# Background Issues for On-Line Aircraft Documentation

by

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Currently, almost all aircraft documentation in commercial aircraft cockpits is presented via hardcopy manuals. Several recent projects are aimed at eliminating all paper documentation in cockpits using "electronic libraries". Electronic libraries encompass diverse information bases including aircraft systems documentation, operations and procedures, checklists, maintenance logs, minimum equipment lists, maps and charts, and flight management information. These electronic libraries are envisioned to be embedded in the avionics so as to provide real time monitoring and display of information. The research presented here examines background issues--motivation, information retrieval models, and preliminary designs--for the on-line presentation of aircraft systems documentation including operations, procedures and checklists.

The primary motivation for the automation of aircraft documentation must be safety. While other motivations can be cited, flight safety must be primary. The incorporation of on-line documentation should provide faster access to more accurate, more easily understood information in a more reliable manner so as to increase pilot awareness and thus aid the pilot's decision making process. Designing on-line documentation which is better than hardcopy manuals will be no small task. Accomplishing this requires a study of safety issues and in particular how these issues relate to the delivery of aircraft documentation. Perrow [1] reviews accidents in a variety of domains and characterizes a class of accidents as "system accidents". This class is characterized by: 1) multiple failures, 2) tight coupling, 3) interdependence of events, and 4) impossibility of operators comprehending the sequence of events. Within this analysis of accidents, overcoming operator incomprehensibility would be an appropriate target of on-line documentation; however, embedding the documentation within the aircraft systems would increase the interdependence between the documentation and other systems (e. g., power supply). This fact, along with other limitations of on-line documentation, suggests that the new documentation must be carefully designed so as to capitalize on its strengths in order to truly improve aircraft safety.

NTSB Accident Reports and a database search including 469 reports (referencing systems documentation, manuals, or checklists) from the NASA Aviation Safety Reporting System provided the basis for an analysis of aircraft incidents (and accidents). This analysis indicates that aircraft incidents and accidents tend to involve many of the following elements:

1. subsystem failure(s),
2. inoperable items which do not ground the aircraft,
3. flight crew stress or fatigue,
4. complacency or over-reliance on maintenance, dispatch, other crew members, or equipment to perform functions flawlessly,
5. initial disregard of the seriousness of a warning,

6. lack of information regarding what happened or how to deal with the situation,
7. events "out of sync" (either rushed or delayed),
8. adverse weather, or
9. economic pressure to continue operation.

These are not necessary conditions for a serious accident; however, they probably comprise sufficient conditions.

How can on-line documentation address these issues? First, automated checklists can allow for better tracking of exactly what has and has not been accomplished particularly when events are "out of sync" [2]. Second, faster access to accurate information about aircraft systems and procedures would help in addressing the lack of information. In many emergency situations, time is critical; the pilot has only seconds to react. On-line documentation could immediately display appropriate abnormal checklist. In time-critical situations, improved access to aircraft systems descriptions could have only indirect impact at best--the pilot must use information in his/her head and information immediately visible in the cockpit. However, many emergency situations have origins on the ground or at high altitudes where the pilot does have time to investigate the problem. In these cases, on-line documentation can speed access to the appropriate information and assist the decision making process.

Having identified two areas where on-line documentation could increase aircraft safety, design issues related to checklists and information retrieval have been addressed. First, a prototype, on-line checklist system has been developed (see Figs. 1 and 2). While targeted to a color, touch-sensitive monitor, the figures illustrate the marking of completed items (reverse video and checked), the next item to be done (boxed), and the items not accomplished (normal video). Pilots would indicate completion of items by touching the screen.

Second, to address the speed and accuracy of information retrieval, one must understand when and how pilots use aircraft systems documentation. Almost no one, including pilots, uses documentation unless there is no other choice. For pilots, accessing the manuals is a next-to-last resort (the last resort is to call the company operations office). Accessing the systems manual is only done when some problem arises for which the pilot does not have a solution in his/her head. Thus, retrieving information from a manual is always an embedded task guided by a specific context. Most models of information retrieval involve novice users and are inappropriate here. However, the constructs from a field of study called "search theory", while not originally intended as a model of operator behavior, may provide such a model [3]. Fig. 3 illustrates how these constructs can model an expert user searching for information within some information base.

Future research should investigate the utility of the search theory model of information retrieval, based on this model provide an overall architecture for an on-line documentation system, implement this system, and test the usability of the resulting system.

References

1. Perrow, C. Normal Accidents. New York: Basic Books, 1984.
2. Degani, A., and Wiener, E. L. "Human Factors of Flight-Deck Checklists: The Normal Checklist". NASA Contractor Report 177549, 1990.
3. Janes, J. W. "The Application of Search Theory to Information Science.". In Katzen, J., and Newby, G., Eds., ASIS '89: Managing Information and Technology. Washington, DC, Oct 30-Nov 2, 1989.

