Łukasz Puzio
Mgr inż.
Państwowa Wyższa Szkoła Zawodowa w Chełmie, Centrum Lotnicze
lpuzio@pwsz.chelm.pl

Mateusz Milewski
Inż.
Storkjet sp. z o.o.
mateusz.milewski@storkjet.com

Robert Sklorz
Mgr inż.
Wizz Air Hungary Ltd. (member of Wizz Air Group)
rsklorz@nestmail.pl

Arkadiusz Tofil
Prof. nadzw. dr hab. inż.
Państwowa Wyższa Szkoła Zawodowa w Chełmie, Centrum Lotnicze
atofil@pwsz.chelm.pl

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Unstabilized approach in aviation training on the basis of the fliight data monitoring (FDM4GA)

Abstract: The article takes up the issue based on flight monitoring systems (FDM) in the aspect of aviation training. The key element is the use of Storkjet software and data recorded on flight recorders from the Aviation Training Center (OKL) of the State School of Higher Education in Chełm. The authors of the article have adopted a model of an approach path including air regulations, aircraft performance based on Aircraft Flight Manual (AFM), procedures based on OKL's the Standard Operating Procedures (SOPs) and navigation data based on approved navigation information for specific airports. The problem of unstabilized approaches has been analyzed on the basis of data from various flight groups (e.g. instrument flights, night flights, etc.). As a result, flight groups were selected, which statistically from the point of view of the risk management system bring the largest operational risk during the aviation education process.

Keywords: Unstabilized; Monitoring; Event

The development of transport aviation around the world has forced continuous efforts to increase the level of security in order to increase the attractiveness of this type of transport. One of the flagship systems improving aviation safety is FDM (Flight Data Monitoring), which supports the management of aviation safety by showing exceedances and trends based on data recorded by the flight recorder. Acquiring data from digital recorders gives the possibility of using computer software that automatically monitors violations and defined indicators related to safety and aviation technology. The information obtained through FDM allows you to increase the level of safety, operational efficiency and improve the reliability of the aircraft. Until now, the number of general aviation aircraft equipped with digital avionics has been small, which has been changing rapidly over the past few years. This is related to the fall in costs of digital avionics, sometimes below the cost of traditional instrumentation.

The digital avionics of a typical aircraft used for pilot training is able to register from several dozens to several hundred different flight parameters at a frequency between 1 and 4 Hz. The analysis of a single flight should include exceedances resulting from the restrictions contained in the flight manual of the aircraft, operating instructions or aviation regulations, but also indicators enabling monitoring of operational trends or the technical condition of the components. The time required to perform such an analysis requires many times more time than the time of the flight in question. Conducting a manual analysis of several hundred flights would require a significant investment in human resources. The use of software that automates the analysis process is crucial.

The European Aviation Safety Agency (EASA) recommends undertaking activities related to the monitoring of flight parameters in general aviation in documents such as:

- "*Investigation of the technical feasibility and safety benefit of a light airplane Flight Data Monitoring (FDM) system*",
- "*Safety and research document EAFDM*"
- Or in the European Aviation Safety Plan.

Documents define, among others key security indicators that can be determined by means of recorded parameters and relate directly or indirectly to groups of events with the highest operational risk, such as CFIT (Controlled Flight Into Terrain), RE (Runway Excursion), LOC I (Loss of Control in Flight).

In order to improve safety in general aviation and to adapt to the proposed requirements, Training Centers of Pilots are obliged to introduce automated monitoring and analysis systems of flight parameters. As part of the cooperation between the Aviation Training Center in Chełm and Storkjet, the concepts of key safety indicators were applied to the problem of violation of the runway during landing. Using the data collected from 1550 flights of C-152, C-172, PS28 aircraft during school flights made at OKL in Chełm and based on software automating the processing process provided by Storkjet, overflows and indicators of unstable landing approaches were analyzed. closely related to the RE type event group. The effects of a non-stabilized approach may be, inter alia, landing outside the designated area or stopping the aircraft outside the runway. These events are included in the National Security Plan for 2017-2020. Incorrect contact with the runway is included in the group of air accidents determined by EASA (in EPAS) and ICAO (in GASP) as "Runway Safety". Incorrect contact with DS is very often a precursor to runway loss and is the most frequent accident area in the EASA States in the category of air accidents without casualties.

