

## MANAGEMENT OF FLIGHT OPERATING DOCUMENT SYSTEMS

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### ABSTRACT

This paper reports one part of a collaborative effort between researchers, air transport operators and aircraft manufacturers to improve document management systems. The NASA/FAA Operating Documents Group has been involved in the reorganization, updating, and integration of existing guidelines into an interactive manual. Over the years, the Group has experienced a shift in focus from paper documents to digital data along with the need for an approach and tools to organize and manage document data. This led to the specification and development of a prototype user interface for a Documents Database (DDB) that incorporates the information elements, requirements, sources, users, and related data essential to the management of flight document systems. The DDB interface has been designed to help operators move from the development of documents (e.g., individual manuals and checklists) to the management of essential flight operations information.

### INTRODUCTION

Initially, NASA and the FAA supported two independent research efforts to integrate crew resource management (CRM) principles into flight crew procedures. These research projects analyzed ways of enhancing crew performance through better designed procedures and their supporting documentation. One of the projects identified the need for a complete set of guidelines to help airline personnel design new procedures (Seamster, Boehm-Davis, Holt, & Schultz, 1998). The other project looked at a comprehensive redesign of documents across an entire multi-fleet operation. Both projects worked directly with airlines and exposed a need for operationally relevant guidance that could be easily used by those developing flight documents.

There were numerous guidelines for flight document development, but they emphasized paper documents and were difficult to use because they were distributed across different publications (e.g., Adamski, & Stahl, 1997; Degani, 1992; Degani, & Wiener, 1993; Degani, & Wiener, 1994; FAA, 1995;

Turner, & Huntley, 1991). To address this situation, airline document developers participated in a structured process to identify the most important topics and issues and to organize them in a way that is operationally meaningful for those working in the flight operations environment.

In working with more than 20 airlines, it became evident that two areas were becoming increasingly important to all types of operations including regionals, cargo, and majors. Those two areas were the organization of documents and the transition to electronic media. More recent work within the NASA/FAA Operating Documents Group has concentrated on these two areas, and the group has seen a pronounced shift from a concentration on paper documents and their formatting to the organization and management of digital data. The Group's concerns are now less about the formatting of pages of text and much more about the exchange, storage, and re-use of flight operations data.

### From Documents to Data

This NASA/FAA Group has produced the manual, *Developing Operating Documents* (NASA/FAA 2000) which was based on a careful review of the main issues and the identification of new requirements and operator needs. This manual included guidelines and examples gathered from existing studies and from operators who have participated in a set of operating document workshops (NASA/FAA, 1997a, 1997b). Work on the manual has highlighted the importance of how one organizes operating documents and how one transitions to electronic media. In reviewing the issues surrounding the organization and management of data, it became evident that operators would need to think about not just the manuals and documents, but the data that is contained and re-used in those documents.

At the beginning of the project (NASA/FAA, 1997a), operators had been concentrating on traditional paper documents and were just starting to consider the use of electronic media. Electronic data was being considered in flight operations, specifically databases and tagging to manage document systems.

On the flight deck, stand alone and integrated electronic flight documentation were being evaluated. Whether in flight operations or on the flight deck, the move to digital data brings with it the challenges and dangers of information overload and nonfunctional design (Lintern, Waite, Talleur, 1999). Digital data displays remove constraints like the physical page that bounds paper documents along with the weight and size limits inherent in existing operating documents. The removal of these constraints places document developers in a new environment with a profusion of information and interface options (Lintern, Waite, Talleur, 1999). Thus, the shift from documents to the systematic content of documents, or data, became more evident to the Group which had started at a time when document databases were not widely used to manage flight operating documents.

### Flight Documents Database

The need for a database grew out of the realization that some computerized system would help manage the large amount of information and documents required to support flight operations. The Group had been working with tables of document elements and decided to expand them into a prototype database called a Documents Database (DDB). A DDB should be tailored to meet the operator's individual needs while adhering to standards. The DDB was conceived as a structured listing of information topics, requirements, sources, users, and related data essential to operators in the management of a flight documents system. A DDB should be designed so that it may be linked with other operational databases containing crew training and assessment information.

