Avidyne Entegra Avionics Suite. It caught the eye of every pilot and aspiring aircraft owner. At the time, it was surely progressive, but now we look at those avionics as ancient, since we operate mostly aircraft of generations 5 and 6. The innovation cannot be halted. Therefore Cirrus equips all new models with the Garmin G1000 avionics suite, which is specially tailored for the SR series and marketed as "Garmin Perspective+" [ref. Figure 2]. This consists of two large digital screens. They are designated as PFD – the primary flight display and MFD – the multi-function display. While the PFD provides all the information from the old six-pack integrated into the digital environment of the user interface, additional information can be added. The nature and amount of supplementary information can be customized by the crew at any given time. As an example, these could include a small inset map displaying terrain, traffic, weather, GPS route, or any combination of those. Another option is synthetic vision, which virtually portrays what the pilot can or could see out of the window. Enabling features like pathway boxes and flight path vector turns the instrument flying into an immersive videogame-like experience. The MFD provides an enormous selection of data to be displayed. An enhanced engine monitoring system, navigation pages, satellite weather, traffic map, airport, and en-route charts, digital checklists, performance data, and flight plan data, to name a few.

Figure 2: Garmin Perspective+ equiped cockpit. Source: Authors.

Apart from other safety features, like spin-resistant wing design and technologies like TCAS, TAWS, satelite weather and many more, all Cirrus aircraft features an improvement in aviation safety that had become a legacy icon of the brand. Since introduced in 1998, a ballistic recovery system comes as standard with every Cirrus built ever since. The system is marketed as Cirrus airframe parachute system, CAPS in short, and consists of a single-use, solid-fuel rocket stored in a special compartment in the aircraft's tail section, a parachute 16 to 20 meters in diameter, depending on the aircraft generation, with sturdy paracord straps to the crew and passenger compartment, and an activation pull-lever-style handle. As of May 12th, 2021, there have been 104 successful CAPS deployments with all occupants surviving with none or only minor injuries, when the system was activated in designer conditions. The limitations only mention minimum height for system deployment, varying from 500 to 600 feet above ground level, depending on the specific model, and maximum demonstrated deployment speed of 140 knots of indicated airspeed. The first condition ensures that the parachute has enough time to get successfully deployed, while the latter one is related to the possible load factor on the airframe and parachute cords when activated at high airspeeds. Nevertheless, there have been successful deployments or saves, as Cirrus likes to call them, also outside the designed envelope. Once the system is activated by pulling a red handle from the cabin ceiling with a force of 20 kilograms, an electrical fuse activates the rocket, which subsequently pulls out the packed parachute, and the entire airplane, or the cabin at least, lands on the ground. To ease the impact, there are special energy-absorbing seats installed and airbags integrated into the shoulder harnesses. The CAPS might be used in case of engine failure in instrument meteorological conditions, at night or simply when an adequate landing site is not available, in case of a mid-air collision, loss of control in flight, or anytime a safe outcome of any given situation is in doubt. This system has become the ultimate safety net for Cirrus pilots all around the globe.

6. Sample flight

First comes the briefing based on student's performance during the last lesson and rehearsal of the problematic areas that need further attention. This is achieved by reviewing the previous flight log and discussing what could have been done differently to achieve better results. Another part of the pre-flight routine is obviously route briefing, weather analysis, mass and balance, fuel and performance calculations, as well as aircraft inspection.

For the flight itself, the student pilot takes the left seat while the flight instructor is acting as a pilot in command from the right seat. A training mission at the company, where I currently operate, could take us practically anywhere from the North sea all the way down to the Mediterranean. Irrespective of the destination, a strong emphasis would be given on single-pilot resource management, which is the core topic we are focusing on when teaching our clients how to safely and efficiently perform a flight according to the instrument flight rules.

After the flight is finished, data is downloaded from the SD card inserted into the aircraft's avionics suite and portrayed using debriefing software. While this process is done, the student gets an opportunity to assess themselves. This is usually a good indicator of their self-esteem level. If too high or consequently too low a level of flying self-confidence is observed, additional measures should be taken in order to help the student reach the right level. Once the data is available, the instructor uses those to rewind back in time and take advantage of so well recorded altitude, heading, speed and much other information to demonstrate which areas were problematic. Then he or she only has to explain how to correct the imperfections.

