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UTILIZATION OF AIRCRAFT SYSTEM DATA FOR AIR TRANSPORT SAFETY AND EFFICIENCY

VYUŽÍTÍ SYSTÉMOVÝCH DAT LETADEL PRO BEZEPEČNOST A EFEKTIVITU LETECKÉ DOPRAVY

Abstract

The article is focused on aircraft's flight and system data utilization for aviation safety and efficiency. This includes work with Performance Engineering Programs (PEP) output which is based on data recorded by Data Management Unit (DMU). Output is analyzed using tools supported by MS Office. The goal is to provide simple guidelines for operators that are unable to afford the systems for automatic data check send by the aircraft manufacturers.

Abstrakt

Tento článek je zaměřen na využití letových a systémových dat letounu pro bezpečnost a efektivitu letecké dopravy. Toto zahrnuje práci s výstupem programu poskytujícího letová výkonová data pro letecké inženýry (PEP), který se zakládá na datech pořízených prostřednictvním jednotky řízení dat (DMU). Výstup je analyzován za pomocí nástrojů MS Office. Cílem článku je poskytnout jednoduchý návod pro male provozatele, kteří si nemohou dovolit systémy pro automatickou kontrolu letových a systémových dat zasílaných výrobci letadel.

Keywords

Aviation safety, Aviation efficiency, Data analysis, DMU, PEP, MS Office

1 INTRODUCTION

Lack of relevant information is one of the main reasons of aviation systems failure. At the first look it seems that the problem is in an insufficient quantity of overall information, but currently the reason can be the opposite. Nowadays there is an access to a big amount of information but some of the crucial ones could get lost among the redundant ones. This can cause, not only in aviation, losses of lives, health or properties. It is the common interest of the air transport industry to operate most safe and efficient at the same time, which is sometimes very difficult task. The optimal approach could be to handle all important information efficiently and keep the process cheap. Two questions have to be answered by solving this problem. Where to obtain the right information and what to do with them afterwards. In both cases several things are desired. Firstly, the process should be as easy as possible. Secondly, the process itself does not require new technologies or learning of overcomplicated procedures. The best option is the one where an operator uses tools that he already has, but he learns to use them in more efficient way. This especially applies for smaller operators who are unable to afford systems that would perform such tasks automatically. The process described in text bellow is designed specifically for operator with small numbers of Airbus A320 family airplanes.

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2 PROCESSING DATA

Concerning the collection of information about the airplane, while airborne, the first what comes on mind are systems such as the flight data recorder (FDR), the cockpit voice recorder (CVR) or the airborne image recorder, but these systems are designed more for a reactive use. FDR data are for example used by Special Event Search and Master Analysis (SESMA) system in search for exceedances during a daily use of the airplane [5], and more over the FDR data are meant to provide as complete as possible image of the plane. If the operator requires data about specific part of the airplane, without superfluous information, it is better to use sets of data designed for such purpose.

In case the operator needs information quickly and uses airplanes made by the Airbus Company, it is appropriate to use the Data Management Unit (DMU). This system cooperates with the Aircraft Integrated Data System (AIDS) to generate reports, usually based on trigger conditions. These reports contain large amount of information which can be used by an accident or incident investigation, an engine maintenance or by a long term monitoring of airplane's performance. [1] These reports are also easily accessible because an airplane can immediately send them via Airborne Communication and Reporting System (ACARS) to Airbus company servers which afterwards send the report to the airplane´s operators in a form of the electronic mail. It shall be mentioned that the ACARS transmits the reports in a very compact format therefore it is very difficult to interpret incoming message without a software aid. [2]

For a correct interpretation of DMU reports there are the Performance Engineering Programs (PEP) used. Based on inserted database, represented by txt file with a copied e-mails' content, PEP produces a final report containing collected data organized in understandable way. Additionally, reflecting the recorded data, PEP calculates other parameters. At the end of the final report there is a value of parameter that is the most important for the operator, for example the Degradation of Specific Range (DSR). This is the value that the operator needs to know as an input for the airplanes computer as it directly influences the airplanes performance (Specific Range). Specific range expresses the distance covered by airplane per unit of fuel burned. Besides weigh and aerodynamic characteristics, it depends on engine performance which can degrade with time [1]. So we may say that all other data can be disregarded. The issue is a low frequency of values that are outside of the expected range which may be overlooked. The other example are series of numbers that are not so different, but each subsequent number is tiny bit higher than previous and together those numbers create a trend that could be problematic in the future.

It is difficult to spot such irregularities in the PEP final report because the whole output is just a simple text file where all values without a careful validation look the same. For a more effective work with these numbers, a more customizable environment is needed. As mentioned at the introduction, the best tool is the one that the operator is familiar with to a certain degree. For most of workplaces, such tasks are executed with the help of Microsoft Office tools. The fact that the operator works with these programs does not imply that he has a capacity to use their full potential which would simplify his job to the maximum extend. The tools proposed to be used for better PEP output analysis are the MS Outlook and MS Excel.