DDB development should include the identification of information units or topics needed to be included in the document system. Some topics should be specified at a relatively high level and others specified at lower levels if they require decomposition for easier management. For example, some topics may have several different users and may also need to be presented in more than one operational context suggesting the need for greater definition. Operators should review their own document system or those of others with similar operations in order to identify topics and help determine their appropriate level of detail. An iterative process may be useful, starting with relatively high-level topics or units of information that may be further divided as operational needs dictate. Both topic identification and the DDB interface should have sufficient flexibility so that they can be easily updated and reorganized.

A major challenge in the development of a DDB is

ensuring that essential information is included without making the database so large or complex that it cannot be easily used or maintained. In order to achieve this balance between completeness and maintainability, the NASA/FAA Operating Documents project has worked with operators to identify their information management needs. Manufacturers provide specific information on their products (aircraft, engines, individual systems, etc.) in flight manuals, operating manuals and training manuals that can be used as a first step to ensure a comprehensive DDB. When manufacturers and operators agree on a data exchange format, operators may achieve some level of automatic DDB update when manufacturer data is translated into specific operator information.

The DDB should be developed and used as early as possible in the design of an operating document system. Once developed, the DDB can be used to manage the operating documents implementation process to include the tracking and distribution of document revisions. In addition, the operator may include notes about design and implementation issues and difficulties that need to be addressed during document system changes or future revisions. By maintaining a history of these issues, operators can capitalize on lessons learned and avoid repeating mistakes that may have been made at an earlier point in time.

### APPROACH

A workshop and several focus groups were used to identify operating document user requirements. Participants, including those in charge of developing and managing document systems, grew to about 100 individuals from more than 30 organizations representing a cross section of major, regional and cargo operations, the FAA and aircraft manufacturers. The user-centered approach started with the identification of user requirements and proceeded with a focus group review and usability testing of the prototype DDB user interface.

#### Identification of User Requirements

To start with, a series of surveys was administered in order to identify the topics and issues of highest importance to operators. The first survey was used to identify the most important topics out of a relatively large set collected from project participants. Those topics were then decomposed into issues relevant to the development of operating documents. This delineation of issues was achieved through working group discussions at a two day workshop. Those issues were then rated by all workshop participants

through an evaluation process. First, issues were presented and explained in the context of their relevant working group topics. Then, participants were asked to rate each issue's importance to the broader airline industry, rather than to just the rater's individual airline. The results summarized in Kanki, Seamster, Lopez, Thomas & LeRoy (1999) indicated that the top issues ranged across all major topics including organization of documents, standardization and usability, development and maintenance of documents. Further, these issues were relevant to the both paper and electronic media although specific applications would be dramatically different for paper versus electronic documents.

**Table 1: Importance Ratings for Organization Topics (5-point scales with 1=Most Important)**

<b>DOCUMENT ORGANIZATION</b>	
<b>Information Requirement</b>	
Information sources	2.33
Create list of information	2.37
<b>Documents Required</b>	
Logical grouping criteria to create manuals	2.17
<b>Document Location</b>	
Required for flight	1.67
Responsibility to ensure pages are correct/up-to-date (Working Agreement)	2.20
Responsibility to ensure document available	2.20
Airplane accessibility (Routing)	2.49
<b>Guides / Cards / Checklists</b>	
Develop for time critical information	1.80
Develop for ease of use	2.09
Develop for memory aid	2.44
Requires controlled dating system	2.42
Requires synchronized revisions	2.50
<b>Indexing</b>	
Non-normal indexing is very time critical and important	2.00
Single across document master index is very helpful	2.06
Need to maintain accuracy of index	2.06
Who designs indexing (need user input)	2.24
Forwarding references must be available if redundant information eliminated	2.27
<b>Reorganizing Documents</b>	
Get feedback from flight crews and others involved in operation	1.85
Test organization logic in simulator under real time operation	1.91
After major events	2.48

Issues Related to DDB

As the project focused on DDB issues, the sets of issues related to the Organization of Documents and those pertaining to Electronic Documents became more salient (see Tables 1 and 2). For example, the content and purpose of the DDB should be reflective of the way in which an operator defines and manages its entire document system and responsive to the demands an operator faces in distributing information across documents and locations to satisfy information requirements. For instance, participants identified important organizing criteria that emphasize how often information is used, when it is needed, what level of accessibility and indexing is required, and a number of other time and location requirements. These become key descriptors of the information data in the DDB. Reorganizing principles (e.g., obtaining feedback from information users, conducting realistic testing), can be well served by their inclusion in the DDB as well.