7. Traditional vs modern evaluation methods

In most flight schools, the evaluation of training flights is solely the responsibility of the flight instructor. Every aspect of the flight has to be recorded by the instructor in their notes, organized in a such way, that it might be later used for debriefing with a student. It is also of great importance to not overwhelm the student with an unnecessary and unproductive amount of data that he cannot work with. Instead, the instructor should attempt to work on a specific area to improve during each lesson. This and other challenges tend to have a negative effect on their workload. The increased workload might be beneficial to some extent since increased stress level improves focus and productivity to some people. However, once the stress exceeds a bearable amount, a human is no longer able to cope with it and their performance starts to deteriorate rapidly. Another factor contributing to one's ability to deal with the workload is fatigue. As the day progresses, as the instructor has to deliver over and over again, the fatigue level rises. A rising level of fatigue may result in moving the critical stress level threshold lower and lower. Once this happens, the flight instructor might not always be objective with their students due to exhaustion setting on. This might present a serious issue in the training process. Even if this was not the case, relying exclusively on handwritten notes and black or whiteboard is a time-proven way of educating, but since we live in a modern, everchanging world, there must be a better way.

Contrary to traditional methods, the modern ones I am utilizing do not put the flight instructor in the role of the sole evaluator of the training flight. In my belief, just like in business administration, outsourcing is the key. Pilots already outsource the actual stick and rudder flying to the autopilot, air traffic controllers outsource finding future traffic conflicts to high power computers, so why should flight instructors not outsource part of their duties to a computer as well? Not the actual instruction though, only the evaluation part. The modern methods used in my research consist of recording elaborate flight data on an SD card, processing them using high-end software, and finally presenting them to the student in a well-arranged user interface. Furthermore, the software provides additional features for making the flight debriefing a more enjoyable environment for the student, turning the entire flight training process into a game-like experience. The flight gets scored automatically and provides an option to focus on problematic areas.

8. The research results

After tracking students' progress throughout tasks within the training program, figures 3 through 5 provide an overview of the results. Figure number one introduces data for students of the research group, while figure number two shows the performance of students of the control group and figure number three provides an overview of an average number of required flights for all students within both groups. Each column tracks the progress of an individual student. Each row provides the name of a task that students must be able to perform in other to obtain a record of competency before proceeding with the training. The core of the summary sheet provides information about the number of flights required to achieve satisfactory performance since the first introduction of the given task. The data in brackets state the difference compared to the average number of required flights among all students including the control group.

Table 1: Research data - group 1. Source: Authors.

Task / Flights required	Student A	Student B	Student C	Average
Attitude flying	2 (-2)	5 (+1)	3 (-1)	**3**
VOR radial intercepting	3 (+0)	3 (+0)	2 (-1)	**3**
3D Approach	4 (+0)	4 (+0)	3 (-1)	**4**
2D Approach	2 (-2)	3 (-1)	3 (-1)	**3**

Figure 2: Research data - group 2 (control group) Source: Authors.

Task / Flights required	Student D	Student E	Student F	Average
Attitude flying	7 (+3)	4 (+0)	5 (+1)	**5**
VOR radial intercepting	2 (-1)	3 (+0)	2 (-1)	**2**
3D Approach	9 (+5)	5 (+1)	4 (+0)	**6**
2D Approach	7 (+3)	4 (+0)	4 (+0)	**5**

Figure 3: Research data - average of both groups Source: Authors.

Task / Flights required	Average both groups
Attitude flying	**4**
VOR radial intercepting	**3**
3D Approach	**4**
2D Approach	**4**

9. Conclusion

Although students who have been debriefed using modern methods demonstrated slightly better performance, it is not apparent whether this is the main contributing factor. Attitude towards the entire training process varied significantly among each individual student. While some have great motivation, are aviation enthusiasts, study additional materials on various flying related topics on their own and always complete their home assignments, while other students lack adequate motivation and systematic approach towards learning, barely invest any time in studying, except for lessons with instructor and do not seem to be very interested in their aviation career, only in the fact that they can refer to themselves as pilots.

There are too many variables and a rather insignificant sample of testing subjects, To mitigate fluctuations in each student's individual performance, I would propose to conduct similar research on a much larger scale, perhaps with subjects of the younger generation that is more adaptable and used to working with new technologies on a daily basis.

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