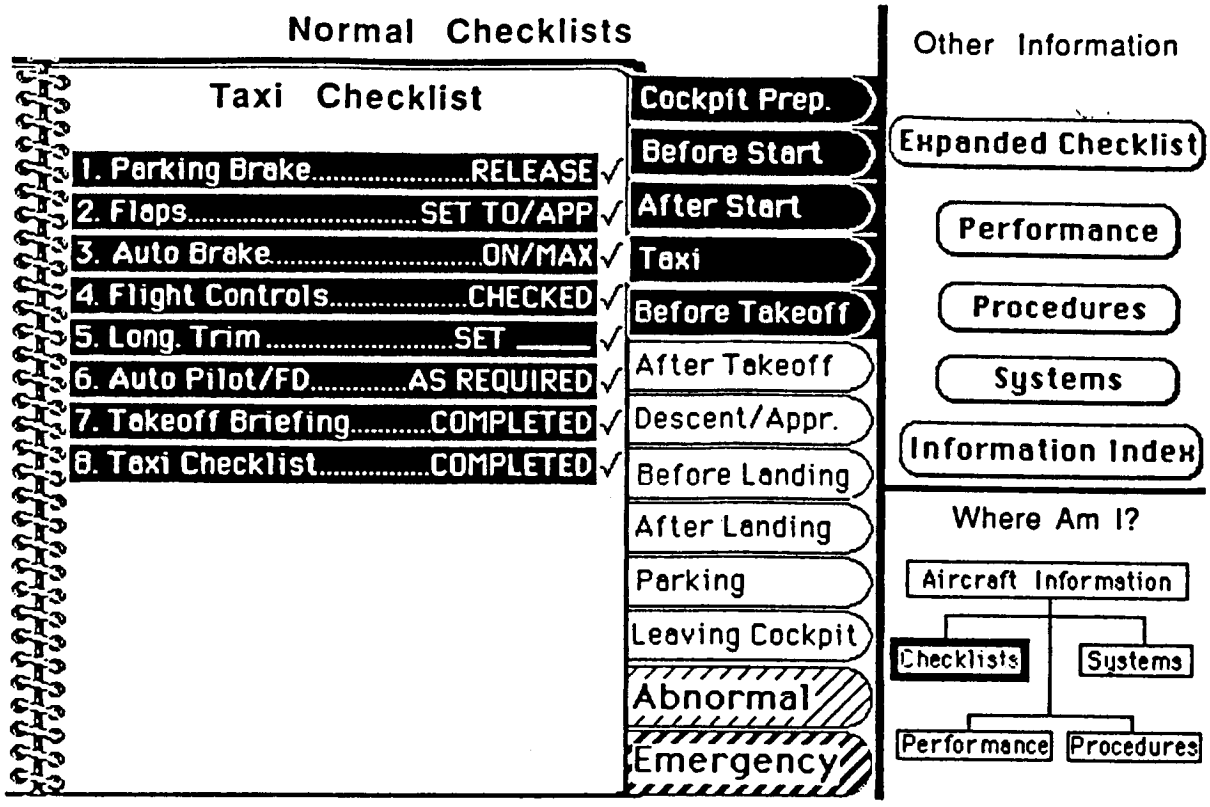


Figure 1. Checklist with All Items Completed

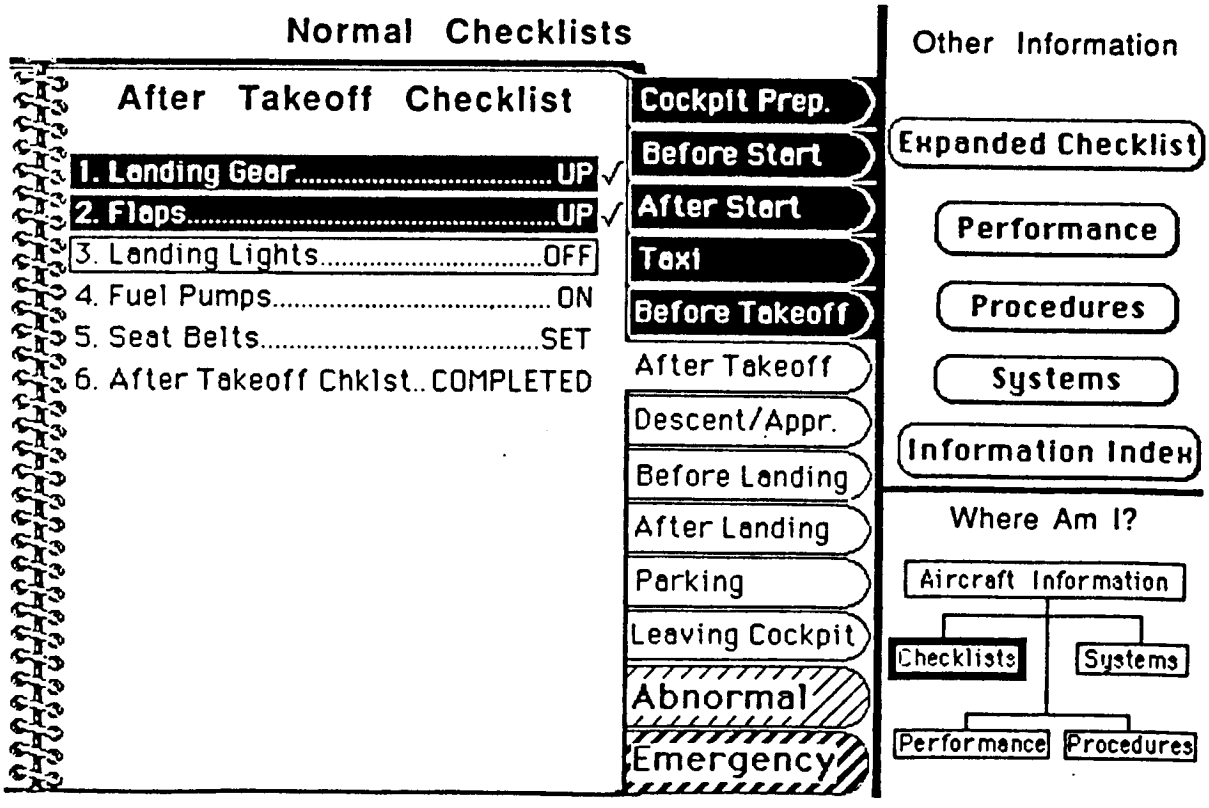


