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IT SUPPORT FOR TEST FLIGHTS

Informatyczne wsparcie wykonywania lotów próbnych

Abstract: *The paper reviews the significance of conducting test flights and the statistical analysis of air events in their course. It was demonstrated that it is necessary to support the processes of analysing and evaluating the selection of the crew for tasks conducted using a specific aerial vehicle. The authors presented an IT system supporting superiors supervising test flights, simultaneously increasing the effectiveness of managing safety and preventive actions. The system's design was briefly described and its operation confirmed using selected examples. The results were graphically visualized, in a manner exhibiting high legibility and simplicity of the system's operation.*
Keywords: test flights, aircraft operation, test pilot, flight safety

Streszczenie: *W artykule przedstawiono znaczenie wykonywania lotów próbnych oraz analizę statystyczną zdarzeń lotniczych podczas ich realizacji. Wykazano, że niezbędne jest wsparcie procesów analizy i oceny doboru załogi do zadań wykonywanych na konkretnym statku powietrznym. Zaprezentowano opracowany system informatyczny wspierający przełożonych podczas prowadzenia nadzoru nad lotami próbnymi, zwiększając jednocześnie skuteczność zarządzania bezpieczeństwem i działaniami profilaktycznymi. W skrócie przybliżono budowę systemu, a jego działanie potwierdzono na wybranych przykładach. Wyniki zobrazowano graficznie, w sposób pokazujący dużą czytelność i prostotę działania systemu.*
Słowa kluczowe: loty próbne, eksploatacja statków powietrznych, pilot doświadczalny, bezpieczeństwo wykonywania lotów

1. Introduction

Due to the rapid development of aviation, in-flight aircraft tests and studies are becoming more and more complex.

Operational tests conducted during various test flight types are part of product quality assessment tests. Their scope is different depending on an aircraft life cycle. They include reliability – durability – functional testing of [2] tribological node assemblies and strength structures [3, 5]. Testing experimental and pre-production prototypes includes test flight and a full operability, in accordance with the suggested operating model [4]. The objective of these tests is a preliminary in-flight verification of aircraft airworthiness by a pilot or the crew. The second sphere of the studies relates to operational, diagnostic, overhaul and preventive (e.g., maintenance) verification.

Aircraft – after the production process, factory units are subject to in-flight testing as per standard verification programs (assembly compliance verification). The basic validation in terms of operation is conducted to the same extent.

2. Static assessment of test flights

When assessing the causes of air crashes in the test flights, the analysis covered all aviation accidents that occurred in 1981-2010 (fig. 1).

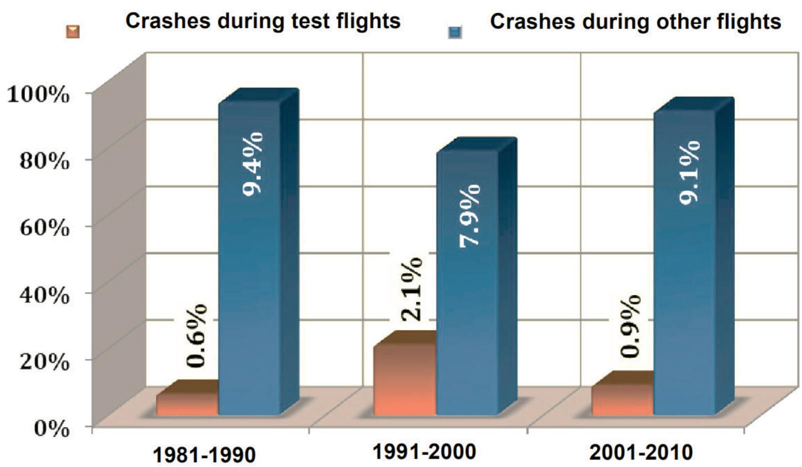

Fig. 1. Air crashes of military aircraft in the years 1981-2010

It can be seen that the most tragic years for test flights were the 1990s, because during that period, every 5th air crash occurred during a test flight (21%). Detailed analysis of test flight air crash causes (fig. 2) indicated that more than half of them is a consequence of human mistakes (55.6%). It is hard to comprehend in the case of test flights, since experimental pilots are master- or first-class airmen and it's hard to suspect they made mistakes due to lack of knowledge, experience, training or skills. Routine was the likely cause.