The purpose of the activities is to minimize the number of incidents from the category of incorrect contact with the runway, and indirectly minimize the incident from the runway departure category and to improve the level of training and risk awareness during the implementation of landing and landing procedures.

The category of incorrect contacts with the road includes a whole series of landing operations among which we stand out:

1. a hard landing
2. landing after the touchdown point
3. landing outside the central axis of the runway
4. landing on a non-parallel aircraft into the axle
5. landing on the front shin
6. landing or take-off with a tail or wing tip against the runway surface, except for hitting an obstacle;

Most airlines and aviation organizations set minimum acceptable criteria for continuing the approach to landing. They differ in detail, but the following summary allows you to understand the whole idea of stabilized approaches.

In all studies, it was suggested that "all flights must be stabilized at an altitude of 1000 feet above the airport level in IMC (Instrument Meteorological Conditions - Instrument weather conditions) and 500 ft above airport level in VMC (Visual Meteorological Conditions - Meteorological conditions for flights with visibility). "The approach is stabilized when all of the following criteria are met:

- The aircraft is on the right flight route
- Only small changes in heading / altitude are necessary to maintain the correct flight path
- The speed is not greater than VREF + 20kts of the indicated speed and not less than VREF
- The aircraft has the correct landing configuration
- Descent speed is not more than 1000 feet / minute (if the approach requires a descent speed of more than 1000 feet / minute, a special briefing should be performed)
- The power setting is appropriate for the airplane configuration and is not below the minimum power for the approach defined in the instructions for use
- All briefings and checklists have been carried out

Certain approaches are stabilized if they also meet the following conditions:

- ILS approaches must be within one dot of the locator slope
- Category II or III approaches must take place in the extended location band
- when approaching with orbiting, the wings should be leveled to the final level when the aircraft reaches a height of 300 feet above the elevation of the aerodrome; and,
- exceptional landing conditions or abnormal conditions requiring departure from the above elements of a stabilized approach require special clearance.

An approach that becomes unstable below 1,000 feet above the IMC airport level or 500 feet above the VMC airport level requires an immediate departure in accordance with the procedures.

Some operators also determine the status of the aircraft on the gate should "before" the "mandatory" gateway provided by the system. Usually, it is 500 feet above the "must" gate, for example, the "should" gate at 1000ft AAL (Above Aerodrome Level), and then the "must" gate at 500ft AAL. Failure of the former requires corrective actions to be enforceable and taken, while failure to comply with the latter requires going to the circle. Continuing an unstable approach may result in the aircraft reaching the runway threshold too high, too fast, off the runway centerline, incorrectly configured, or otherwise unprepared for landing. This may result in damage to the aircraft during landing or falling out of the runway, resulting in injury or damage to the aircraft or aerodrome system.

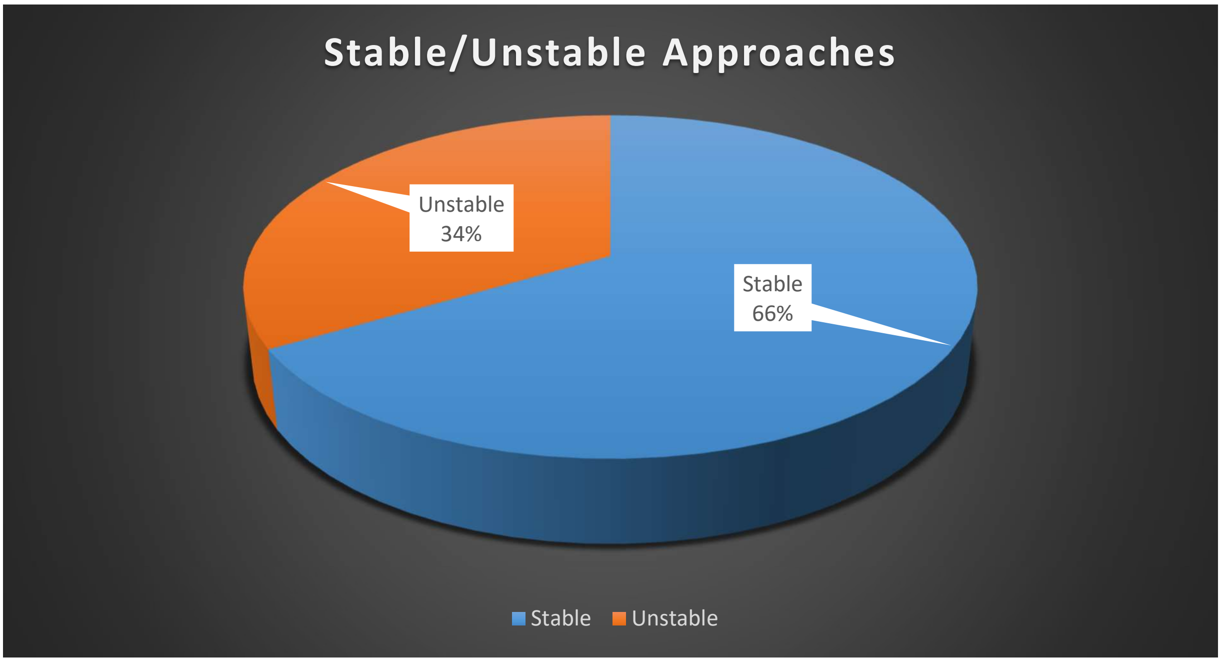
Appropriate procedures and training allow the flight crew to determine if the approach is sufficiently stabilized to allow the flight to continue in the specified "gates". Confirmation of the stabilization of the approach can be obtained by analyzing the results of FDM flight monitoring software processing. Statistical analysis of results for many flights allows to determine the level of security, indicate and link observed trends with operational or procedural changes, as well as standardization activities.

