Development and Use of an Operational Procedure Information System (OPIS) for Future Space Missions

by

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Abstract

An MS-Windows based electronic procedure system, called OPIS (Operation Procedure Information System), was developed. The system consists of two parts, the editor, for "writing" the produre, and the notepad application, for the usage of the procedures by the crew during training and flight. The system is based on a standardised, structured procedure format and language. It allows the embedding of sketches, photos, animated graphics and video sequences and the access to off-nominal procedures by linkage to an appropriate database. The system facilitates the work with procedures of different degrees of detail, depending on the training status of the crew. The development of an "language module" for the automatic translation of procedures, for example into Russian, is planned.

Introduction

The scientific output of a manned space mission is highly dependent on the correct execution of an experiment according to instructions called "procedures" the astronaut has to follow. The procedures of today (at least for spacelab missions) are very explicit paper versions and require hours of crew time just to read. For the future, especially for long-duration missions, the possibilities of modern computers and text processing should be used to improve the procedure standard allowing for the transition to the use of electronic procedures on board. OPIS, a development of DLR, in cooperation with WIB, is a step in this direction.

For the European mission Euromir 94, it is planned to use OPIS, installed on the portable Crew Support Computer (an `IBM Thinkpad`), as the prime tool for the performance of one material science experiment. The post-flight evaluation of its practicality will be a milestone for it´s further development (e.g. prime tool for procedures on Euromir ´95).

Approach

The source that safeguards the experiment success in current SpaceLab missions is called the Payload Flight Data File, a complement of books containing the crew work schedule, procedures and reference documents. A similar set of documents exists for the use on Russian MIR missions. Some shortcomings are associated with this type of flight documentation:

- large volume and high weight of files
- time-consuming implementation of paper uplinks into the documents
- long procedures in checklist format tend to tire out crewmembers which leads to mistakes
- embedding of graphics, sketches etc. is difficult
- usage of animated graphic sequences or video clips within the procedure, or the linkage to a data base is impossible

Our idea was to firstly develop a procedure format better suited for the work on a computer than the checklist format in use by NASA[1], thereby reducing the training effort (necessary for long-term missions and space station operation) and minimizing mistakes in the experiment performance. Secondly, the crew member should be provided with a tool that facilitates access to supporting and reference information (e.g. malfunction procedures, photos, videos, etc.).
Crew activites were analyzed based on the evaluation of the Payload Flight Data File of the German Spacelab missions D1 and parts of the D-2 mission,. The categories of the typical crew activites are displayed in figure 1 below.

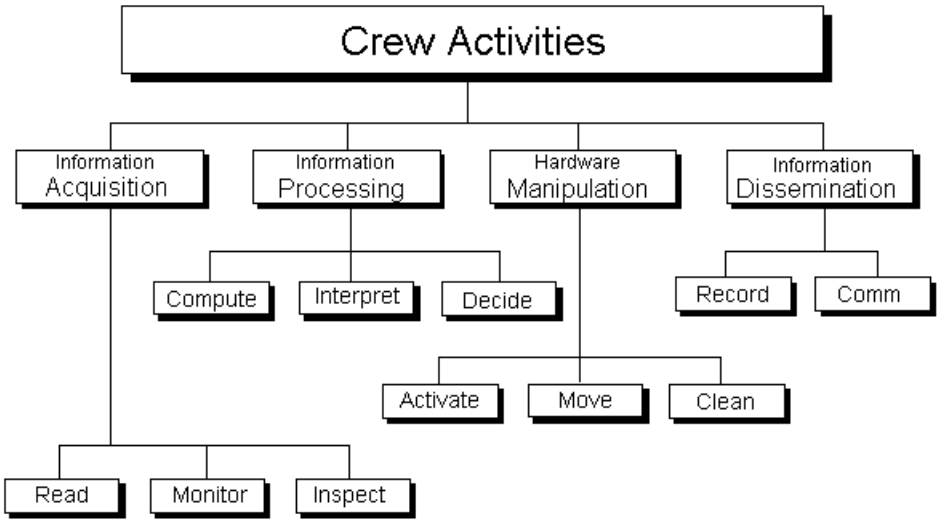

Figure 1: Classification of Crew Activites

These investigations were used to develop a new format for procedure instructions that is better suited for use on a PC than the checklist format which is used at present. The format is

build on procedure elements which describe the single task. A procedure element consists of seven defined positions as shown in figure 2. The last position leads to additional information concerning the performed step using a short code form. The OPIS standard was published in 1993 and presented to the German Space Agency (DARA) in the final presentation of the TOREX[2] study.

