1-1-1998

The development of a systems design model for job performance aids : a qualitative developmental study

Anthony J. Adamski

THE DEVELOPMENT OF A SYSTEMS DESIGN MODEL FOR JOB PERFORMANCE AIDS: A QUALITATIVE DEVELOPMENTAL STUDY

by

ANTHONY J. ADAMSKI

DISSERTATION

Submitted to the Graduate School

of Wayne State University,

Detroit, Michigan

in partial fulfillment of the requirements

for the degree of

DOCTOR OF PHILOSOPHY

1998

MAJOR: INSTRUCTIONAL TECHNOLOGY

Approved by:

Rita C Richey March 12, 1998

Advisor Date

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ACKNOWLEDGMENTS

A study of this nature can only be accomplished with the help and cooperation of many people. The author would like to express his appreciation to the seven individuals who made up my subject-matter-expert panel. Their time and effort, which was totally voluntary, is greatly appreciated. Consequently, I thank Dr. Walter Dick, Dr. Gordon Rowland, Dr. Joan Dessinger, Dr. H. Beau Altman, Dr. Kathleen Mosier, Dr. Ron Westrum, and Mr. Greg Miller for their time, their expertise, and their encouragement.

I would like to extend a special appreciation for the guidance, encouragement, and support offered by my advisor and committee chairperson, Dr. Rita Richey. Additionally, I would like to thank my committee members: Dr. Gary Powell, Dr. Al Edelson, and Dr. Frank Westervelt.

An extra note of appreciation is also in order to Dr. Beau Altman, president of FACTS Training International, who graciously made available the corporate aircraft cock-pit/cabin simulator so that I could conduct the experimental portion of this study. I would also like to acknowledge my friend and associate, Mr. Tim Doyle, who put his classical education to work and graciously edited much of this study.

Last, but not least, I would extend a quick note of appreciation to my wife. Perhaps now I can get back to more domestic chores.

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CHAPTER I

FOUNDATIONS OF THE STUDY

Today, many industries utilize complex technologies in high risk environments. These industries are comprised of numerous high risk, high reliability (HRHR) organizations in which sub-standard human performance can result in not only damage to equipment but loss of human life. For example, past research in the aviation industry has shown that a major contributing factor in fatal and non-fatal aircraft accidents has been the human operator and much of this human contribution is a result of poor decision-making and ineffective performance.

Aviation safety experts maintain that a key factor to effective decision-making and effective performance is having accurate operating information readily available to the operator when needed. This information requirement can be accomplished by means of job performance aids (JPAs) that are effectively designed to meet the human operators' information needs. Consequently, it is argued that a JPA design model which leads toward the effective development of JPAs can improve the information gathering process used in decision making, provide for error reduction on the part of the human operator, and improve overall performance of HRHR organizational systems.

Introduction To The Study

This study, which is developmental in nature and uses a qualitative approach, examined theories and design principles from the fields of instructional technology and human factors that could be applied to the development of JPAs for use in HRHR organizational systems. Additionally, this study used the aviation industry as a representative sample industry as it is made up of numerous HRHR organizational systems.

Seels and Richey (1994) define the field of instructional technology as ". . . the theory and practice of design, development, utilization, management and evaluation of processes and resources for learning" (p. 1). A recent trend within the field is a movement toward exploring how to improve human performance in the workplace. This movement emerged from "the coalescing of principles derived from the carefully documented practice of thoughtful behavioral psychologists, instructional technologists, training designers, organizational developers, and various human resource specialists" (Stolovitch & Keeps, 1992, p. 3).

The field of human factors also has similar roots derived from the fields of "production engineering, design, education, psychology, medicine, work study, and the law" (Edwards, 1988, p. 4). Sanders and McCormick (1987) state, "Human factors discovers and applies information about human behavior, abilities, limitations, and other characteristics to the design of tools, machines, systems, tasks, jobs, and environments for productive, safe, comfortable, and effective human use" (p. 5). A critical factor in effective performance identified by human factor specialists within the aviation environment is the process of aeronautical decision-making (Orasanu, 1994). Aviation studies have demonstrated the important role JPAs play toward effective performance and proficient decision-making. Additionally, the field of instructional technology has recognized the importance of JPAs toward enhancing performance.

Both fields, instructional technology and human factors, have explored the use and benefits of job aids. Rossett and Gautier-Downes (1991), instructional technologists, define job aids as, "repositories for information, processes, or perspectives that are external to the individual and that support work activity by directing, guiding, and enlightening performance" (p. 11).

In a human factor study of job aids, Snow and Newby (1989) emphasized the importance of job aids. Their research indicated that increasing the amount of information a worker must hold in working memory reduced the amount of mental work that could be accomplished. Most importantly in regard to this study, Snow and Newby state, " In addition to increasing job output, job aids can reduce the frequency of errors" (p. 26).

A common thread found within the fields of instructional technology and human factors is systems theory. Each discipline applies the principles of systems theory in its respective theories, models, and applications (see Dick & Carey, 1996; Edwards, 1988;

Meister, 1971; Richey & Tessmer, 1995; Rothwell & Kazanas, 1992; Sanders & McCormick, 1987; Schiffman, 1991; Seels & Richey, 1994). This study also explored the potential for a job performance aid (JPA) to serve as a systems link between performance and training.

Traditional job aids have been used in the workplace for many years to provide an external storage device for information and to guide worker performance (Harless, 1986). Robert W. Swezey (1987) a human factor specialist with the Behavioral Sciences Research Center, McClean, Virginia, defined four advantages of properly designed job aids:

> First, they are generally based directly on an analysis of what the intended user must do in performing his or her job task. Second, they contain what-to-do, how-to-do, and when-to-do instructions relating to those tasks. Third, they are capable of covering all tasks in a job, such that all decisions can be made using an appropriately designed job aid. Fourth, they tend to present information in small chunks and are designed to alleviate problems involving retention of long procedures in short-term memory. (p. 1040)

There are few conditions, however, under which JPAs are more important to aiding task performance than when used to prevent or correct errors in high-reliability, high-risk organizational (HRHR) systems.

High-Reliability, High-Risk Systems

A "high-reliability" organizational system concentrates on having few incidents and accidents. It is one in which there is little tolerance for error as the result may be particularly grave. High-reliability systems require a tight coupling of system components to meet the dynamics of the situation and place an emphasis on balanced objectives and team effort (see Westrum, 1995; Westrum & Adamski, in press). Information gathering and transfer are crucial components of a high-reliability system.

A "high-risk" organizational system engages in complex technologies in which reliability rather than productivity is the bottom line. The focus of these systems is on extremely high reliability in that errors may not lead only to employee death or loss of equipment but to "catastrophic consequences of such magnitude that they are unacceptable to the organization or a larger public" (Von Glinow & Mohrman, 1990).

The HRHR system is one which encompasses the characteristics of high-reliability and high risk. Examples of such systems include nuclear power plants; petrochemical plants; earthbound systems such as dams, mines, and lakes; and marine and aviation organizations (Perrow, 1984).

Aviation HRHR Systems and JPAs

The field of aviation consists of many HRHR systems, and Turner et al. (1991) argue that certain JPAs are critical factors to aviation safety within the flight environment. JPAs such as aircraft checklists vary as "aircraft manufacturers and operators do not fully agree on what should be included" (Gross, 1995, p. 2). Following the tragic 1987 Northwest Airline accident at Detroit, Michigan, the National Transportation Safety Board (NTSB) recommended that steps be taken "to determine if there is any type or method of presenting checklists that produce better performance on the part of user personnel" (NTSB, 1988, p. 3).

JPAs for error prevention provide procedures and guidance for the user and the concern for effective design of such devices has not decreased since the 1988 NTSB report. Transport Canada, the aviation regulatory agency of Canada, recently published a report of an aircraft accident that emphasizes a need for effective message design in the development of JPAs ("Severe Icing", 1996).

> The Emergency Checklist was a poorly reproduced collection of pages copied from the manual. However, the captain made no comment about not using the checklist and appeared not to have monitored the (incorrect) actions of the first officer. Under stress it is often difficult to absorb information, and the condition of the Emergency Checklist prompted the comment: "This document infringes most of the basic considerations in the design and presentation of visual information." (p. 5)

The need for effective procedures which required accuracy of information and effective presentation was emphasized in a recent NASA report. Degani and Wiener (1994) argued:

> Flight deck procedures are the backbone of cockpit operations. They are the structure by which pilots operate aircraft and interact with other agents in the system. Procedures are probably one of the most important factors in maintaining flight safety - - during both normal and abnormal conditions. (p. 53)

Procedures are provided to the operators of flight systems by means of a number of JPAs including printed documents, electronic displays, and environmental structures. Each method requires effective design to achieve optimum information transfer. These devices not only provide procedural course of actions for the user; they provide important information to assist the user in making operational decisions.

The Role of Decision Making

Since the call from the NTSB in 1988 for research into checklist design and Degani and Wiener's (1994a) recent call to address procedures, the aviation safety community has come to recognize another critical element of aviation safety which involves decision-making. This element is termed "aeronautical decision-making" (Kaempf & Klein, 1994). Orasanu (1994) argues that an important component of aeronautical decision-making is information gathering.

An important factor to information gathering in HRHR systems is the use of error-prevention JPAs. Within these systems, JPAs become a form of instructional message as they provide the user with external memory aids to support retention or recall of facts that are not part of the current users' "gestalt" (see Reason, 1990). The concern is the quality of information reaching the user. Pipe (1992) presents a sound argument for the use of performance aids:

> In a well-structured task, the operator should be able to determine — from memory, observation, or an aid — the current status of the system, what is needed if deviations are present, what is possible within the constraints of the job, and what to do next. The more difficult any of these, or the more critical it is that the task be handled correctly, the stronger the argument for using performance aids. (p. 359)

Pipe's views support the need for JPAs within HRHR systems. Tasks within HRHR systems can become very critical and must be handled effectively as the alternative is unacceptable.

Nature of the Problem

Turner et al. (1991) conducted a study for the Federal Aviation Administration (FAA) that examined the influence of JPA design on aircraft safety. The study identified problems in the design of JPAs used in aviation HRHR systems which included the following:

1. The National Transportation Safety Board found that between January 1983 and October 1986 there were 21 accidents/incidents of multi-engine aircraft in which a defective or a misused checklist was involved.
2. Checklists are valuable, even indispensable tools of airline safety. Yet it is clear that checklists are being misused or ignored in the industry.
3. Although it is not clear whether checklist design contributed to the crash of Northwest Flight 255, the National Transportation Safety Board recommended that the FAA undertake steps to determine if there is any better method of presenting checklists to produce better performance on the part of user personnel.
4. The design, organization, and contents of checklists and manuals were often nonstandard. There were missing, inconsistent, and incorrect procedures. There was also a lack of clear directions to crews in the use of checklists in many cases.
5. Readability varied widely, even within the same company's checklists. Type size and clarity were dissimilar and the need for guidelines was apparent.
6. A review of 195 Aviation Safety Reporting System (ASRS) reports that spanned the previous five years of the study and were relevant to the study indicated that checklist and manual design accounted for 20% of the reports. An ASRS report is a self-disclosure report made by a crew member on a dangerous event or situation.
7. Many manuals and checklists lacked organization and the completeness needed to support informed use by flight crews.

The National Transportation Safety Board (NTSB) examined the use of passenger safety information JPAs which included printed safety cards and videotaped briefings. The NTSB (1985) found that a wide variation of information presentation on the printed cards existed as well as variation in the degree of compliance with FAA guidelines. The cards differed in the degree of understandability of written and pictorial information. The NTSB indicated that it was evident that many of the cards examined were not developed by testing or evaluating the clarity of the information presented. Additionally, some of the cards depicted inaccurate information that was contrary to FAA recommended procedures. Furthermore, the NTSB (NTSB, 1985) stated:

> . . . that testing the understandability of safety card instructions and the behavior of persons carrying out these instructions has not been pursued by the SAE, the FAA, or the airlines. The Safety Board finds this unfortunate in light of the wide variations shown in the information contained on the safety cards which were examined in this study. (p. 44)

The Flight Safety Foundation (FSF), a prestigious non-profit international aviation safety organization, examined methods to optimize checklist design and argued for further research (see Gross, 1995). The FSF reported that of 37 flight crew-involved in major accidents of U.S. airlines from 1978 through 1990, "six of eight takeoff accidents involved procedural checklists failures during the taxi phase" (Gross, 1995, p. 2). The FSF report suggests that poor organization and design of aviation JPAs may make them difficult to use or even discourage use. Furthermore, Gross states:

> Although much can be learned from existing studies, it is also important to recognize that much research remains to be done in improving the man/checklist/machine interaction. Other factors, perhaps extremely important factors, have yet to be explored. In checklist studies, as in aviation safety research generally, the focus must consider not only the aircraft but the most complex system on board the aircraft — the human mind and body. (p. 9)

JPAs include not only printed documents such as checklists, manuals, and passenger briefing cards, but they also include expert-system JPAs called "automated decision aids." Currently within the aviation industry a movement is taking place toward the use of "automated job aids," such as: electronic checklists, computer generated warning systems, and other automated information displays. Mosier (in press), a researcher with the National Aeronautics and Space Administration (NASA), examined the current research on automated decision aids and reports:

> Additionally, the users of automated decision aids, hindered by factors such as poor interface design, inadequate training, or lack of familiarity, may not understand the design intent or the workings of automated and expert systems. Many expert operators have misguided notions of what their automated system can and cannot be expected to do (Will, 1991), and system users, as well as those who design them or prescribe their use, may fall prey to misconceptions, or "myths" concerning the nature and function of automated aids.

As Mosier and Skitka (in press) also argue, "Research guiding system design must also incorporate studies on how the appropriate input and timing of information to be presented, as well as the role of the decision aid." Furthermore, in regards to design of automated decision aids, they state, "To build a strong relationship between human decision makers and automated decision aids, attention needs to be given to design issues on the one hand, and human psychology on the other."

Mosier and Skitka's argument sets the stage for incorporating the best of both instructional technology and human factors toward the development for a JPA design model for use in HRHR systems.

Historical Background of JPAs

Historically, job aids have been considered as aids to recall, alternatives to memory, or mechanisms to store information external to the user (Pipe, 1992). This perspective emerged from military research conducted during the 1950s, the 1960s and 1970s that addressed major problems in performance involving troubleshooting tasks and use of complex weapon systems (Chalupsky & Kopf, 1967; Dessinger, 1989). Past military research confirmed a rationale for the traditional use of job aids. Today, however, job aids are playing a new role toward achieving effective performance in HRHR systems.

The Traditional Definition of Job Performance Aids

Harless (1984) defined JPAs as guidelines used on-the-job to perform tasks. Grau (1986) refined this definition by narrowing Harless' concept and stated:

> Included in this concept of JPAs are a wide variety of formats: checklists, algorithms, decision tables, worksheets, "cookbooks," proceduralized manuals, and others. The key common elements are that the job aid provides information (procedural or factual) needed to perform a task or set of tasks, is constructed so that it can be readily used during actual performance of the task(s), and eliminates the need for the performer to recall the information it contains. (p. 10)

Dessinger (1989) explained that the concept of job aids was developed by the military during the 1950s and 1960s. Her study on job aids and technical troubleshooting defined JPAs as:

> JPAs are procedural instructions presented in the format of an algorithm, i. e. , a list, flowchart, matrix or a hybrid which combines two or more of the traditional forms. JPAs are highly prescriptive, i. e. , they give step by step directions on how to perform a task. A well designed JPA makes it unnecessary for the technicians to rely on

long-term memory or discover their own procedures. (p. 3)

Unlike the previous definitions, JPAs for use in HRHR systems should provide critical information to the user for the primary purpose of aiding the user's decision-making process in determining a course of action to maintain safety and prevent or overcome errors. Rossett (1991) argued, "Job aids can do and be more. Not only can they provide information and prompt memory of procedures, but job aids can also be used to guide perspectives, decisions, and self evaluation" (p. 2).

Military Research on Job Performance Aids

Albert Chalupsky and Thomas Kopf (1967), under the authority of the Manpower Development and Training Act, conducted a study for the Department of Labor that examined the results of military and civilian research on JPAs. They reported that the first reports on research and development of JPAs appeared in the 1950s. They reviewed the work of a number of military researchers and found that a report by J. R. Berkshire was the first such report completed for the U. S. Air Force in 1954.

Berkshire (1954) found that the use of color-coded schematic diagrams and written troubleshooting instructions he called trouble locators significantly reduced the number of errors made by both experienced and inexperienced personnel in repairing radar sets and enabled inexperienced troubleshooters to identify malfunctions in about the same time as experienced troubleshooters.

In 1958, A. J. Hoehn and A. Lumsdaine of the Maintenance Laboratory of the U. S. Air Force Personnel and Training Research Center summarized a number of research and development efforts on the design and use of job aids. Hoehn and Lumsdaine (1958) maintained that well designed job aids could reduce the amount of training for technicians and increase the efficiency of job performance. One of the major findings identified in this early research, and one that continued throughout the literature, is the need for better methods of task analysis that emphasized the behavioral processes addressed by JPAs.

In the early 1960s, J. D. Folley, Jr. completed a series of reports for the U. S. Air Force that addressed the then current state of research on job aid design. Robert Swezey, the Director of the Behavioral Sciences Research Center, summarized the research by Folley and associates (see Folley, 1961a; Folley, 1961b; Folley & Munger, 1961; Folley & Shettel, 1962). Swezey (1987) summarized Foley's recommendations for the design of JPAs used for operating and maintaining man-machine systems by providing the following guidelines:

> 1. Identify the task elements for which job aids should be considered: (a) describe the job or position, (b) describe each task involved, (c) analyze each task element. In this process, consideration is given to providing performance aids for each task element where one (or more) of three conditions occurs: (a) it is judged that the anticipated task performer population (including their backgrounds as well as the training they are likely to receive) will not be able to achieve the required level of performance without an aid; (b) use of an aid is anticipated to significantly improve performance above the required minimum level; and (c) providing an aid will result in cost savings (in the form of reduced selections and/or training requirements) without a decrement in performance.
>
> 2. Determination of what job aid functional characteristics will enhance the performance of each task element. The functional characteristics of a job aid are defined as the operation that an aid must perform in order to accomplish the required improvement. These characteristics are considered to be independent of the physical means of providing the functions; that is, they merely describe what the aid must do with respect to a given task element, not how it must do it.
>
> 3. Specification of the physical design characteristics required of the aids to carry out the necessary functions. This activity has three steps: (a) combining the functional characteristics into appropriate groupings, (b) determining the most suitable method of performing each combination of functions, and (c) specifying the physical characteristics of the recommended aid for each combination of functional characteristics. According to this approach, the physical design characteristics of performance aids describe the mechanisms or devices that will perform the required aid function. In turn, they depend primarily on the specific nature of the function (i.e., the ways in which the characteristics can be combined in the situation in which aids must be used).
>
> 4. Evaluation, modification, and updating of the resulting aids. Here, five steps are recommended: (a) review the training versus job aid tradeoff; (b) check that the behavioral requirements involved in using each aid are compatible with the work performance situation; (c) build prototypes of sample job aids and conduct tryouts; (d) modify specifications as indicated by the evaluation; and (e) periodically update the information content of aids in order to keep them current with changes in the system. (p. 1051)

Folley's work, although it made a number of recommendations for JPA design, consistently called for further research. Folley found no solution to determining the information requirements of a task, and he found little guidance to determine any tradeoffs between information provided in a JPA and information learned during training. Lastly, Folley suggested a need for further research into human performance and under what conditions errors were likely to occur.

Chalupsky and Kopf (1967) identified two major military programs that were carried out by the Human Resources Research Office under contract to the U. S. Army. The programs were referred to as task MAINTRAIN and task FORECAST.

Task MAINTRAIN addressed the development of a maintenance manual to assist trained technicians to troubleshoot complex electronic equipment faster and more accurately, and the development of an experimental manual covering troubleshooting of the Nike Ajax missile system. Chalupsky and Kopf (1967) reported, "The experimental group using the improved manual accomplished troubleshooting substantially faster and more effectively than did the control group which used standard schematic and functional diagrams" (p. 16).

Task FORECAST involved a variety of related efforts including the development of training content and methods, and improving job methods, aids, devices, and data formats (Chalupsky & Kopf, 1967). The major finding of this project was that the FORECAST approach could produce proficient technicians in less training time than that required with the conventional techniques of that time.

The Army also studied the use of an audio-visual information system (A-VIS) that was designed to augment standard technical manuals that were used as maintenance job aids. Chalupsky and Kopf (1967) reported that "it was concluded that A-VIS was superior to technical manuals as a maintenance aid. The major contribution to audiovisual superiority was in information format" (p. 17). The Army also explored the use of JPAs as management aids and manpower policy aids.

The U. S. Navy sponsored a number of studies during the 1960s that addressed the development of JPAs including the use of a head-worn audiovisual viewer which presented programmed guidance for performing maintenance tasks (Brown, 1964), the development of an experimental fault locator for troubleshooting radio transceivers (Rigney, Fromer, Langston & Adams, 1965), the development of a wallet-sized measurement conversion chart (Hooprich & Steinemann, 1965), and the use of the U. S. Army's FORECAST method to develop a technical manual and training for a Long Range Navigation (LORAN) system (Shriver & Trexler, 1965).

Charles Duncan (1985), an educational specialist with the U. S. Army, reported, "The majority of the research findings on job aids have come from studies conducted by the U. S. Air Force and the U. S. Navy" (p. 1). Additionally, Duncan maintained that the military achieved great success with such aids and he maintained that job aids helped the Army "train smarter and do more with less" (1985, p. 1).

Duncan's (1985) review of military research conducted during the 1960s and 1970s discussed the work of T. C. Rowland, R. W. Swezey and R. B. Pearlstein. Duncan reported that their research concluded that JPAs produced accurate performance and usually in a short period of time; furthermore, their research reflected that JPAs demonstrated a characteristic of virtually assuring a high level of job performance.

Robert J. Smillie, a researcher with the U. S. Navy, suggested that one of the most comprehensive studies on JPA effectiveness was the U. S. Air Force project PIMO — Presentation of Information for Maintenance and Operation — conducted in the late 1960s (Smillie, 1985). Smillie reported that the PIMO study indicated that JPAs can improve maintenance performance by allowing inexperienced technicians to perform procedural maintenance tasks and that the use of JPAs allowed more experienced technicians to perform more complex fault-isolation tasks. Additionally, Smillie maintained that the use of JPAs, instead of reliance on training and experience alone, reduced errors.

Civilian Research On Job Performance Aids

The civilian world also addressed the use of JPAs during the 1960s. Chalupsky and Kopf (1967) reported that their research identified a number of JPAs being used in civilian applications that covered a "myriad of applications" (p. 29). The major industrial research on JPAs identified by Chalupsky and Kopf was completed in the 1960s by K. S. Teel and F. B. Chaney of North American Aviation, Inc. Their study examined methods to overcome deficiencies in the performance of machine parts inspectors. They explored the effects of training alone, the effects of visual JPAs used alone, and a combination of training and use of JPAs.

Chalupsky and Kopf (1967) described that Teel and Chaney reported to the American Psychological Association that the use of training alone resulted in a 32% increase in defects detected, a 42% increase in defects detected by use of visual aids alone, and a 72% increase in defects detected with the use of both; while performance of the control group did not change.

During the early 1960s, several unpublished studies were also conducted to examine the effect of photographs used as JPAs (Chalupsky & Kopf, 1967). One study examined JPAs for use in inspection of solder joints, another study examined the effect of photographic JPAs used to communicate inspection standards to inspectors, and a third study evaluated a JPA for inspecting the photographic masks used in the production of circuit boards. Chalupsky and Kopf reported that the results of these studies indicated sizable reductions in learning time, in defects, in supervisory time, inspection time, and assembly time (1967, p. 26).

Chalupsky and Kopf also mentioned the emergence of computer-based job aids which were just beginning to surface when this study was completed in 1967. Additionally, Chalupsky and Kopf (1967) recognized the impact of the computer on the design and use of JPAs as they stated, ". . . development of computer-based job aid display systems will very likely play a major role in influencing the informational requirements of many technical jobs" (p. 28). Furthermore, in their 1967 research they suggested specific research questions be addressed in the future and these questions remain valid today. Chalupsky and Kopf (1967) asked:

1. What is the potential contribution of job performance aids for reducing basic aptitude requirements?
2. What is the ideal relationship between job performance aids and training?
3. What is the optimum sensory channel for various types of job performance aids?
4. What are the implications of applying new information handling technology to the design of job performance aids? (p.67)

Theoretical Foundations of Job Aid Development

According to Swezey (1987), "It appears that the historical basis for the technology of job aiding technology lays in the area of behavioral psychology" (p. 1043). Swezey (1987) states that two learning theory principles underlie JPA development: . . . "first, the requirement for a precise description of the specific behaviors necessary to perform a task; and second, immediate feedback or reinforcement for action, whether correct or incorrect" (p. 1043).

The behavioral influence on JPA design can be traced back as early as 1926 to the work of Sidney L. Pressey in his development of a machine for automated teaching of drill material (Shrock, 1991). It was B. F. Skinner's research, however, that elaborated the theory of reinforcement and his advocacy of its application that led to the first instructional technology: programmed learning and the teaching machine movement (Seels, 1989; Swezey, 1987).

Skinner developed the concept of operant conditioning by studying animal learning. He suggested that human learning could be maximized by carefully controlling the reinforcement for desired behaviors (Shrock, 1991). Skinner maintains that "The whole process of becoming competent in any field must be divided into a very large number of very small steps" (Skinner, 1960, p. 108). It is Skinner's perspective on the process of attaining competence — breaking the whole into very small steps — that guided his development of his teaching machine which led to an instructional movement in programmed instruction (Shrock, 1991).

Skinner's basic concept of breaking the whole into small steps for instructional purposes also provided a foundational root toward the development of task analysis as a tool for instruction and job design. An examination of his description of his teaching machine reflects the importance of the process of breaking down the whole into parts. Skinner (1960) explained this process in describing the requirements of a teaching machine:

> A second requirement of a minimal teaching machine also distinguishes it from earlier versions. In acquiring complex behavior, the student must pass through a carefully designed sequence of steps, often of considerable length. Each step must be so small

> that it can always be taken, yet in taking it the student moves somewhat closer to fully competent behavior. (p. 141)

The teaching machine movement provided a basic frame of reference for the development of proceduralized instruction and later led to today's developments in computer-aided instruction. Swezey (1987) maintained that the applications of this framework were rooted in Robert Gagné's hierarchical learning model which was developed in the early 1960s. Gagné theorized that there are eight types of learning that are hierarchically arranged from simple to complex. Gagné's (as cited in Swezey, 1987) original classification of the eight types of learning was published in the first edition of Gagné's book <u>Conditions of Learning</u> in 1965. The eight types are: signal learning, stimulus-response learning, chaining, verbal association, multiple discrimination, concept learning, principle learning, and problem solving.

It was Gagné's work that helped spur the military's movement toward the use of instructional system design (ISD) and the subsequent development and refinement of procedures for criterion-referenced instruction and measurement.

<u>The Influence of Robert Gagné</u>

A great deal of the military research on job aids during the 1960s and 1970s was based on a need for effective problem solving, especially in the aviation environment. R. S. Jensen and R. A. Benel (1977), who conducted research in pilot judgment training for the Department of Transportation, maintained that much of this research was based on the work of Robert Gagné who first addressed the issue of military training and principles of learning in the 1960s. Jensen and Benel reported that Gagné's principles of learning are an integral part of any pilot judgment training. They pointed out that Gagné argued that practice is not an effective training method even for the acquisition of such motor skills as field gunnery; rather, "training should emphasize the principles and procedures (or thought processes) involved, and practice should be directed to take advantage of these principles or take a minor role" (Jensen & Benel, 1977, p. 51).

Gagné's early work identified the need for intensive task analysis that focused on desired task performance. This focus is a critical component for effective JPA design as argued by Snow and Newby (1989), Bullock (1982), Pipe (1992), and Swezey (1987). The subject of task analysis is examined by Gagné (as cited in Jensen & Benel, 1977, p. 52) in 1962 as he explained:

> 1. Any human task may be analyzed into a set of component tasks which are distinct from each other. . .
>
> 2. These tasks components are mediators of the final task performance; that is, their presence insures positive transfer to a final performance, and their absence reduces such transfer to near zero.
>
> 3. The basic principles of training design consist of: (a) identifying the component tasks of a final performance; (b) insuring that each of these component tasks is fully achieved; and (c) arranging the total learning situation in a sequence which will insure optimal mediational effects from one component to another. (p. 52)

Winfred Hill (1963) in his text Learning: A Survey of Psychological Interpretations addressed the influence of Gagné's military research in his discussion on the importance of principles concerned with the "hierarchical arrangement of component tasks and sequence of operations within a larger task" (p. 211).

Dessinger (1989) maintained in her doctoral dissertation, "A great deal of the 50s and 60s literature on trouble shooting was based on Gagné's work on problem solving" (p. 12). Dessinger reviewed several technical papers written for the U. S. Air Force in the 1950s by Gagné and she pointed out that Gagné was interested in studying problem solving as a cognitive processing skill and he perceived troubleshooting as a form of problem solving.

Dessinger (1989) also pointed out that in Gagné's writings in 1964 and 1965 he "stressed the importance of using or internalizing a schemata to aid in problem solving tasks" (p. 13). Gagné (1984) defined a schemata as "an interconnected and meaningful related set of ideas specifically relevant to the type of problem presented" (p. 195).

In recent work, Gagné, Briggs, and Wager (1992) called for the use of higher-order rules to achieve effective problem solving and performance as they stated, "Rules play an essential role in problem solving. . . . Performance requires the invention and use of a complex rule to achieve the solution of a problem novel to the individual" (p. 65). They emphasized the role of task analysis, procedural analysis, the use of rules and higher-order rules, the capability to retrieve relevant subordinate rules and relevant information, and a need to synthesize concepts and rules into new forms.

An important component of JPA design is task analysis of which the outcome is task classification. Gagné, Briggs, and Wager (1992) defined task classification as "the categorization of the learning outcome into a domain or subdomain of types of learning" (p. 23). The five categories of learning outcomes defined by Gagné et al. (1992) were (a) intellectual skill, (b) cognitive strategy, (c) verbal information, (d) motor skill, and (e) attitude (p. 44).

The literature review leads to the premise that Gagné's learning outcomes are potential components of a JPA design model as they provide a means to analyze information requirements of a task, determine the performance requirements of a task, and serve as a systems link between performance, training, and decision making.

In the previously mentioned study on pilot judgment training, Jensen and Benel (1977) argued that the challenge is two-fold regarding learning and performance as they state, "Instructors must be trained and motivated to teach judgment, and devices or techniques must be developed that permit adequate judgmental instruction with less than perfect flight instructors" (p. 55). Perhaps Donald H. Bullock (1982) made the best case for the use of JPAs as he stated, "Guiding job performance with job aids offers a powerful alternative and supplement to training" (p. 36).

The Role of Systems Theory

A common thread between the fields of instructional technology and human factors is systems theory. Systems theory provides for an analytical approach to both the analysis and design of instruction or to the analysis and design of human relationships with technology. The instructional technology domain of design encompasses processes including ". . . models for the development of instruction, such as instructional systems design (Seels & Richey, 1994, p. 12). The basic and fundamental concept in human factors is the system. The concept of systems "serves to structure the approach to the development, analysis, and evaluation of complex collections of humans and machines" (Sanders & McCormick, 1987, p. 12).

Systems theory was critical to the field of instructional design in its formative years as it provided the theoretical base as well as rational link to the fields of psychology and communications (Bell, 1981). World War II created an enormous need for instruction. Thousands of military personnel had to be trained in an efficient and effective manner, and the military turned to well-established researchers to develop a new instructional methods that resulted in a systems approach to instruction (Shrock, 1991).

Seels (1989) described the historical evolution of instructional design to include three primary components: psychology, communications, and a systems approach. Salisbury (1990) maintained, "General systems theory actually provided many basic concepts from which instructional systems models have been derived. Concepts such as feedback, goals, input, process, product, and output are terms with which instructional designers are well acquainted" (p. 1).

Rothwell and Kazanas (1992) stated, "Instructional design is based on open systems theory" (p. 9). Even Robert Gagné, who is considered a major contributor to both the fields of instructional technology and human factors, and his associates stated that a basic assumption of instructional design "should be conducted by means of a systems approach" (Gagné et al, 1992, p. 5). And they stated, "Any institution that has the express purpose of developing human capabilities may be said to contain an instructional system" (p. 20).

Julien Christensen (1987), a human factor specialist, described the relevance of systems in the field of human factors:

> The complexity of modern systems demand that a systematic, well-defined set of procedures be applied initially and throughout the various stages of systems development and acquisitions. We believe that development of even the simplest products can benefit from adherence to the "systems approach;" we seriously doubt that complex systems can be developed successfully without such an approach. (p. 13)

Purpose of the Study

The purpose of this study was to develop a design model for the development of JPAs for use in aviation HRHR systems and to examine the potential role of JPAs as a systems link between performance and training to enhance the decision making process.

Research Questions

The following research questions were explored during the four phases of this study:

Phase One.

1. Based on a literature review and panel interviews, what are the theoretical foundations and factors from the fields of instructional technology and human factors that provide for the development of a conceptual and procedural design model for JPAs?

Phase Two.

1. Based on the literature review and panel interviews, what are the possible components of a conceptual and procedural design model for JPAs and how would such a model be designed?
2. Based on a formative evaluation of the initial JPA conceptual and procedural design model by a panel of experts, what factors may be added, deleted, or revised to develop a functional and effective JPA conceptual and procedural design model?

Phase Three.

1. Given an actual project to design a JPA for use by aviation cabin crewmembers to assist their decision making processes and task performance in aircraft emergency situations, can an effective JPA be created based upon the elements of the procedural design model?
2. What are the strengths and weaknesses of the JPA procedural design model? Factors to consider include the following: (a) context, (b) accuracy, and (c) capability to meet JPA intent.

Phase Four.

1. To what extent does the developed JPA influence aviation cabin crewmember performance and decision making processes?

2. Is there any improvement in performance by aviation cabin crewmembers using the developed JPA over aviation cabin crewmembers using traditional devices? Factors to be considered will include: (a) time, (b) errors of omission and commission, (c) problem solving, and (d) procedural accuracy.
3. What is required to facilitate the effective use of the developed JPA? Factors to be considered will include: (a) training, (b) physical JPA design and format, (c) user visual and textual literacy, and (d) ease of use.

Significance Of The Study

The significance of this study is rooted in Foshay and Moller's (1992) call for continuing research in the emerging field of performance technology. They refer to this field as Human Performance Technology (HPT) as they state:

> Human Performance Technology (HPT) is a new field, invented by thoughtful practitioners grappling with human performance problems in real-world settings. As a consequence, practice seems usually to have outrun theory; advances in the technology seem to have come more from the experience of solving practical problems than from formal research. Indeed, there are virtually no examples of systematic research projects undertaken to validate major models. (p. 701)

Seels and Richey (1994) refer to the performance technology movement "as an alternative perspective of instructional technology, or to some as a clear alternative to the field" (P. 89), and this study attempted to fulfill Foshay and Moller's call for research. Furthermore, this study heeded Rossett's (1991) call to develop a broader view of job aids. This approach calls for the development of job aids that provide information, support procedures, and influence effective decision making.

Discussions with members of the human-factor research branch of the National Aeronautical and Space Administration (NASA) emphasized a need for research into the design of JPAs and their influence on aeronautical decision making (J. Orasanu, personal communication, January 8, 1996. K. Mosier, personal communication, January 30, 1996).

The fields of instructional technology and human factors provide substantial contributions to JPA design concepts. A synthesis of the foundational theories from each field provides a framework to build a JPA conceptual design model and a JPA procedural design model. And most importantly, it is argued that such a synthesis between the fields is not only feasible but it is also desirable.

CHAPTER II

METHODS AND PROCEDURES

This study was developmental in nature and used qualitative methods to formulate a conceptual model and a procedural model for designing a Job Performance Aid (JPA) for use in high risk, high reliability (HRHR) organizational systems. This Chapter consists of this study's methods that encompassed four separate phases. Each phase had a specific purpose that used applicable data collection procedures and analysis methods. The methods used for each phase are presented here. Additionally, a project checklist was used to further document the procedures followed. The completed JPA Project Checklist is presented in Appendix A.

Phase One

The purpose of Phase One was to explore the design literature taken from the fields of instructional design and aviation human factors and to conduct interviews with subject-matter-experts (SMEs) that explored JPA design for use in HRHR organizations.

Methods

The methods used for Phase One consisted of a literature review of publications applicable to the design of JPAs and interviews with a panel of SMEs who represented the disciplines of instructional technology, human factors, and the field of graphics design. The data collected were used to develop the foundations for a JPA conceptual design model and a JPA procedural design model which were developed in Phase Two of the study.

Population

The population for Phase One consisted of the SME panel that was composed of three individuals who represented the discipline of instructional technology; three individuals who represented the discipline of human factors; and one individual who represented the field of JPA professional design.

The individuals selected from the field of instructional design to serve on the SME panel were Walter Dick, Gordon Rowland, and Joan Dessinger. Dick was asked to participate because of his vast background in instructional design modeling. Rowland was asked because of his research in areas of design, and Dessinger was asked because of her past research on JPAs.

The individuals selected form the field of human factors were H. B. Altman, Kathleen Mosier, and Ron Westrum. Altman was asked to serve on the panel because of his aviation human factor experience. Mosier was asked because of her research experience at the National Aeronautical and Space Administration, Ames Research Center. Westrum was asked because of his research in technology and organizations. The panel members from each of these fields held a Ph.D.

The person who was selected from the field of graphics design was Greg Miller. Miller was asked to serve on the panel as he had much experience as a graphic designer in the development of airline passenger information cards. Miller's design's were being used on many of the world's major airlines.

Each member of the SME panel signed a letter stating that permission was given to publish the data from their respective interviews and to use their names in this study.

Procedures

The Literature review

The literature review encompassed a review of 132 publications which addressed subjects related to JPA design. The publications consisted of 59 instructional technology publications, 63 human factor publications, 4 government aviation related reports, and 6 publications that addressed technology, design, and the aviation industry. Additionally, the 63 human factor publications included 13 research reports.

SME Interviews and Data Collection

A letter introducing the study was sent to each SME. The letter outlined the study and included a copy of the Dick and Carey Instructional System Design Model (see Figure 1, p. 25). The model served as a starting point for the initial SME interviews.

The initial SME interviews consisted of telephone interviews conducted with each panel member. The initial interviews used a structured format in that each interview consisted of the same set of 10 core questions. Interview data were recorded, transcribed, and entered into a information-management-database for further analysis. The following questions were used as the core questions for the interviews:

1. What expected outcomes can a Design Model provide for the user (a user is defined as a person who is assigned the responsibility to construct a Job Aid for some specific industry such as aviation)?
2. Do you envision the model to be linear - systematic in nature?
3. Do you think a Job Aid can influence decision making?
4. What are the characteristics of an effective Job Aid?
5. What are the most critical activities - or components of a model - required in designing a Job Aid?
6. What role do you see the components of information processing play in the model (e. g. , perception, motivation, relevance, accessibility, interpretation, transfer)?
7. Do you feel a Job Aid can influence decision making strategies?
8. How can the design of a Job Aid address the critical factor of time?
9. Do you feel the Job Aid should incorporate more visuals than text, or more text than visuals?
10. What is the role of training in regards to the use of a Job Aid? Should training be a component of the model?

The procedures completed in Phase One were documented on the JPA Project Checklist (see Appendix A).

Analysis of Data

Two qualitative methods were used to analyze the data. These methods were *interpretational analysis* and *reflective analysis*. The data collected from the literature review and SME interviews were examined to determine constructs, themes, and patterns that could explain the design and development of JPAs. Literature review data were examined to identify design variables and design activities. This data were then compared with the data from the SME interviews.

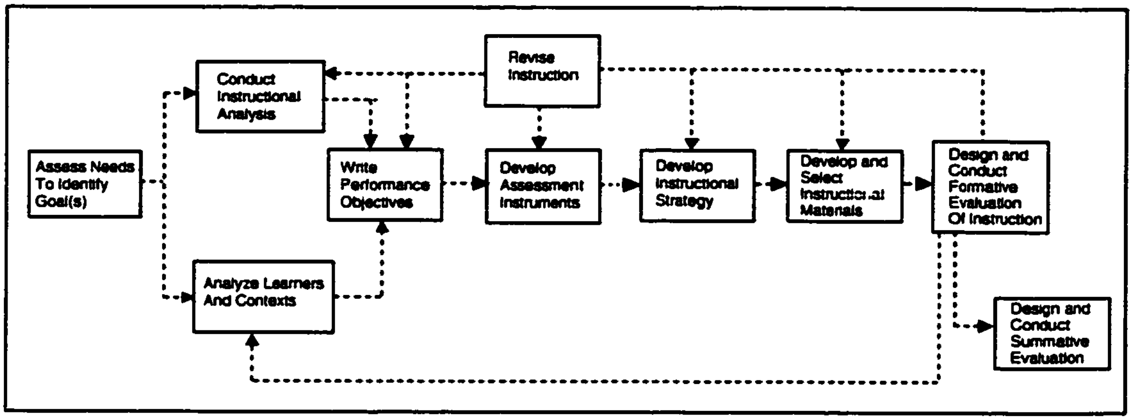


Figure 1. A model of systematic instructional design (Dick & Carey, 1996) used as a starting point for the initial subject-matter-expert interviews.

The SME interview data were entered into a information-management-database and then examined to identify constructs and patterns that pointed to design variables and activities. The findings were then compared with the literature review findings to initiate a synthesis of data that was completed in Phase Two. The synthesis consisted of linking similar concepts and design principles into a common framework.

Phase Two

The purpose of Phase Two was to analyze and transform the data collected in Phase One into a usable form that could be graphically presented by the use of models that depicted variables which influence JPA design and reflect activities that make up the JPA design process.

Methods

The methods utilized in Phase Two included three major activities: (a) the synthesis of data collected in Phase One, (b) the transformation of the data into representative models, and (c) the evaluation of the developed models by means of a two-round Delphi with the SME panel.

An initial JPA conceptual design model and a JPA procedural design model were constructed based on the frameworks established in Phase One. The draft of the models and associated definitions for the components and elements of the JPA procedural model were made available to the SME panel and a two-round formative evaluation process was used to assess the strengths and weaknesses of the JPA models. The JPA Project Checklist was also completed for Phase Two. The population consisted of the same SMEs that were used in Phase One.

Procedures

The procedures utilized in Phase Two included (a) the synthesis of data, (b) the transformation of the data into representative models, and (c) the evaluation of the developed models by means of a two-round Delphi with the SME panel.

Synthesis

The data collected from the literature review and SME interviews were examined and clustered into major areas based on commonalities of purpose and relationships. The SME interviews data were analyzed using an information-management-database system and clustered into major themes that addressed model development and JPA design. Key terms and phrases were highlighted in the database and compared with the findings of the literature review in order to categorize the data either into design variables or design activities.

Transformation of Data

The design variables were transformed into a visual representation by construction of a conceptual design model. The design activities were transformed into a visual representation by means of construction of a procedural design model and the development of definitions for each of the components and the components' elements which made up the procedural model. The initial models were titled (a) the JPA conceptual design model, and (b) the JPA procedural design model.

Evaluation of The Models

The evaluation of the JPA models consisted of a two-round Delphi process that incorporated expert-review formative evaluations.

First-round evaluation. A first-round formative evaluation package was mailed to each SME panel member. The first-round evaluation consisted of telephone interviews that were recorded and transcribed. The first-round formative evaluation interviews used an informal structure as the SMEs were asked for comments by means of open-ended questions and probes. The data were then entered into the information-management-database.

The SME comments were examined using the database and common comments were highlighted and extrapolated into a record of hits which were labeled (a) conceptual, (b) procedural, and (c) definitions. The data were analyzed and clustered into critique items which provided the foundation for subsequent revisions. The models and definitions were then revised for the purpose of a second-round evaluation.

Second-round evaluation. A second-round formative evaluation package was mailed to each SME that contained the revised models and definitions. The SMEs were asked to respond by E-mail to state their concurrence or provide additional comments regarding the models and definitions. The data collected were used to make a final revision to the JPA conceptual design model, the JPA procedural design model, and procedural definitions. Each procedure of Phase Two was documented using the JPA Project Checklist (see Appendix A).

Phase Three

The purpose of Phase Three was to determine if the models could be applied in a real-world situation that required the design of a JPA for use in a HRHR aviation organization.

Methods

The test for model application was accomplished by designing a task-specific JPA for use in an aviation HRHR environment using the procedural steps defined in the JPA procedural design model. Additionally, the task-specific JPA was evaluated during the design and development processes in accordance with the JPA procedural design model by means of an *expert review* and *small group evaluation* as defined by Tessmer (1993). Lastly, the JPA Project Checklist was completed to document the procedures accomplished during Phase Three (see Appendix A).

Population

The population for the expert review consisted of a human factor specialist who owned and managed a corporate aviation training company that provides corporate aviation crewmember emergency training programs. Additionally, two trainers who conduct emergency training programs for the training company participated in the second expert review.

The population for the small group evaluation consisted of three active corporate flight attendants who were attending a recurrent emergency procedures class. Each of three were female and all were employed by the same corporation. Each had been flying as a corporate flight attendant for over five years, and each was current in the same type and model aircraft. Additionally, they were very familiar with and proficient in the procedures depicted on the JPA.

Procedures

Based upon the JPA procedural design model, a JPA was constructed that provided the procedures and decision points necessary for an aviation cabin crewmember to prepare an aircraft cabin and passengers for an emergency landing.

JPA Task Selection

The task selected to be displayed by a JPA was the preparation of the passengers and cabin of a cabin-class corporate airplane for an emergency landing by a professional corporate flight attendant. The task is called the TEST - PREP procedure and it is an acronym for the following procedures: type of emergency, exits of choice, signals to be given, time to go, prepare passengers, ready the cabin, evacuation review, and pilot-in-command report.

JPA Design

The components of the JPA procedural design model were followed using the sequence depicted in the model. The initial design was a collaborative effort using the collective imaginations of the author and the owner of the training company. Component elements that were determined not to be applicable to the proposed JPA were omitted from the design process. The formative evaluation called for by the model included an expert review and a small group evaluation.

Expert review. The initial draft of the JPA was reviewed by the owner and principal trainer of a corporate aviation crew emergency training company. His suggestions were used to revise the JPA into a second draft and the JPA was sent back to the training company for further expert review. The second draft was re-evaluated by the company's owner and two trainers who conducted emergency training. The JPA was revised into a third draft based on the second round expert review.

Small group evaluation. The JPA's third draft was then reviewed by a group of three professional corporate cabin crewmembers. Their critique items were reviewed and used to revise the JPA into its final form.

Analysis of Data

The data collected during Phase Three were the outputs of the formative evaluations and processes including the expert-reviews and small group evaluation. The researcher used a qualitative technique of *reflective analysis* to arrive at the decisions regarding revisions to the JPA drafts and implementation of the findings of the formative evaluations. Reflective analysis (see Gall, Borg, & Gall, 1996) involved a reliance on the researcher's intuition, experience, and judgment in order to evaluate the recommendations and proposed revisions to the JPA drafts.

Phase Four

The purpose of Phase Four was to determine the effectiveness of the JPA's design by testing the effectiveness of the JPA under simulated but realistic conditions. Additionally, the subjects were queried to further assess JPA effectiveness.

Methods

The JPA was tested in a simulated aircraft emergency aboard a corporate aircraft cockpit-cabin simulator (see Figure 2) by comparing performance between a control group and an experimental group consisting of professional corporate aviation cabin crewmembers.

Six simulations were conducted for the experimental group and six simulations were randomly selected from a bank of videotapes to form the control group. The videotapes were used as de-briefing tools from previous emergency training programs. Each simulation was performed by a subject who had just completed an initial emergency training program. Additionally, the JPA was introduced to the experimental group just prior to the simulation sessions. The introduction consisted of a short briefing on the purpose and use of the JPA. The introduction session also provided time for any subject questions.

Subjects in the experimental group were provided the JPA during the simulation. Two JPAs were stored in the cockpit and were readily accessible to the pilot-in-command (PIC) and the cabin crewmember. Each simulation was videotaped in order to collect and preserve observational data for later analysis.

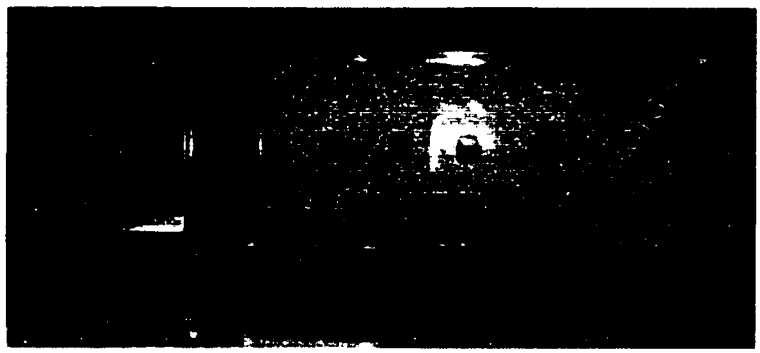


Figure 2. Cabin simulator used to conduct simulations.

Subject performance and JPA effectiveness were evaluated by: (a) observation of the videotaped experimental and control group simulations, (b) the completion of a JPA Subject Evaluation Form by each subject of the experimental group (see Appendix B), (c) prompt recall subject interviews conducted by the researcher with each member of the experimental group, and (d) completion of a Subject Simulation Score Sheet for each simulation by the researcher (see Appendix C).

A posttest only design was used to compare a control group (cabin crewmembers who did not have access to the JPA) with an experimental group (cabin crewmembers who had access to the JPA). The comparison was made by comparing performance scores between the control group and experimental group. Each group performed a similar simulation which involved preparing passengers and cabin for an emergency landing. Lastly, all Phase Four events were documented on the project checklist (see Appendix A).

Research Design

The research design for the simulation portion of the JPA field test used a control group posttest-only design (see Fitz-Gibbon and Morris, 1987). The selection of the subject population was limited to 11 participants attending a formal aviation crewmember emergency training program. A random sample of 6 subjects was drawn from the class to form the experimental group with the control group randomly drawn from videotaped performances of six participants who had previously completed the crewmember emergency training program.

The sample size of 6 was used as this was determined to be the maximum number of simulations that could be conducted in order to meet time constraints and without disrupting the training class. Figure 3 provides a graphic presentation of the research design.

	Time		
			Posttest
Experimental Group	R	X	O
Control Group	R		O

Figure 3. Posttest only research design adapted from Fitz-Gibbon, C. T., & Morris, L. L. (1987). How to design a program evaluation.

Population

The six subjects who made up the experimental group consisted of corporate aviation cabin crewmembers selected from a group of students who had completed a corporate aviation crewmember emergency training program. The program was conducted by HBA Corporation, FACTS® Training International. The experimental group had the following characteristics:

1. The subjects consisted of one male and five females. Three of the subjects had previous airline training and experience. The remaining three subjects had little previous crewmember experience and they had no previous training.
2. Subjects were employed as aviation crewmembers by flight departments of major U.S. corporations.

3. The subjects volunteered to participate in the study and they were randomly selected from a class of 11 recent graduates of HBA Corporation, FACTS® International Crewmember Emergency Training programs.
4. The subjects had successfully completed a crewmember emergency training program in accordance with Federal Aviation Administration requirements and they had successfully demonstrated proficiency in conducting in-flight emergency procedures in accordance with the training program's syllabus.
5. The subjects had demonstrated declarative knowledge for the emergency procedures displayed by the JPA by scoring a minimum of 85% on the written training program's competency exam.
6. The subjects were fluent in the English language.

The control group consisted of 6 previous graduates of the training program. The control group simulations were similar to the experimental groups' simulations; however, the control group did not use the JPA. The control group also consisted of professional corporate aviation cabin crewmembers and was formed by a random selection of 6 videotaped simulations from past training programs.

Instruments

Two written instruments were developed to evaluate the effectiveness of the JPA. The first instrument was a JPA Subject Evaluation Form (see Appendix B) and the second instrument was a Subject Performance Score Sheet (see Appendix C).

The JPA Subject Evaluation Form

The JPA Subject Evaluation Form was designed by the researcher to assess the subjects' attitudes regarding five key design areas. The five areas were (a) the level of need for a JPA to perform the specified task, (b) the level of perceived performance improvement, (c) the influence of training on using the JPA, (d) the degree of JPA clarity, and (e) the adequacy of the JPA's physical format. The form had five statements with one statement targeted to each area.

Each statement was scored by the subject marking a response box. The response boxes were assigned a quantitative value to form the following Likert-type scale: (a) the strongly disagree box was assigned a value of 1, (b) the somewhat disagree box was assigned a value of 2, (c) the no opinion box was assigned a value of 3, (d) the somewhat agree box was assigned a value of 4, and (e) the strongly agree box was assigned a value of 5.

There were two open-ended questions to be answered by the subject that completed the form. The first question one asked the subject to comment on what they liked best about the JPA and the second question asked the subject what they liked least. The JPA Subject Evaluation Forms were completed by each subject shortly after the subject's simulation was completed. Appendix B provides a sample Subject Evaluation Form.

The Subject Simulation Score Sheet

The second instrument was a Subject Simulation Score Sheet (see Appendix C). This instrument was scored by the researcher and it addressed each element of the TEST - PREP procedure. Quantitative values were assigned to performance levels for each element scored in order to determine a subject performance score. The performance levels were assigned the following values: (a) poor was assigned a value of 1, (b) fair was assigned a value of 2, (c) average was assigned a value of 3, (d) good was assigned a value of 4, and (e) excellent was assigned a value of 5.

The differences between each of the levels was determined by specific errors of omission or commission (see the descriptors for each element in Appendix C), and a list of passenger related safety items that were addressed or not addressed by the subject were noted to assist the researcher in the reflective analysis of the performances. Additionally, a reliability analysis was completed that provided an indication of the instrument's accuracy.

Procedures and Data Collection

Upon completing the formal crewmember emergency training program, each subject performed a emergency simulation that required the use of the TEST - PREP procedure. The simulation, conducted on a full motion cockpit-cabin simulator, consisted of an emergency situation involving an engine fire that occurred immediately after takeoff which required an immediate return to the departure airport. Additionally, the simulation scenario called for the fire to be severe enough to require an emergency landing and emergency evacuation.

There were a minimum of six passengers in the cabin for each simulation. Two passengers occupied the two rear table seats and the inboard passenger held a large briefcase. One female passenger, who was holding an infant (doll) in her arms, occupied a forward facing seat adjacent to the left emergency exit window. One passenger wore glasses. The passengers were instructed to follow all instructions given by the cabin crewmember during the simulation.

The elapsed time for the simulation began with cabin crewmember exiting the cockpit after receiving the emergency briefing by the PIC. Each subject received the same emergency briefing as follows:

> We have experienced an engine fire in the right engine. We are unable to put it out and tower reports that we are trailing smoke. We are going to return to the airport and make an emergency landing. Plan on using the main door as our primary exit. I will give you the standard signals, 2 minutes and 10 seconds before touchdown. You have 5 minutes to get them ready. Any questions?

The scoring for the subject's performance level during the crew briefing was made by the person acting as PIC. The person acting as PIC for each simulation was an actual and experienced PIC. The end of the simulation was considered as the point at which the cabin crewmember gave the cabin ready sign to the PIC. The timing for the simulation was stopped at this point. The subject was instructed to complete all required procedures dictated by the nature of the emergency and the PIC's briefing.

Each subject was asked to complete the JPA Subject Evaluation Form immediately after completion of the simulation. The data from the forms were reviewed and analyzed by the researcher at a later date (see Appendix A for competion time).

The prompt recall interviews were conducted within two hours after the simulation sessions. The prompt recall interviews consisted of recording the subjects comments during the showing of a videotape of their individual performance. The subjects were instructed to comment on what they were thinking and what they were doing each time the videotape was paused during playback. The videotape was stopped very 30 seconds to allow for the subject's comment. The researcher also probed the subject when it appeared that the subject could not provide sufficient detail. The recorded interview data were transcribed and analyzed at a later date (see Appendix A for completion time).

The videotapes of each experimental group simulation and each control group simulation were reviewed and scored by the researcher using the Subject Performance Score Sheet. The scoring was used to compare performances between the experimental group and the control group to determine if there were any observable differences with the use of the JPA. Additionally, each videotape was reviewed a minimum of three times to provide the researcher an opportunity to observe the performances and determine if any common themes or patterns appeared to emerge.

Analysis of Data

Phase Four provided a great amount and type of data; consequently the data were reviewed and analyzed in four stages (see Appendix A). Stage one consisted of analyzing the data collected from the JPA Subject Evaluation Forms. Only the mean score for each statement was calculated to determine central tendency because of the small sample size. Additionally, the responses of the open ended questions were reviewed to determine if any common theme existed.

Stage two consisted of the analysis of the prompt recall interview data. The transcribed data were reviewed using interpretive and reflective analysis to determine if any major weaknesses or strengths in the JPA's design could be identified which resulted from the use of the JPA procedural design model.

Stage three consisted of an analysis of the data collected from the Subject Simulation Score Sheets. Subject scores were analyzed to determine the mean scores for each element of the TEST portion of the simulations, the mean scores for each element of the PREP portion of the simulations, and the cumulative mean scores for all elements. An independent-sample t-test using a significance level of .05 was conducted to compare the means of each element and the cumulative means between the experimental and control groups.

Stage four involved reflective analysis. This was accomplished by the researcher observing the experimental groups and then the control groups videotaped performances at least three times consecutively in an attempt to identify common patterns within each group and determine if any comparison patterns may exist.

Limitations of the Study

The researcher recognizes that there are limitations to any study and acknowledges that the limitations of this study included the potential for researcher bias during the interpretive and reflective analyses processes employed in this study and that the comparison of means between the experimental and control group in Phase Four involved a small sample size.

Interpretational analysis relies on the ability of the researcher to identify commonalties within large amounts of verbal information. As such, it is susceptible to various types of error including data entry into the information-management-database, interpretation of words and phrases, interpretation of meanings, and personal judgments and decisions on what is and what is not influential. Consequently, the researcher must also rely on reflective analysis.

Reflective analysis relies heavily on the researcher's expertise, intuition, personal judgment, and tacit knowledge. It involves a continuous examination of data to search for patterns that can lead to theory which becomes the task of the researcher to justify to members of the scientific community within the researcher's line of study.

It was recognized by the researcher that the sample size for Phase Four was small (six subjects), and that the comparison of means between the performance scores of the experimental group and the control group would not be inferential, being only attributable to the subjects making up the experimental group. However, the purpose of the study was not to test for experimental design significance regarding subject performance; rather, the study was to determine the apparent and potential benefits of a specific design application using the JPA procedural design model.

Furthermore, for the purpose of this study which used observational research methods in Phase Four, appropriate sampling was more purposive than random sampling. Savenye and Robinson (1996) explained in reference to purposive sampling that for a study to be valid, "The reader should be able to believe that a representative sample of involved individuals were observed" (p. 1181). It is argued that the criteria used to select the purposive sampling under the given conditions provided for a convincing sample representation that would be believable and acceptable to the readers of this study. Lastly, the purpose of the study and the phenomena under scrutiny provided sufficient grounds for the qualitative research methods selected.

CHAPTER III

PHASE ONE: JPA DESIGN CONSIDERATIONS

The fields of instructional technology and human factors have each explored the JPA design process and each has examined the various roles that JPAs play in human performance. Both of these fields have developed concepts for the design of JPAs and there appears to be some commonality in the JPA design processes. Each field has addressed the need for task and audience analysis, display factors, and evaluation, but each field has taken a different approach. Consequently, the purpose of Phase I of this study is to determine the variables and activities identified within each of these fields that apply to JPA design and to synthesize the data into a common ground that could be depicted in a JPA design model which reflects the premises of both fields.

This study incorporates a review and analysis of relevant literature from the fields of instructional technology and human factors plus the input of subject-matter experts (SMEs) who are involved in the practice of instructional technology, human factors, or professional JPA design. The data collected provides foundations for effective JPA design.

Principles Underlying Design

As this study progressed towards the development of a design model, it was concluded that it was necessary to examine the concepts of design as applied to model development and to define the role of developmental research as used within this study. The literature review indicated that a developmental study which encompasses the creation of a design model involved addressing three major considerations: (a) the concept of design (see Richey, 1986; Rowland, 1993), (b) the employment of models (see Kirlik, 1993) and (c) the role of developmental research (see Richey, 1995; Richey & Nelson, 1996).

Concepts of Design: The Field of Instructional Technology

Gordon Rowland (1993), an instructional technologist, stated that "design is similar to composing" (p. 81). Rowland maintained that composing is frequently intended for a particular situation, setting, audience, and medium. He proposed that design involves a new creation "intended to satisfy a specific practical purpose" (p. 81). Furthermore, Rowland explained that the design process was affected by many factors including the designer's knowledge, skill, and experience; the design task; and methods and management.

William Winn and David Synder (1996) stated that the purpose of design was "to select the alternative from among several courses of action that will lead to the best results" (p. 132). They argued that the degree of success depends on the designer's validity of knowledge in a given subject and the reliability of procedures used.

Rita Richey (1986) defined design within the context of instructional design as, "the science of creating detailed specifications for the development, evaluation, and maintenance of situations which facilitate the learning of both large and small units of subject matter" (p. 9). It was concluded that Richey's 1986 definition closely matched the concepts of design as described by Rowland, Winn, and Synder and was very applicable to this study.

Although it may be argued that JPAs do not facilitate learning, the literature points to the fact that JPAs are instructional in nature. Furthermore, the purpose of a design model is to provide the designer a means to create specifications for the elements identified within the model.

Concepts of Design: The Field of Human Factors

The field of human factors looks upon design using a systems approach. David Meister, a human factor specialist, described the role of design as a function of systems development. Meister (1987) stated:

> Development is the process of transforming the system requirement (what the system is supposed to do, as described in words and numbers on paper) into the actual functioning system. Development encompasses (1) design, which is everything other than fabrication that is required to produce a functioning system, and (2) testing, which is the evaluation of design and of the system to ensure that these satisfy specifications, standards, and requirements. (p. 18)

Design within the field of human factors include similar elements as addressed in the field of instructional technology including systems thinking, the man/machine interface, and the role of the operator. Urban Kjellén (1987) of the Royal Institute of Technology called for the use of strategies that addressed not only the complexities of the technologies involved but the distribution of roles and tasks between the operators and the hardware of the system.

George Kaempf and Gary Klein (1994), aviation human factor specialists, argued that approaches to design must take into account "what the operator is thinking, what decisions s/he must make, or what information the decision maker needs" (p. 248).

Donald Schon (1983) synthesized the concepts of design, as he wrote:

> A designer makes things. Sometimes he makes the final product; more often he makes a representation — a plan, program, or image — of an artifact to be constructed by others. He works in particular situations, uses particular materials, and employs a distinctive medium and language. (pp. 78–79)

<u>The Use and Types of Models</u>

The idea of modeling is not new. Both the fields of instructional technology and human factors are rich in the use of models to portray some segment of reality. Ivor Davies (1996), an educational technologist, provided one concept of a model as he defined a model as a specific representation of reality. He stated:

> A model, which usually has a quantitative dimension, is much more specific and detailed representation of reality. Just as a child's model car bears a quantitative relationship to the real thing, so that the distance between the rear wheels on the model can be used to calculate the distance between them on the real car, so a model in science bears a quantitative relationship to reality. (p. 24)

Richey (1986) defined a model as "a representation of reality presented with a degree of structure and order" (p. 16). Additionally, Richey described three common symbolic models used in the field of instructional technology: (a) conceptual models, (b) procedural models, and (c) mathematical models. Richey (1986) defined the three types of models as follows:

> The conceptual model is one that is most likely to be confused with a theory, as it is a general, verbal description of a view of reality. Typically it is not truly explanatory, but the relevant components are presented and fully defined. The conceptual model is more likely to be supported by experience, as well as limited data. There are not clear statements of laws or propositions which are supported by quantities of systematically collected data.
>
> Procedural models are straightforward. They describe how to perform a task. In instructional design the steps are usually based upon the knowledge of what creates a successful product. This knowledge is experienced-based or is derived from another related theory or model.

> Mathematical models are equations which describe the relationships between various components of a situation. By applying data from new situations to a mathematical model, one can simulate the results. (p. 17)

The field of human factors also uses models for representing reality. Marca and McGowan (1988) defined a model used in their concept of structured analysis as "a complete, concise, and consistent description of a system which is developed for a particular reason" (p. 8). Wilson and Rutherford (1989) described a designer's conceptual model as a "target system image characterized through displays, documentation, structure, and operation" (p. 619). They also proposed that the classification of a designer's conceptual model could be extended to include the designer's model of the user's mental model.

The use of models in instructional technology was amply described by Richey (1986), "Models can be a vehicle for translating theory into concrete terms suitable for application or theory testing" (p. 17). The use of models in human factor applications was also explained by Kirlik in his description of the importance of modeling to analyze the use of performance aids and strategic human behavior in human-automation systems. Kirlik (1993) stated, "The modeling approach could also be used to assess the feasibility of introducing an existing aid into a new task environment, or to determine effective strategies for using newly introduced aiding systems" (p. 223).

Both of the fields use models in various applications; however, it is Richey's 1986 definition that set the stage for this study. Although the original proposal called for the development of one JPA design model, Richey's explication of models led to the conclusion that this study actually develop two models: a conceptual model which addressed the relevant components of JPA design, and a procedural model which addressed a specific JPA design task to evaluate the effectiveness of the conceptual model.

Richey's work in the role of models disclosed that conceptual models can take various forms including narrative descriptions, taxonomies, and mathematical formulations (Richey, 1986). In regards to the role the conceptual model played in this study, Richey's classification of Merill's component display theory (see Merrill, 1983) as a conceptual model provided the foundation for the development of a conceptual and procedural model for this study. Richey (1986) wrote:

> A more comprehensive conceptual model is component display theory (Merrill, 1983). This provides a theoretical basis for creating specifications for the development of instructional materials. It also serves as a procedural model. Component display theory includes taxonomic elements, explanatory matrices, in addition to narrative explanation. . . . A conceptual model is a product of a synthesis of the related research and knowledge base. . . . A key function of a conceptual model is to facilitate theorizing from a common orientation. (pp. 24 – 27).

Furthermore, Marca and McGowan's (1988) and Wilson and Rutherford's (1989) definitions of design supported the concept to develop a conceptual design model as well as a procedural model for this study.

The Role of Developmental Research

As stated in the introduction of Chapter I, this study was developmental in nature and falls under the realm of Type 2 developmental research as defined by Richey and Nelson (1996). Developmental research has been defined as "the systematic study of designing, developing and evaluating instructional programs, processes and products that must meet the criteria of internal consistency and effectiveness" (Seels & Richey, 1994, p. 127).

Developmental research can provide for a production of knowledge with a goal of improving processes of instructional design, development and evaluation. Richey and Nelson (1996) explained that Type 1 developmental research studies a specific product or program design, development or evaluation project; whereas, Type 2 developmental research addresses the design, development, and evaluation processes themselves rather than a demonstration of such processes. They maintained that Type 2 developmental research was directed towards general principles which were applicable to a wide range of design and developmental projects.

Although it may appear that this study is specific in that it focuses on JPA design for HRHR organizational systems, it was concluded that this study fit more closely into the realm of Type 2 developmental research as a major focus of this study was to develop a JPA conceptual design model which was adaptable to a wide range of JPA design projects.

Designing Job Performance Aids

Rossett and Gautier-Downes (1991) maintained that there were three major ways of employing job aids: (a) job aids that provided information, (b) job aids that supported procedures, and (c) job aids that coached perspectives, decisions, and self-evaluation. The literature from both the fields of instructional technology and human factors indicated that the three broad applications categorized by Rossett and Gautier-Downes were applicable to the design of JPAs for HRHR systems.

Peter Pipe (1992) applied the field of ergonomics to an examination of performance aid design. Pipe argued that performance aids should go beyond serving only as a memory aid and also serve as a means to aid the mental aspects of a task by making information accessible and support decision making. In regards to the design and use of job aids, Pipe (1992) wrote:

> There should, however, be room in the solution for ways of prompting other than words and pictures — via color coding, for example, and, if equipment is being used, through the layout of controls and information displays. . . one would try to block impediments to successful performance and seek ways of enhancing both the physical and the mental environment in which work is performed. This is typically the most fruitful place for seeking ergonomic aids. (p. 355)

Pipe's major means for the development of effective performance aids involved task analysis and he argued that task analysis "is the best tool in pinpointing exactly where an aid is needed" (Pipe, 1992, p. 355). Furthermore, Pipe (1992) argued that the task analysis be in-depth, address the appropriate end-user, and carefully analyzed as he stated:

> The task analysis has to be carried farther than it typically is, beyond what one might consider the routine task as performed by an expert. What the expert does may not address the problems of the person most in need of help — the less-than-expert performer. (p. 355)

The need for addressing human information processing in the design of information displays used in aviation systems was argued by Frank Hawkins, an aviation human factor specialists. Hawkins (1987) maintained, "It is fruitless to provide an operator with information from displays, for example, without an understanding of how effectively the information can be processed" (p. 21).

Hawkins argued that the interface between the human performer and information displays encompassed the non-physical aspects of the aviation flight system. He described that aviation information displays included procedures, manual and checklist layout, symbology, and computer programs.

The argument made by Pipe for addressing the non-expert performer and the argument by Hawkins for addressing information processing led to the conclusion that the interfaces between the human and the information display must be addressed in JPA design. And it is further concluded that it is task analysis which can support the selection of design strategies and assist in the identification of obstacles and limitations to the design of effective interfaces between the human performer and the information display.

Strategies For JPA Design

JPAs are used for a multitude of purposes within HRHR systems and it is critical for the designer to focus on the purpose for which the JPA is designed. For example, Smillie (1985) explained that "the passenger emergency information card on airlines is an attempt to convey a small amount of important information in a fully pictorial, attention getting format" (p. 221). The strategy used is to present information in a pictorial format that can be easily learned and recalled as passengers vary widely in experience and language ability. Furthermore, research has shown that passengers generally have a low motivation to learn information about a situation that will most likely not occur (NTSB, 1985). If there was a large amount of information to learn or a number of critical procedures to follow sequentially such as the checklists used by pilots in the cockpit, a different strategy would need to be employed (Smillie, 1985).

The literature review indicated that one of the most important design elements was the selection and use of an appropriate design strategy. Rossett and Gautier-Downes (1991) emphasized in their text A Handbook of Job Aids the importance of the designer to be aware of the kinds of job aids and match the kind of job aid with the work site. The design criteria, suggested by Rossett and Gautier-Downes, is a design strategy.

Smillie (1985) examined JPA design strategies and maintained "A primary characteristic of JPA development is the consistent focus of attention on the user in both the identification of information requirements and the formatting of that information" (p. 222). Furthermore, Smillie tied JPA formatting to design strategy by categorizing JPA formats as: (a) directive, (b) deductive, or (c) hybrid. His categorization of formats was closely related to the kinds of JPAs addressed by Rossett and Gautier-Downes.

Directive format strategy. With directive formats, all the information that is required to complete a task is presented, and it is assumed that the user knows no more about the task than the general population (Smillie, 1985, p. 223). An example of a directive JPA used in the aviation industry is the airline passenger safety information card that provides safety and emergency information to the novice passenger.

Smillie (1985) maintained that the format requirements for a directive JPA would also have to address the users' unfamiliarity with the task, which necessitated the use of illustrations to clearly convey the intended meaning. The research by H. B. Altman (1974) on the use of pictorial materials in aircraft passenger safety instruction supported Smillie's view in that Altman found that pictorial formatting was superior to a text-only format as the general airline passenger population knew little about the safety tasks required.

Deductive format strategy. With deductive formats, the users are expected to know some information by means of training or experience (Smillie, 1985). For example, within the aviation industry the cockpit checklist and the flight operations manual used by pilots are deductive JPAs as the training on the tasks and procedures displayed by the JPAs are integral components of aviation training (see Degani & Wiener, 1994a; Gross, 1995; Turner et al. 1991).

Smillie (1985), based on his examination of JPA design, concluded that two basic design strategies emerged as he related the type of format to the type of user. Smillie stated, "directive formats are best for novice users, deductive formats are best for experienced users" (p. 223).

Hybrid format strategy. Smillie (1985) also maintained that for a JPA to be effective to a wide range of users that a more flexible design strategy was required. This strategy involved presenting information at both the directive level and the deductive level. Smillie stated,

> The purpose of the hybrid JPA is to enhance performance by allowing individual flexibility in using the task information, that is, the inexperienced user can use the directive portion of the JPA and at the same time observe how the deductive portion of the JPA can be used to perform the same task. (p. 227)

Aviation human factor specialists have argued that flexibility, a middle ground, was critical to the design of effective flight-deck procedures that are often displayed in aviation JPAs. Degani and Wiener (1994a) stated:

> The system designer and operational management must occupy a middle ground: operations of high-risk systems cannot be left to the whim of the individual. Management must likewise recognize the danger of over-procedurization, which fails to exploit one of the most valuable assets in the system, the intelligent operator who is "on the scene." The alert system designer and operations manager recognize that there cannot be a procedure for everything, and the time will come in which operators of a complex system will face a situation for which there is no written procedure. It is at this point that we recognize the reason for keeping humans in the system. Procedures whether executed by humans or machines, have their place, but so does human cognition. (p. 2).

An example of a hybrid JPA used within the aviation industry is an airplane flight manual. The manual, provided by the airplane manufacturer, typically presents deductive level information in the form of checklists and directive level information in the form of expanded explanation of the steps displayed in the checklist items.

Motivational Considerations For JPA Design

Smillie (1985) suggested that motivation on the part of the user of a JPA will be high when the need to accomplish a given task is also high. Aviation studies, however, have found that this is not always the case. Turner et al. (1991) found that 43% of the aviation safety reports they studied which encompassed a period beginning January, 1983 through October, 1986 reflected that the flight crew had not used the checklist at all, or had missed important items on the checklist" (p. 5). Turner et al. (1991) also found that National Transportation Safety Board investigations undertaken during the same period of time confirmed that checklist misuse was discovered in 81% of aircraft accidents which resulted in substantial damage or destruction (p. 2).

A sad fact is that the misuse or lack of use of aircraft checklists continues. In fact, an accident that occurred in 1994 had as a direct causal factor the failure of the pilots to conduct a prestart checklist properly and the National Transportation Safety Board cited 11 specific violations of the airline's checklist procedures (NTSB, 1995).

The lack of user motivation regarding aviation JPAs such as aircraft checklist use was best stated by Frank Hawkins (1987) in his question posed to the aviation industry: "How is it that reading of a checklist, which requires no special skill but only an appropriate, responsible attitude, seems to give so many problems within certain operational cultures" (p. 218)?

L. Zeitlin (1994), a human factor specialist, explored the question of why people fail to follow safety instructions such as presented in certain JPAs. The findings of Zeitlin's research indicated that people make a subjective assessment of risk and that attitudes and experience often prompted readers to ignore safety instructions. Zeitlin recommended that well crafted safety instructions included a rationale for obeying the instructions.

Zeitlin's findings led to the conclusion that training should be a component of the JPA design model. Additionally, it was concluded that the training content address the risks involved when the JPA is neglected or mis-used as one means to provide the end-user with the rationale behind the JPA.

Richard Gross and the Editorial Staff of Flight Safety Foundation (1995) asked the aviation industry, "Could the contents, organization or design of certain checklists make them more difficult to use or even discourage their use" (p. 3)? The aviation literature reflected the importance of motivation and led to the conclusion that motivation be addressed in the design model.

Motivation as an element of JPA design is based on past traditional studies of needs and motives that explored the principle of relevance (Smillie, 1985, p.). Keller and Burkman (1993) defined relevance as "need stimulation" (p. 10). Although there are a number of studies that explore motivation, Joseph Grau (1986) in his article on job aids and motivation argued that "one theory which seems to make excellent sense is the model devised by Vroom" (p. 10).

Victor Vroom popularized this theory in the 1960s and the model reflects that motivation was a function of expectancy, valence, and instrumentality (Gordon, 1991). Grau (1986) suggested that job aid design could incorporate motivation by addressing Vroom's three functions. Grau explained that expectancy was the perceived probability that the effort will actually result in the desired performance; valence was the value of the outcome to the performer and, instrumentality was the perceived probability that the desired performance will produce a particular outcome or reward. Furthermore, Grau (1986) argued that job aids could have a significant effect on motivation by: "(a) positively affecting expectancy of achieving desired performance, (b) reducing the level of effort required to achieve desired performance, and (c) enhancing valence in terms of job satisfaction" (p. 10).

John Keller, an instructional technologist, applied Vroom's principles in his research on motivational principles for instruction and the motivational design process. Keller (1987) developed the ARCS model of motivational design that addressed: (a) attention, (b) relevance, (c) confidence, and (d) satisfaction as key components for design (p. 2). Furthermore, Keller (1987) wrote:

> Audience analysis is of particular importance in motivational design, and would be analogous to task analysis and instructional analysis in instructional design. It identifies where the motivational gaps are; that is, the specific areas in which you might have to give greater than normal emphasis to stimulate and maintain audience involvement. (p. 2)

Keller and Burkman (1993) argued that the majority of motivational text, graphic and print prescriptions related to "(1) gaining and maintaining attention, (2) relating the content of materials to learner interests, goals, or past, and (3) building and maintaining learner confidence to use the material" (pp. 30—31). The use of text and graphics are the primary communication methods for JPAs, and by substituting the word "user" for "learner," Keller and Burkman's motivational principles can easily be applied to JPA design.

The literature review regarding motivation pointed to potential key components for a JPA conceptual design model for HRHR organizational systems that included the characteristics of the audience or target population, the use of task analysis, and influence of training. Furthermore, Keller and Burkman (1993) emphasized that motivation should be considered throughout the entire design and development process and not just an embellishment.

The Target Population.

The literature indicated that a critical design consideration was who made up the audience or general population. Swezey (1987), in his summary of Foley's work on job aids, defined the population in more specific terms as "the anticipated task performer population including their backgrounds as well as the training they are likely to receive" (p. 1051). Within the field of instructional technology, Dick and Carey (1996) termed the performers — learners for any given set of instruction — as the "target population" (p. 90). Additionally, they described what information a designer needed to know about the target population. Dick and Carey (1996) stated:

> Useful information includes (1) entry behaviors, (2) prior knowledge of the topic area, (3) attitudes toward content and potential delivery systems, (4) academic motivation, (5) educational and ability levels, (6) general learning preferences, (7) attitudes towards the organization giving the instruction, and (8) group characteristics. (p. 91)

Five of the eight learner characteristics defined by Dick and Carey were deemed applicable to defining a JPA target population (viz., entry behaviors, prior knowledge, attitudes toward content and delivery systems, attitudes towards the organization, and group characteristics).

Smillie also addressed the importance of the target population in JPA design as he maintained it was necessary to center design strategies about the user. Smillie (1985) stated:

> To be successful, JPA design strategies have to be centered about the user and the user's acceptance of the JPA because a well-designed JPA is useless if the audience does not want to use it. Therefore the level required for the anticipated user is a prime concern. Too much detail and users feel they are being seen as less intelligent than they are. Too little detail leaves the user with the responsibilities of understanding the intent of the JPA steps. The user may then misinterpret the intended meaning and perform the task incorrectly. Thus the development process should incorporate the user into the JPA design strategy by soliciting user comments and reviews during the JPA development process. (p. 239)

The literature from the field of instructional technology emphasized the importance of target population characteristics; whereas, the literature from the field of human factors primarily stressed the cognitive processes of the user (e. g. , Adelman, Cohen, Bresnick, Chinnis & Laskey, 1993; Redding & Seamster, 1995; Wilson & Rutherford, 1989).

The Role of Task Analysis in JPA Design

The literature review indicated that the process of task analysis served as the basis for defining job aid requirements and design strategies. The role of task analysis was summarized by Donald Bullock (1982), a training specialist, in an article that compared the development of training versus the development of job aids as he stated, "Design and development of job aids shares with training the requirement to focus on the desired job performance to ensure cost-effectiveness" (p. 38). Bullock explained that focus was made up of using front end needs assessment and job/task analysis, and looking for anticipated performance problems.

The importance of task analysis in the design of JPAs was emphasized in much of the literature (e. g. see, Bullock, 1982; Dessinger, 1989; Duncan, 1985; Folley, 1961; Pipe, 1992; Smillie, 1985; Swezey, 1987). The literature confirmed that the process of task analysis fulfilled many of the JPA design guidelines summarized by R. W. Swezey reviewed in Chapter II of this study.

To review, Swezey (1987) suggested that a task analysis provided the designer information necessary to (a) identify the task elements to be considered, (b) determine the functional characteristics that will enhance performance, (c) aid in matching the JPA physical design characteristics with the functions required to perform the specified task, and (d) provide data for the evaluation, revision, and updating of the specific JPA.

Swezey (1987) defined task analysis as ". . . a systematic technique that enables precise specifications of behaviors and skill levels necessary to accomplish each task within a job, as well as the steps existing within each task that are required in order to achieve adequate overall performance" (p.1043). Drury, Paramore, Van Cott, Grey, and Corlett maintained that task analysis was a formal methodology derived from systems theory (1987). Robert Mager (1988), a well respected instructional technologist, defined task analysis as ". . . a collection of techniques used to help make the components of competent performance visible. It is a set of ways to draw a picture of what competent people actually do, or should do, when performing a task" (p. 29).

Drury et al. (1987) provided a historical overview on the development of task analysis. Their review found that methods of task analysis were rooted in Frederick W. Taylor's early work in time-motion studies which Taylor used to describe, analyze, and improve the efficiency of factory assembly workers. Additionally, