A Methodology Model for Civil Airplane Flight Crew Operating Procedure Development

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Abstract. The development and evaluation of operating procedures is a complex and long-term task, which may involve various factors and considerations. To make it more effective and productive, the paper aims to establish a systematical methodology for the work. Based on the practice of procedure development and the research on regulations, references and all available materials, a basic model is induced and proposed. All possible considerations on top level policy, design and development method, evaluation and evaluation are then discussed in detail. The model, which was not seen in similar research, is a high-level integration of corresponding knowledge and experience. The effort gives a significant and effective guide for airplane manufactures and airlines in their procedure development, as well as the instructions listed in each section of the discussion.

Introduction

Flight crew operating procedure refers to the normal, non-normal/abnormal and emergency operating procedures in manuals. Based on relevant research and practice of procedure development, a procedure development model is proposed (see Figure 1).

![Figure 1. DDV Model.](image)

The model divides operating procedure development process into 3 phases: The 1st phase as top level designing mainly covers cockpit design principles, operational policies, crew duties and basic principles of procedure design. In the 2nd phase as design and development, the specific design combines all kinds of factors which should be grouped in methodology, content, Format and Expression. In the 3rd phase as validation and verification, viewpoint and concerning of the
development team, authority, customers etc. should be reviewed and combined. The procedure will also be completely assessed and confirmed via flight simulation and flight test.

Usually the 3 phases are much relative and iterative. Problems found in one phase may need returning to the front phase as well as revising the original principles or methods.

**Principles**

**Cockpit Design Principles**

Practices have proved that, at the beginning of procedure development, cockpit design philosophy and the operation principles have much influence on the output of the work. Good concepts and principles will make the work more clear and simple.

**Company Operation Policy**

The design of a new civil airplane should be based on their market positioning. For operating procedures, airplane manufacturer should consider several factors, such as:

1. Introduction of new design concept should make the flying safer, simpler to pilots, and it also needs to comply with pilot’s regular thinking;
2. Changes between the existing technologies and new design should be minimal at all aspects;
3. New types should be designed complying with the international civil aviation technical standards and practices;
4. Training requirements should be as few as possible when a new pilot is trained to the new type.

**Procedure Design Principles**

1. Validity. Execution of the procedure can effectively accomplish specific phases of flight tasks, or effectively dispose the emergency, abnormal condition and recover to a relatively safe and stable state.
2. Be easy to understand and execute. Procedure, from its format and content, can make the crew to understand the requirements and purposes of the operation easily.
3. High fault-tolerant. Potential judging and operating errors will not have a significant, direct impact on safety, and the design should consider the opportunity to realize and correct them.
4. No special crew skills and experience will be required, and the crew's workload is low.
5. Design of the procedure shall meet the civil aviation rules or practices, in line with the manufacturer, operator’s policies and flight technical standards.
6. Design and expressions of the procedures should be as simple as possible, avoiding unnecessary steps and information.

**Design Methodology**

**Procedure Prototype**

There are several bases for the preparation of the procedures and references, such as aviation regulations and recommendation guide, aviation accident analysis databases, etc. In practice, excessive reference to other types while ignoring the design features of the airplane working for shall be avoided.

**Procedure Analysis**

Analysis will explore if the procedure meets the design principles, the logic, content and format, etc., including:

1. Whether or not the procedure is needed?
2. Whether or not the status or condition of the procedure has been clearly defined?
3. Is it the most rational or optimal procedures for handling the problem?
4. Is the logic clear? Are all the branches taken into consideration?
(5) If an action is accidentally omitted or not executed correctly, whether it will cause a serious situation?
(6) Are the procedure and its presentation as concise as possible?

**Task Recombination**
Action items in the procedures need much investigation. Occasionally some items are found to be more suitable to move to another procedure.

For specific phase of flight, not all cockpit tasks are key items. It’s easy to distinguish the main task from secondary ones. Normally, the main task is continuous and coherent, while the secondary task is more dispersive [1]. The main task, including some action items affecting major tasks execution, needs to be integrated, while the secondary task should be separated or rearranged to anywhere appropriate.