Step	Location	Object	Activity	Status	Info Code
1	CSK-1	display	✓ CHECK	address ´66´	CO1

Figure 2: Example of a Procedure Element

The development of the OPIS software started in 1993. DLR provides the software requirements and WIB develops the software under contract by DLR. OPIS uses the WINDOWS environment and consists of two modules: the Editor for procedure generation, and the so called Notepad-version designed for use by an astronaut.

The OPIS Editor

The OPIS Editor allows you to generate procedures in a standardised format by use of a structured language. This language has been constructed to describe tasks in a simple and unique manner. The editor would automatically perform all tasks for the procedure layout and allow easy access to all information which has already been entered for previous experiments for procedure generation . All procedure elements (locations, activities, objects, etc.) are stored in a data base. All activity keywords are linked to appropriate icons. Complex procedure structures (for exeample "REPEAT...UNTIL" or "IF...THEN") can be generated in a simple way via implemented editor commands. A procedure syntax check via a syntax checker within the editor is foreseen for the future. Any sequence within a procedure can be defined as a standard module and can then be handled like a single activity (or command). You can have various standard modules in one procedure. In that way procedures containing activities that have to be frequently repeated can be simplified. The embedding of graphics, video sequences, off-nominal procedures can be realised via linkage to an appropriate data base. For the future the development of a language module for the automatic translation into Russian is foreseen.

The OPIS Notepad

The layout as shown in figure 3 is designed to give the astronaut a clear picture of the steps he has to perform and the ones he already has performed. In the left icon bar the main file functions can be quickly accessed (the numbers 1 to 8 can be used to quickly open specified files). In the procedure window a highlighted bar shows the current step the astronaut is working on. When work on the procedure element is finished it can be tagged with the ´Enter´-key. In this way the system time and the line number will be entered into the ´Report File´ wich is an ASCII-File containing all the information of the timely execution of the

experiment. There is also a possibility for the crew to write notes and enter data into the procedure, which will also be transfered into the Report File. In that sense the original procedure can be used for different runs and the Report File will include all experiment specific infos for evaluation on ground.
Additional useful information is displayed in the status line at the bottom. The actual page and line number can be seen as well as the current time, the elapsed time since the procedure was called up, and a countdown that can be started if waiting periods are included in the procedure.