Based on the data collected at OKL in Chełm and after being processed by the Storkjet FDM4GA program, a set of statistics on unstable landing approaches was obtained. It should be emphasized that the performed analysis is pioneering on a global scale due to the nature of the operation - flight training and a large number of flights.

Data obtained from flights are grouped by type of training. The division was carried out in order to identify what types of training are statistically the most unstable approaches to landing. Then, in order to determine the limits of the correct approach path, the standards depend on the type of flight (VMC / IMC) programmed in FDM4GA. In addition, the aircraft performance based on the Flight Manual (AFM) was included, additional procedures based on the Standard Operating Procedures (SOPs) of the Aviation Training Center and navigation data based on approved navigation information for specific airports.

Tab. 1. Example of restrictions resulting from SOP.

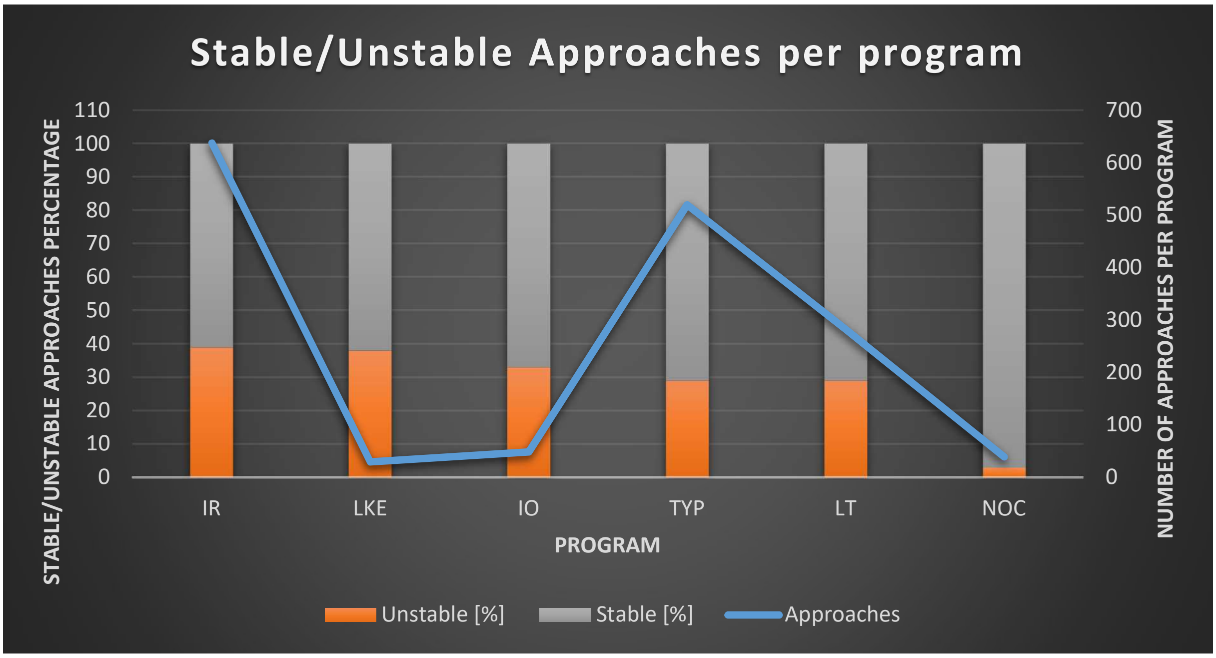
Event	Parameter	Unit	FDM caution limit	FDM warning limit	min_sampl e
High Rate of Descent	Vertical Speed	ft/mi n	-750	-1000	10
High Roll	Roll	deg	20	30	10
Steep Approach	Gradient	%	-10	-12	10



1. Number of unstable approaches for the 500 ft gate.

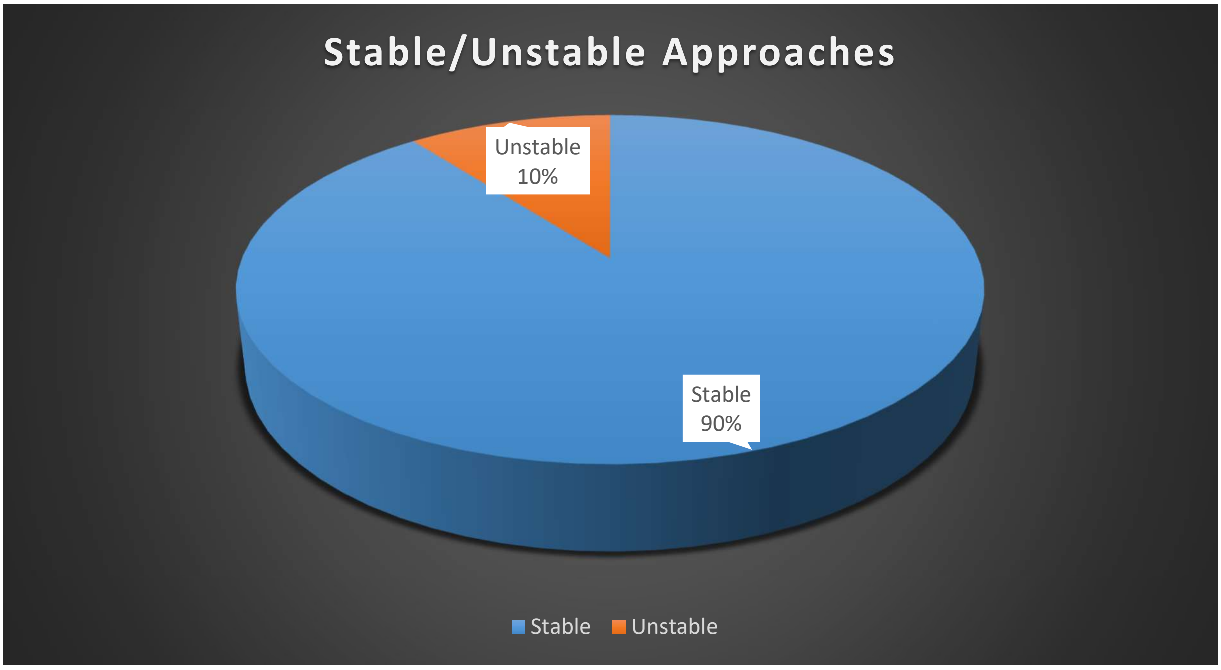
Fig. 2 shows the ratio of stable and unstable landing approaches according to predetermined criteria depending on the type of training. In addition, the total number of operations was presented.

In the case of IR flights (instrument flights), LKE (examination flights of the Aviation Examination Board), IO (flights based on the Operational Manual of the Center), TYPE (flights to aircraft type training) and LT (training flights as the aircraft commander) range between 29% -39%. On the other hand, in the case of NOC flights (flights with ground visibility at night), the number of unstable approaches is definitely lower and amounts to 3%. It should be emphasized that in the aviation industry the number of unstable approaches varies between 1% -3%. In our case, the number of unstable approaches for all types of training to the number of approaches to landing is 34%.