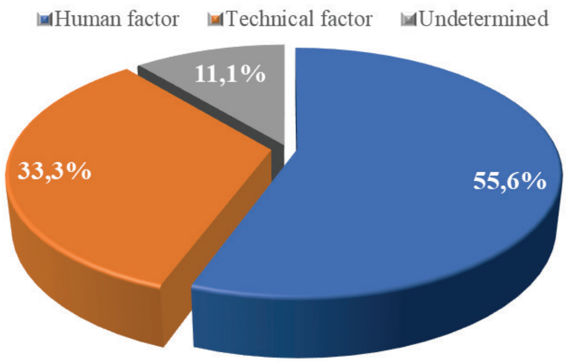

Fig. 2. Causes of air crashes during flight tests, based on [1]

The second largest group of air crash causes during test flights are technical factors (33.3%), indirectly also related to human mistakes.

There was one test flight crash (11.1%) in the 1981-2010 period, the causes of which remain unknown.

All these factors show how important is assigning proper air personnel for a given task. In order to streamline this process, it is necessary to implement an IT system supporting the decision-making in this regard.

3. IT model assumptions

A method for IT support for flight tests is characterized by staging and repeatability. It is necessary to distinguish between individual identification steps, decisions to be made at each of them, as well as their characteristic data and result types. Appropriate algorithms that group activities and decisions for each of the aforementioned steps were developed for this purpose.

The method's procedure includes, among others:

- data analysis in terms of aircraft types,
- data analysis in terms of servicing given aircraft types,
- determination of technical and organizational flight process parameters,
- algorithm for assigning a test pilot to the appropriate flight,
- algorithm for determining test pilot status,
- history of activities.

The adopted assumptions were used as a base to develop the *DOSPIL* application (fig. 3). The application uses the Google Chrome browser and connects with the database in real-time. The database contains necessary dictionaries and software elements that enable quick and easy operation. The application of a three-layer method does not burden a computer and enables third-party access to processed information. Each person at their post has their own password. This allows to track each user movement in the *DOSPIL* system.

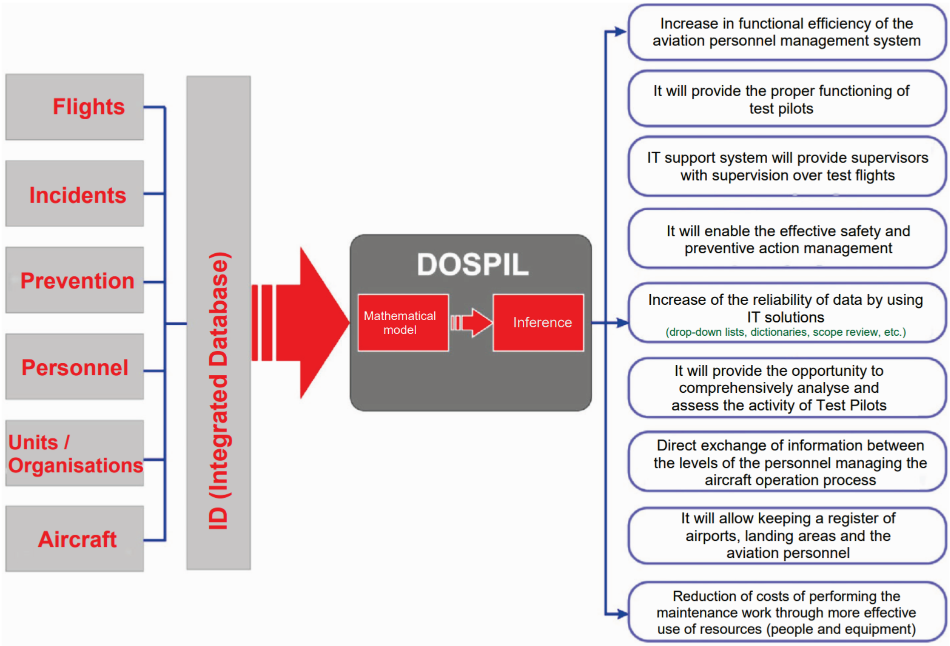

Fig. 3. Information sets processed in the DOSPIL computer tool [5]

The main task of the *DOSPIL* app is supporting decisions related to scheduling test pilot tasks together with aircraft maintenance (fig. 4).

The support IT system provides superiors with supervision over test flights, enables effective management of safety and preventive actions through collecting information. It falls in line with the new trends of proactive flight execution safety management. It offers the possibility of a comprehensive analysis and evaluation of Test Pilot activities and ensures direct exchange of information between individual tiers of personnel managing aircraft operation process.

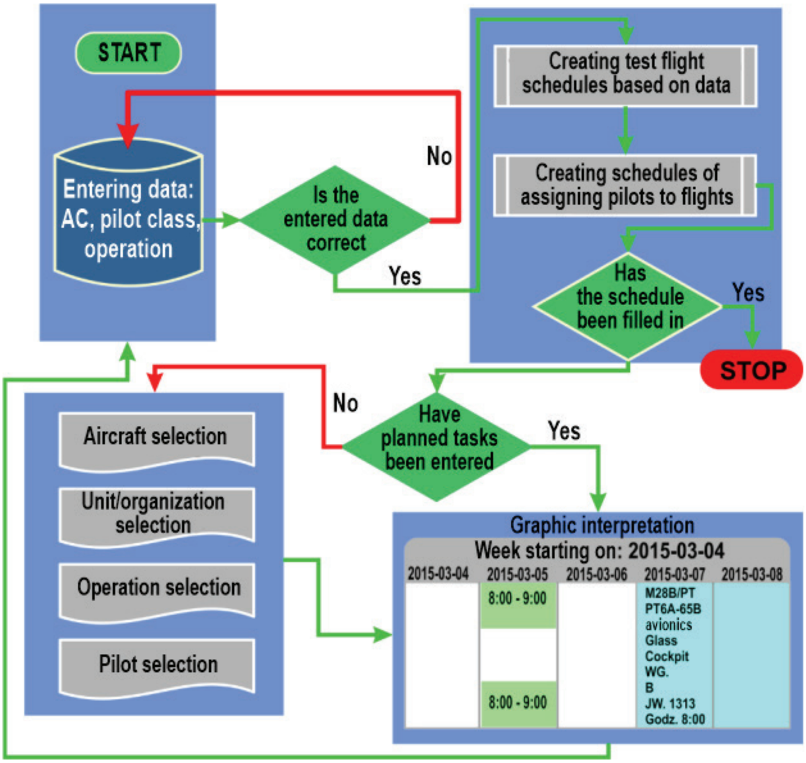

Fig. 4. DOSPIL application schedule determination method algorithm [5]

4. Test flight execution supporting methods

The application server was divided into six basic tabs that enable smooth navigation in the system. The application layer enables feeding the database with information that will enable information extraction and creating summaries and reports, pre-defined by the user. The system has four fundamental roles:

- Test flight manager - responsible for safe task execution;
- Test pilot - responsible for task execution; has access to current information;
- Trainer - adds dictionaries, fills in flying personnel data and updates;
- Timekeeper - enters flights.

Moreover, the system can be viewed by such authorized persons as aircraft maintenance personnel, services securing test flight execution.

The application enables:

a) determining an optimal test pilot and creating a task schedule. The optimizing algorithm takes into account such information as pilot class, service type, aircraft type;

b) generating update status for test pilots. An appropriate algorithm determines technical and economic parameters that allow to assess the effectiveness of the selected solution for assigning a service performance location;

c) schedule optimization based on data determined as per sub-point a) and b).

Functions implemented by DOSPIL software can be divided into two blocks:

– the first one - functions associated with creating, saving, printing or editing data files;
– the second one - functions associated with loading a database, performing calculations, presenting and saving result files.

DOSPIL - owing to the Timekeeper module - enables generating a daily or planned load for a given parent unit (fig. 5). The application records each aircraft flight, including the take-off time and date, total flight time, flight times under specific weather conditions, flight type, information on flight tasks, inspections and all crew members - function on-board and flight time in a covered cabin.

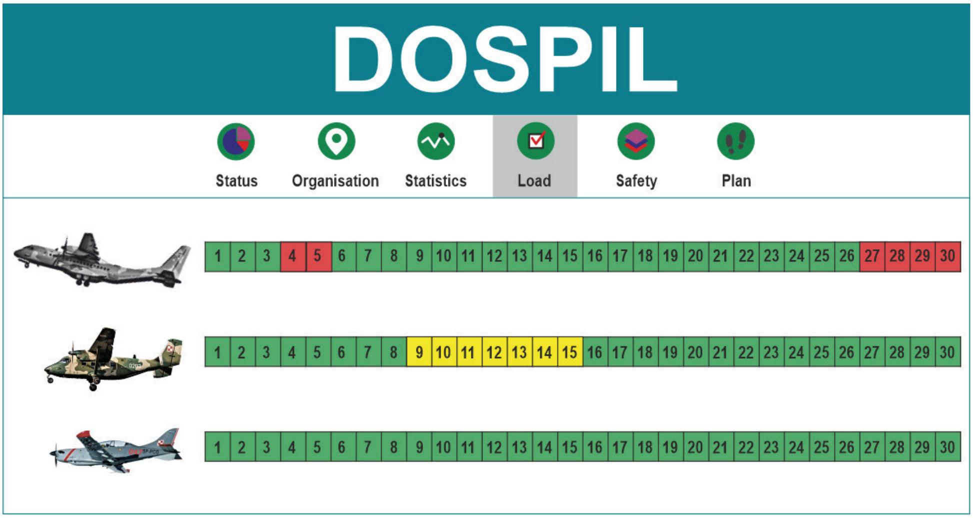

Fig. 5. Depiction of subordinate aviation personnel daily load [5]

The system database stores basic registration and operational data for each aircraft participating in the flight (the data can also be uploaded from other systems). Further data includes preventive activities taken after investigating each test flight event. Events that can be recorded by the system relate solely to events occurring in the course of test flights. The system records all air events, including event location, circumstances and course, description of weather conditions, crew data, aircraft data, commission expert opinions, event causes, shortcomings and others (fig. 6).

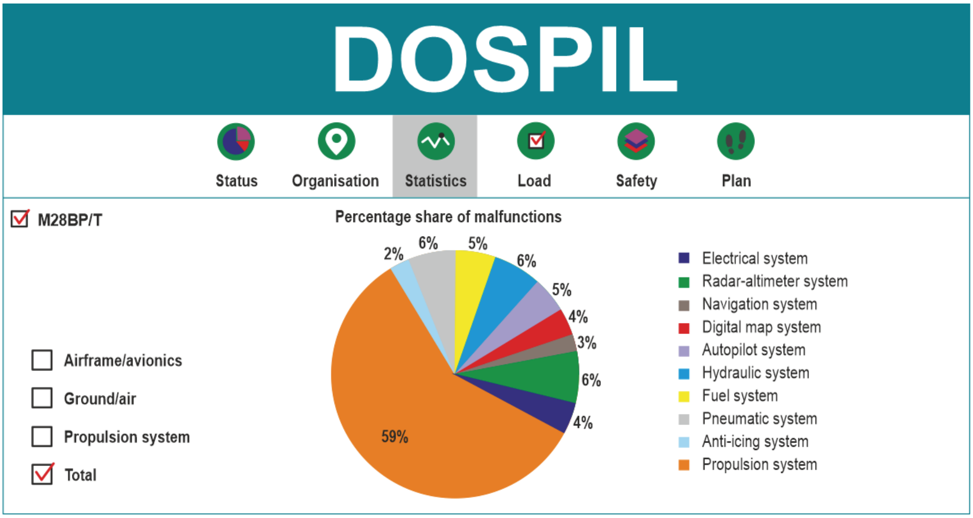

Fig. 6. DOSPIL app statistical module [5]

The “safety” tab records data on each aviation personnel member, including basic registration data, military service record, civilian and military education, foreign language fluency, specialist class, training level, authorizations, service incapacity, health condition, hospital stays, sanatorium stays, holidays and others.

The DOSPIL application stores the entire history of the test flight performance system operation. The application also includes the training of given personnel, which is described using appropriate algorithms to achieve the required level of advancement.

5. DOSPIL system operation

Owing to the aforementioned algorithm, the DOSPIL IT system matches a pilot to a specific task. This happens as a result of satisfying certain requirements. A decision-maker selects the type of an aircraft with planned operations. The system automatically displays flight plans for a given aircraft type. When selecting a given flight plan, the DOSPIL IT system generates available pilots. A given pilot is selected based on strictly defined criteria.

The DOSPIL IT system allows to enter all data related to the aviation personnel. After clicking the "Plan" tab in the DOSPIL application, it is possible to choose the type of the aircraft, where a given operation is planned to be executed by the pilot. After selecting an aircraft, e.g., Bryza M27BP/T, the application displays all numbers of a given type of aircraft that should be assigned a given operation in the near future (fig. 7).

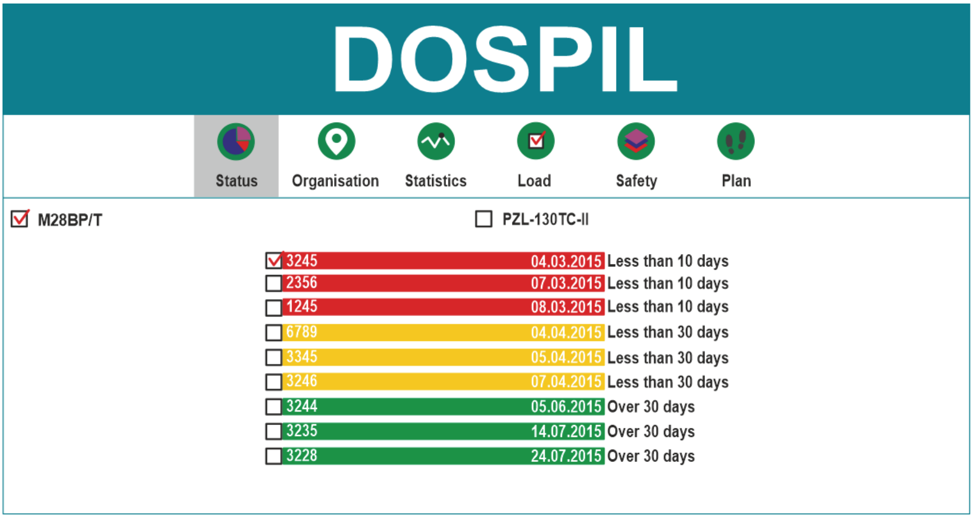

Fig. 7. Aircraft that need to be assigned with a pilot in the DOSPIL system [5]

Aircraft numbers are displayed in order of maintenance which must be carried out as soon as possible. Colours introduced in the system are aimed at mobilizing and reminding the user of the assignment of a given pilot to an aircraft type. Red means that the planned operation takes place less than 10 calendar days from now and it is important to assign the pilot, who meets the required criteria, to a given aircraft number as soon as possible. The orange colour means that the performance of a given test flight was planned within the next 30 days. However, green means planning the flight for a period of more than 30 calendar days.

After selecting an aircraft number, to which we want to assign a given pilot, the application takes us to the next window (fig. 8), with a brief profile of the given aircraft based on aircraft version, side number, serial number, manufacture date, manufacturer, service life, total flying time, number of landings, number of repairs, last repair date, place of repair, service life after repair, number of landings after repair, flying time after repair. At the test stage, that information is entered manually, but the “pro” version offers a possibility to supply the DOSPIL app with information from other systems collecting operational data on individual aircraft operated within the Polish Armed Forces. The integration of these systems is also recommended due to unnecessary data duplication. Next, all possible operation types for a given aircraft are displayed.