The first one is utilized in the PEP database creation. The operator receives high number of messages into his mailbox, but only a fraction of them is from DMU which produces various reports. It is ineffective to open and process all messages one by one. In case of DMU the report´s sender is always the same and messages are often without a subject. However, MS Outlook enables a fast selection of required messages using keywords, regardless of the total number of files in the inbox. To use this functionality, the operator needs to write inside search-bar, with quotation mark at the beginning and at the end, a specific symbol or series of symbols. The program selects all messages that contain given symbol. Due to the fact that DMU reports contain, besides recorded data, a formal heading that includes a type of a report (A01, A04, A14 and so on) this tool is ideal. The next step is an export of all messages or mass copy of messages into a txt file. This way the PEP input is ready in matter of minutes.
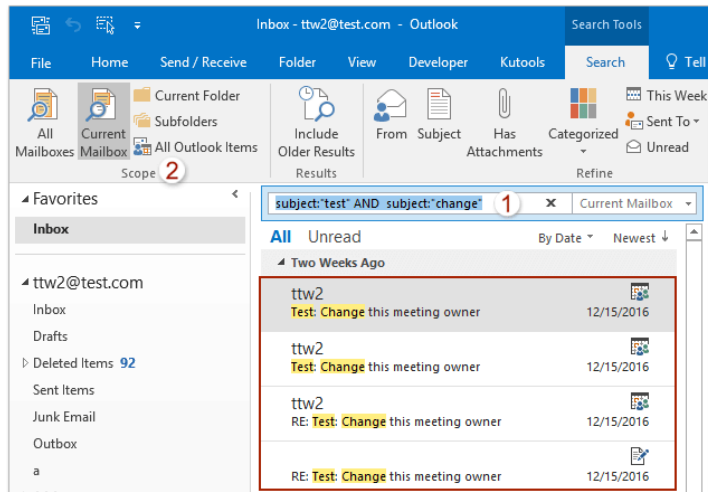
Fig. 1 Example of using MS Outlook for the PEP message selection. [4]

When PEP has processed the input, the operator can work with PEP output. For processing of the output, the MS Excel is used. Output in its original format is not very suitable for a work in the Excel environment, but this can be optimised with a few extra steps. After coping all of data, without formal headings, into Excel spreadsheet, the program registers inputs as a plain text. It is important to use function "Find and replace" to change specific symbols such a full stops, commas and the others to make sure that program will correctly recognize values as numbers, time, date and other formats which may be used. Once this is done, it is safe to use "Convert text to columns". Above described process transforms a compact text, which suffers from a low level of readability, into a structured information. The structured information is further processed to produce graphs which allows faster end more precise analysis of the underlying data e.g. identification of the limit values and outliers as depicted in picture below.

In the Fig. 2 there are presented the data of specific range degradation (DSR) in time. Values outside of limits (red lines) – are clearly visible and, when pointed with a mouse cursor, XY coordinated are shown.
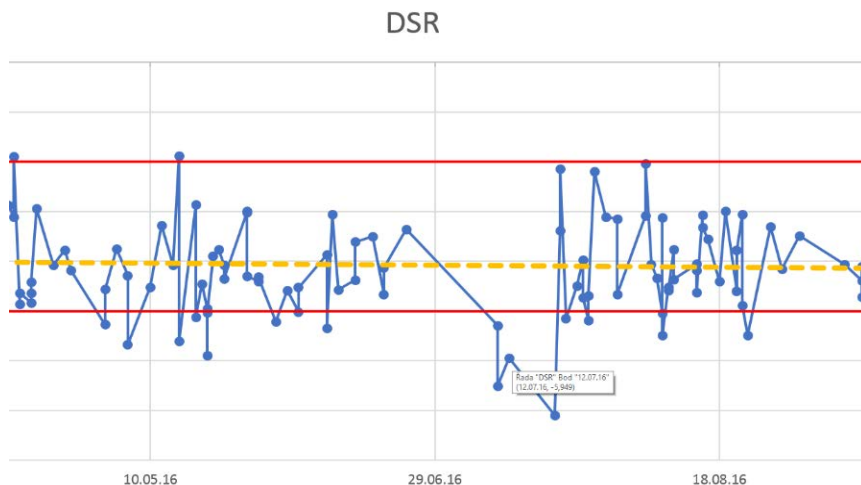

Fig. 2 Specific range degradation in time.

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For the periodical utilisation of the functionality the automated processing by the means of Visual Basic macro can be introduced. A customised macro contains a form into which the operator copies data from PEP output and inserts limit values for parameters that shall be validated. The Forms can be extended with additional functions such as hints that describe how to fill selected cells (see the picture bellow) or validations that ensures correctness of mandatory fields. In comparison to the manual processing the macros improves the efficiency while implementing wide range of user requirements such as: conditional formatting which is very useful for highlighting values inside or outside chosen interval, or graph generation including trend lines and limit values, creating backups on separate spreadsheet or evaluation of all backup data.

Fig. 3 Excel macro window for parameters calculation.

In the Figure 3 there is the Excel macro window for parameters calculation. In the upper part there is a cell for PEP output insertion and bellow there are cells for entering limit values of specific parameters. A form offers functions such as coping of limit values of the first engine into limit values of the second engine, deletion of previously entered data and overall analyses of previously backed up data. In addition, the form provides hints for the cells as can be seen in the cell for parameter EGT2 min.

3 CONCLUSIONS

In this article there was shown one of the simple software tools for processing of a huge mass of raw data as a help for small airplane´s operators which have only minimal manufacturers support by the air transport operations. Because the expected airplane´s Specific range degradation with the time could cause a big problem for the flight crew by the air transport operation on the maximum range, it is an advantage to have some simply tool for supervising this parameter for increasing the safety and efficiency of air transport operation by small air transport operators.

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