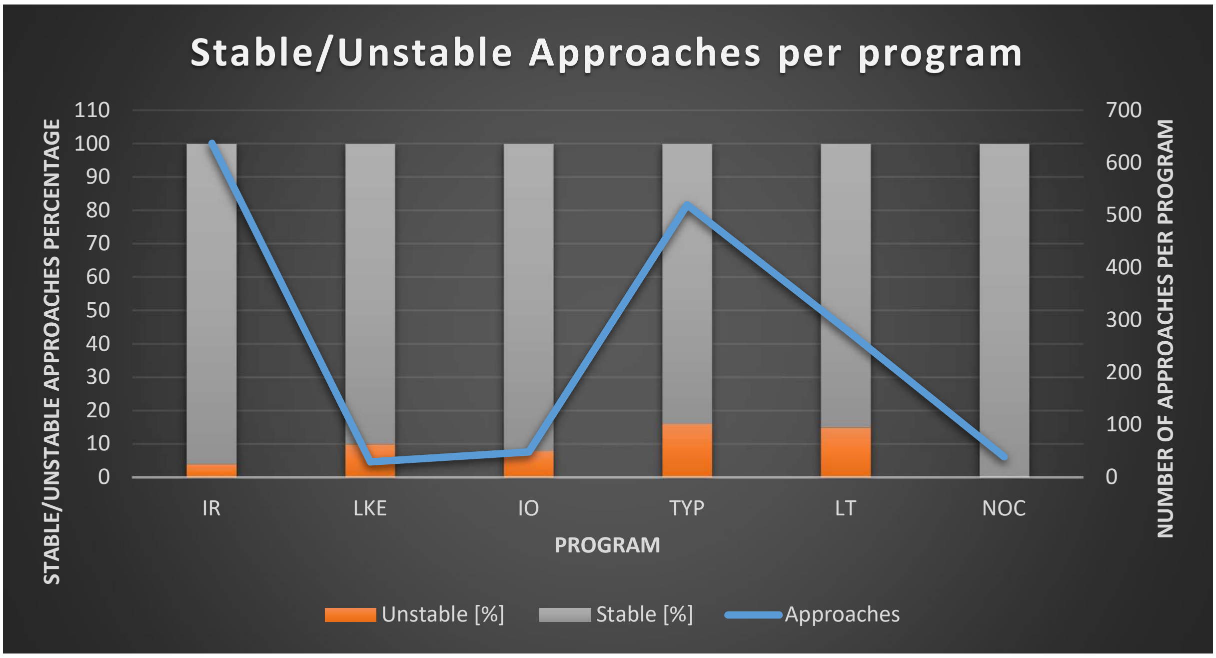


2. Amounts of unstabilised approaches to all approaches.

Then the same operations were analyzed but after changing the height where the stabilization criteria must be met up to 250ft above the DS height. The situation, in this case, is significantly improving and from 34% to 10% of unstable approaches.



3. Amounts of unstabilised approaches to the whole approaches after reducing the so-called "Inlet gate" up to 250 feet



4. Quantities of unstable landing approaches to the whole approaches after reduction of the so-called "Inlet gate" up to 250 feet.

Lowering the goal of 250ft resulted in a significant decrease in unstable approaches from over 30% to 10%, by averaging all types of training. It should be noted that IR flights in this area have the largest increase in stabilized approaches, i.e. 96% to the number of approaches to landings. This is the most similar value to NOC type training, which has 100% of the number of stable approaches. From the perspective of air safety, a group of flights called LT is deserving of special attention, in which stable approaches are 85%. This type of flight is carried out independently by pilots with a tourist pilot license (planes) PPL (A) and a small raid, without supervision instructors on board the aircraft. The nature of these operations is standard. In the case under consideration, an unstable approach should follow a second circle, or an event should be reported to the appropriate safety management cells. In the case of other flight groups, remember that they are school and/or exam flights, which may include additional factors that impair the quality of the flight or create a need for a preventive landing. From the point of view of psychology, they are also burdened with additional stress and often the desire to land at any price.

In summary, each stabilized approach to landing should end with a safe landing at the touchdown point at the appropriate speed. On the other hand, many unstable approaches to landing and attempts at later touchdown carry a risk of accident or circumstances.

It is worth noting that looking at the aspect of unstable approaches in small aviation by risk assessment, it is much smaller than in the case of transport aviation. This is due to the smaller speed of small aircraft. Nevertheless, the majority of pilots after commencing the training start working on airplanes in communication aviation. The acquisition of awareness of the risks associated with the unstable approach and assimilation of actions to be taken in such a case at an early stage of aviation training can prevent accidents, especially communication aviation. The pilot must be aware of the possibility of moving to the other circle, making another stabilized approach and, in the end, a safe landing.