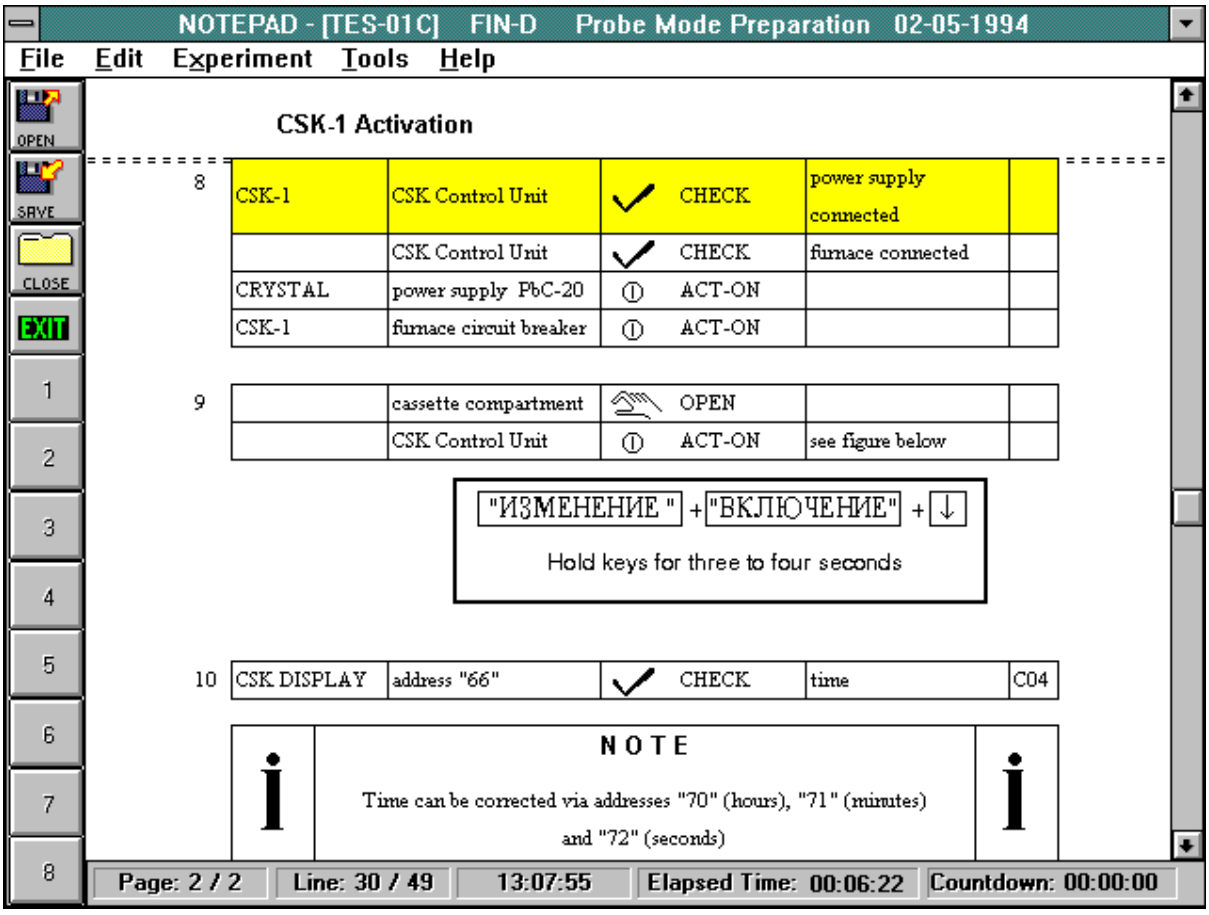

Figure 3: The OPIS Notepad environment

There are off-nominal situations and very complex procedures requiring additional information to safely perform the task. OPIS approaches this problem by establishing an ***interface to a data base*** containing photos, video clips and instructions to solve the problem. The data base currently in use for the TES-Experiment (material science) on Euromir ´94 was developed by BSO under contract from ESA/ESTEC. The data base information can be accessed via a mouse doubleclick into the info-code box of OPIS.

As a paper backup or for self study etc. the procedure can be printed from the editor with a layout identical to the layout on screen, but the computer related features (and that means most of the advantages of OPIS) will be lost.

Outlook and Conclusion

Main topics under consideration at present are:

- Needs of individual crew members for information vary by a wide margin (e.g. for medical experiments) -> ***´personalized´ procedure desirable***

- Long-term missions require procedure systems that are capable of frequently providing updates of information without producing huge piles of paper -> ***file uplink (and downlink)***

- Cooperation with Russia requires translation of procedures -> ***language module***

With the development of an operational procedure information system we try to use the advantages of modern PCs. Our hope is that the ideas behind our system can help to improve the operations on board a manned space station even if OPIS is not the tool to be used at the time. We appreciate every comment to our paper and would be glad to demonstrate the software to interested parties.

References

1 Crew Procedure Management Plan (JSC-08969), NASA Flight Activity Branch, Operations Division, 1991

2 Abschlußpräsentation Technische und Operationelle Standard-Rahmenbedingungen für Experimente unter Schwerelosigkeit (TOREX) WIB GmbH, 23.September 1993. (Technical and Operational Standard-boundary conditions for Experiments under Microgravity)