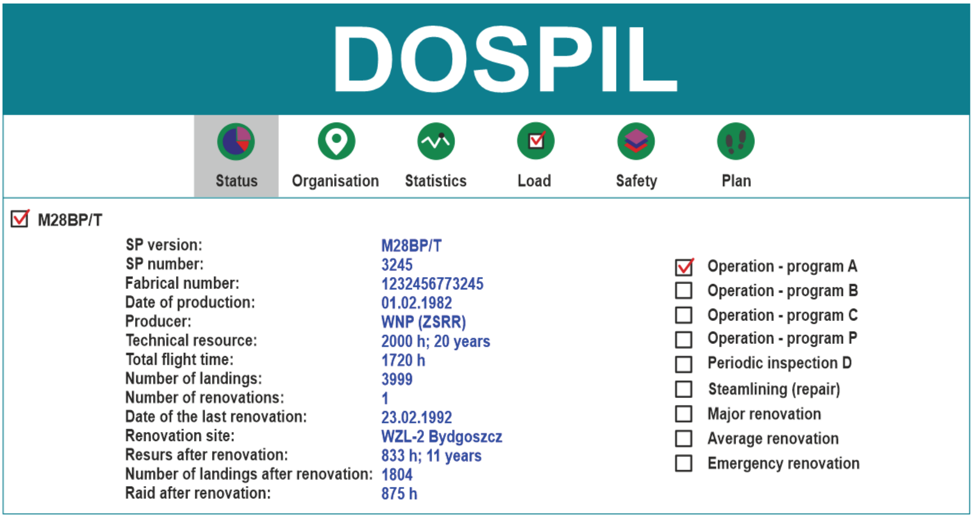

Fig. 8. Operation type selection in the DOSPIL system [5]

Figure 9 shows the result of assigning pilots to a preset operation. Pilot availability is identified after counting the other six factors and taking into account the schedule of possible flights of a given pilot.

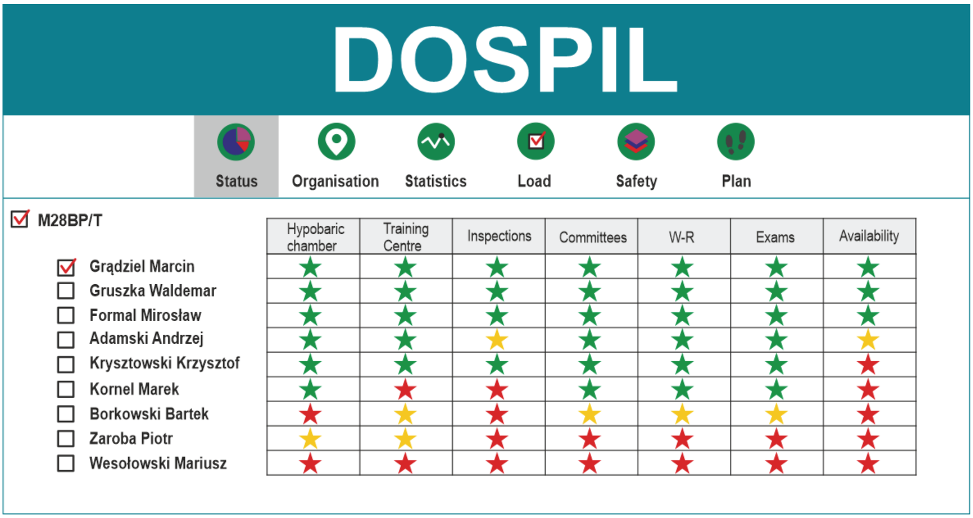

Fig. 9. Pilot selection in the DOSPIL system [5]

A green star allows to choose a given pilot and assign the pilot to a given flight. A yellow star informs us that the test pilot is close to exceeding the time limit for a given category. A yellow start indicated by the “Dostępność/Availability” field means that the pilot is performing or has planned other duties on this date - see flights. If a red star is present by any of the categories, the pilot is automatically excluded from being assigned to any flight, since his/her rights are not valid.

6. Conclusions

The examples of the DOSPIL system operation demonstrated its high effectiveness in matching the crew to the appropriate task performed during the test flight. They introduce clarified system principles in terms of assigning the crew based on seven ready elements – generally speaking, related to health condition, training, availability, etc.

The presented algorithms and methods for analysing and evaluating reliability, safety and aviation personnel training are sufficient to develop an integrated system for optimal aircraft selection and organizing test flight execution – such as the presented DOSPIL system. In addition, it enables a significant elimination of threats when conducting test flights.

Its noteworthy advantage is the graphical representation of necessary data and information, which exhibited high clarity and simplicity of the system.

It is advisable to conduct an analysis in terms of further expansion of the system with new modules to enable integrating all aircraft supervision and operating systems, aviation and technical personnel training, flight reliability and safety analysis (including operational test flights), evaluation of taken risk and the scale of uncertainty.

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