**Procedure Content**

**Terminology**
The use of terminology should keep its clarity and consistency, including the name of button or lever, expression of the action items, communication terms, etc. They should be commonly used in the aviation industry and the company.

**Action Items**
Action items can be ranked in critical items and non-critical items, according to the potential effect of failing to perform them [2]. Critical items are those items, which, if not correctly performed, have a direct, adverse effect on safety. Non-critical items are “housekeeping” items or systems management items, which have a minimal effect on safety and shall be routinely accomplished during a specific phase of flight.

**Sequence of Actions**
Action sequence will be considered with a constant standard throughout the whole procedure development process [2, 3]:

(1) When there’s a choice as to where an item should be placed in a procedure, it should be placed at a point where the crew workload is the lowest.

(2) The procedures should be as short as possible in order to minimize interruptions. Use of electronic checklist, shall be encouraged.

(3) Decision points must be clearly identified, and the correct alternative action or alternative sequence of actions to be taken after each decision point must be indicated. If the adverse weather requires an alternate action, the procedure to account for that action should be designed.

**Procedure Integrity**
Applicability and integrity of the procedure will be reviewed:

(1) Target of the procedure. A procedure should be an acceptable way to achieve predetermined target.

(2) Interface of crew members. The responsible crew member in the procedure must be clearly specified for each step.

(3) Clarity of the expression. If it is not obvious or cannot be universally understood, an acceptable standard of the procedure operation should be noted.

(4) Simplicity of the procedure. The level of simplicity of procedure design should be understood and correctly executed by the least experienced pilots.

(5) References in the procedure. During procedure execution, if tables, other procedures or tools are referenced, they should be indicated clearly with where they locate in.

(6) Crew workload. Under normal circumstances, sufficient time to complete the procedures will be scheduled. Otherwise the procedure or crew responsibility shall be revised.
Other Factors

Critical items shall be considered if they are correctly executed. For example, cases that the execution might be interrupted shall be considered [3]:

The flight crew must verify the accomplishment of all items that have been accomplished up to the point where the current procedure was interrupted.

1) Minimum requirement: For each completed item, verifies that switches, control handles, knobs, or levers are in the positions prescribed and that the associated indicator lights and instrument readings confirm the proper positioning.

2) Additional requirements: If the verification check reveals that any switch, control handle, knob, or lever is not in the position prescribed, then the full procedure must be re-accomplished; If re-accomplishment of the procedure does not correct the disagreement, then the flight crew must report the discrepancy in the log.

Format and Expression

Expression or appearance is an important aspect of procedure design, including the layout and typesetting, indexing, font and size, symbols and graphics, and it is better to keep consistency in the whole manual. For the manuals which are direct for flight crew, the expression should be in an appearance of intuitive to use, easy to read and efficient to operate. As an example, Figure 2 is graphical form of procedure.

Review and Verification

Review by Development Group

Development group should review the safety, fault tolerance, clarity and efficiency of the procedures carefully. The procedure design shall purposely make redundancy for "critical items", which is to verify them at a proper occasion to prevent inadvertent oblivion.

Verification

Means of the procedure verification are mainly the simulator or flight test validation. Normal procedures can be generally validated by simulator training or flight tests. Abnormal and emergency procedures are more difficult to make thoroughly validation, so specific work plan identified by the authority may be needed from in early phase.

Customer Feedback

After development and verification, the procedure still needs continuously improvement. This is mainly based on the customer feedback. Feedback of the customer may come from: customer pilot feedback, the suggestion of manual problem, and the airlines’ operational report.
Conclusion

Flight operating procedure development is a hard project which is difficult to measure or evaluate. A systematic methodology will contribute to the work, making it smooth and organized with high quality output. The model and methods proposed by this article are based on the author’s experience in recent years. The effort, which may have practical engineering value in supporting the procedure development, is an attempt for establishing such a methodology and system.

References


[2] Civil Aviation Authority of South Africa, Approval of Manuals, Procedures and Checklists, Guidance Material for Inspectors of Civil Aviation Authority of South Africa (CA AOC-FO-004), 2008.1