Figure 2. Checklist with Some Items Not Completed

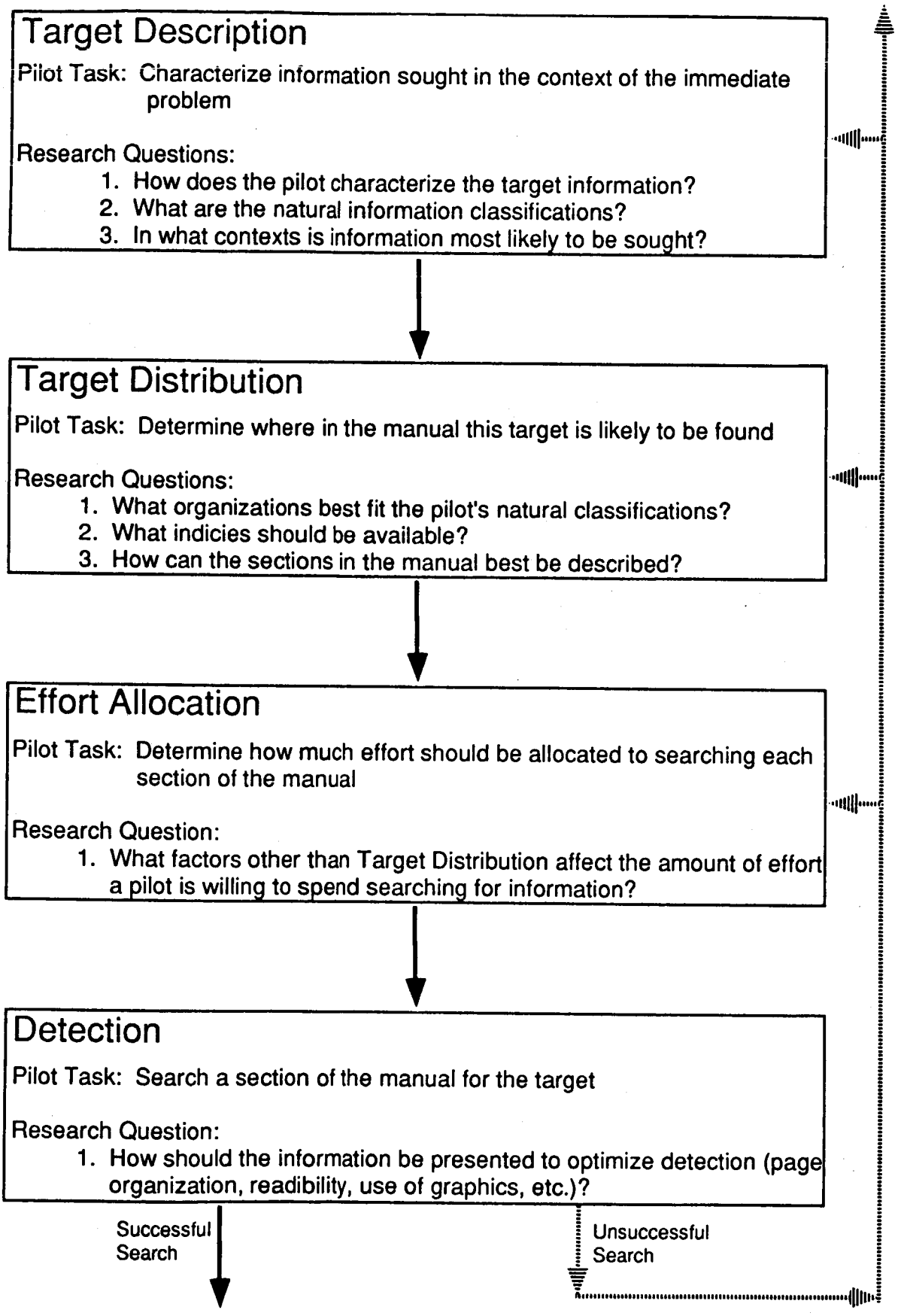


Figure 3. The Search Theory Model of Information Retrieval