While the Organization of Documents issues apply to electronic as well as paper documents, electronic-specific topics were identified as follows: 1) Integration with FAA Standards (e.g., media and formatting standards, certification and approval processes), 2) Design guidelines that optimize electronic media, 3) Internet/intranet security and access issues, 4) Cost/benefit methods and consideration, 5) Principles for using an evolving technology. Clearly these topics and associated issues bear additional inclusion in the DDB when electronic documents are involved.

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#### Focus Group Review and Usability Testing

Group review and usability testing were methods used in several phases of the Operating Documents project. As described above, the identification of user requirements relied heavily on focus group review and ranking process. The development of the Operating Documents Manual also began with focus group reviews of individual parts of the manual culminating in a large group review in which a draft of the manual

was presented and reviewed in its entirety. The manual content, structure, and key issues were also used to design the information management tool. Initial development of the DDB started with the identification of specific content, but it soon became evident that a better approach would be to conduct usability testing. A prototype DDB user interface was developed, reviewed, and then tested by a set of operators who entered information topics and provided user feedback.

**Table 2: Importance Ratings for Electronic Documents Topics (5-point scales with 1=Most Important)**

<b>ELECTRONIC DOCUMENTS</b>	
<b>Integration with FAA Standards</b>	
Industry guidelines needed (e.g. SGML) media	2.10
Desynchronization of paper vs. electronic	2.21
Limited applicable standards for electronic documents	2.28
Cert & approval process unclear	2.34
Revisions dates on electronic media	2.38
<b>Design Guidelines</b>	
Content guidelines remain same; presentation/format to optimize electronic media	2.32
User interface/usability issue (e.g., hypertext)	2.07
<b>Internet/Intranet</b>	
Security	2.17
Access/distribution	2.18
<b>Cost/Benefits</b>	
Training cost reduction	2.29
End-user benefits	2.14
Extensive analysis required	2.14
<b>Evolving Technology</b>	
Take advantage of technology, don't use technology for technologies sake	2.04

## RESULTS

This section details the issue rating data used to direct the initial DDB user interface design. The rating results shown in Tables 1 and 2, based on 36 participants from a two-day workshop (NASA/FAA, 1997b), indicate the highest priority issues, those with a Mean greater or equal to 2.5, on a five-point scale where 1 was "Most Important" and 5 was "Little Importance." As mentioned earlier, these tables consist of issues related to the Organization and Electronic Documents topics because these are most directly relevant to the DDB development.

For example, the first four Organization topics, Information Requirement, Documents Required, Document Location and Document Type (e.g., guides, cards, checklists) raise issues that are fundamental organizing criteria for flight operating documents. They specify what information is required, by whom, for whom, where located, when used and how time critical, as well as issues on updating and revising documents to be current and accessible for the user. The next two Organization topics, Indexing and Reorganizing Documents raise issues on how indexing should be developed and reemphasizes the importance of time critical information and the process by which documents are reorganized from a production and maintenance point of view.

Table 3 shows a sample DDB matrix representing some of the document organization elements. Information type, users, location and importance begin to specify the most defining factors to be considered in designing the system as a whole.

**Table 3. Sample DDB Matrix Representation of Development Criteria**

<b>Information Type</b>	<b>Information User</b>	<b>Information Location</b>	<b>Information Importance</b>
Aircraft Specific	Flight Crew Only	Aircraft	Flight Deck Immediate
General	Cabin Crew Only	Flight Bag	Flight Deck Frequent
Large Content	Flight and Cabin Crew	Domicile	Flight Deck Reference
Route/Geo graphic	Dispatch	Home	Home Reference
Training	Customer Service		
	Load Planners		
	Maintenance		

Table 4 is a sample DDB matrix representing some of links under specific information categories. These links begin to define an indexing structure and also identify some of the pertinent users who should be involved in the design process (refer back to Table 1). More important, it highlights the need for consistency in the way information is defined and used so that cross-referencing, indexing, linking and the simple use of information in more than one place is always accurate and consistent in meaning. Thus, Table 4 begins to lay out a strategy for addressing some of the major electronic documents issues; particularly issues related to the lack of industry guidelines and standards for permitting consistent and accurate information transfer.

**Table 4. Sample DDB Matrix Representation of Information Properties**

Phase of Flight	System (ATA)	Management Structure	Environmental Conditions	Policies
P01 Flight Planning	20 General	Organizational charts	Windshear	Uniforms
P02 Pre-flight	21 Air Conditioning/Press	Responsibilities and authority	Convective	Automation
P03 Engine Star/Depart	22 Autoflight	IROP feedback	Cold WX	Priorities
P04 Taxi-out	23 Communications	Contracts	High altitude	use of CK lists
P05 Take-off	24 Electrical		Hot WX	Aircraft Control
P06 Aborted Takeoff	25 Equipment		Volcanic ash	Admission to Fit Deck
P07 Initial Climb	26 Fire Protection		Contaminated Runways	Wx Briefing
P08 En Route Cruise	27 Flight Controls			Operational Control
P09 Cruise	28 Fuel			Training
P10 Descent	29 Hydraulics			Quality Control
P11 Approach	30 Ice & Rain			HAZMAT
..Etc	..Etc.			

**APPLICATION**

The resulting operating documents topics and issues were used to develop the initial design for the DDB user interface. The need for the tool was based in part on the fact that airlines had the greatest number of important issues under Organization of Documents. Operators were just beginning to look at their operating documents as an entire system rather than as a collection of manuals, cards, and guides. One operator in particular, who was in the process of a complete restructuring of the system, expressed a strong need for a management tool. The DDB interface was designed to help manage flight operations information.

The current structure of the DDB user interface is shown in Figure 1 representing functions that are accessed from top to bottom. The top two sections of the interface, Information Requirements and Information Organization, are used to manage the overall content and structure. The third user interface section, Information Maintenance, facilitates the ongoing maintenance of information. Finally, the Information Descriptors are used to manage data central to the design of operating documents.

**CONCLUSION**

The NASA/FAA Operating Documents project was formed to identify key issues in the development of operating documents, and has resulted in a guidelines manual to help operators address those issues, and a prototype DDB user interface to manage flight information systems. Operators have specific needs

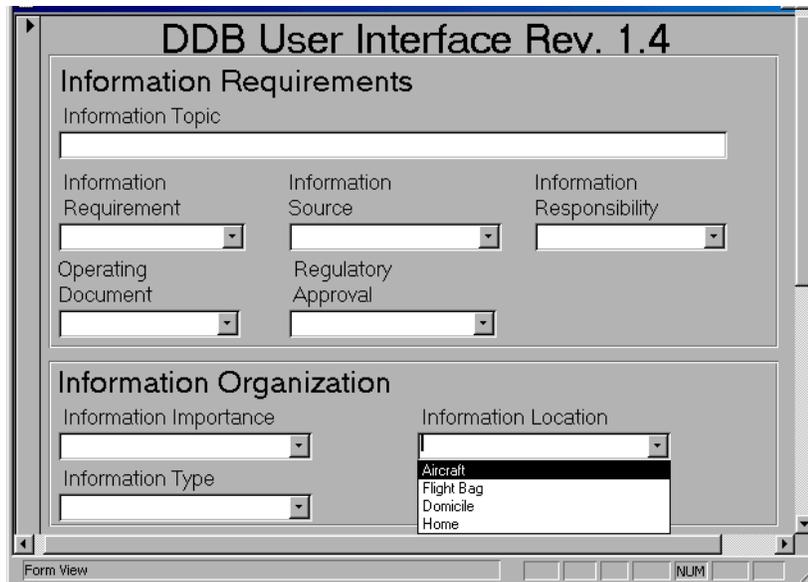
when developing document system, and they are particularly interested in the best way to organize, present, and manage information required for flight, with an emphasis on time critical elements.

The initial emphasis on traditional paper document development grew to include a broader view of the document system, an appreciation of issues related to the transfer to electronic documents, and need for information management tools. At every step of the way, user feedback in the form of survey, ratings, testing, and comments, was collected and analyzed to determine the high priority issues across this diverse user population.

This effort has resulted in the Operating Documents Manual that addresses the most important operator issues and provides current examples of different approaches. It has also produced a prototype DDB user interface to help operators manage flight documents. This collaborative effort between researchers and operators has helped to move the aviation community from a focus on individual documents to an emphasis on the entire flight information system.

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**Figure 1: DDB Prototype User Interface**

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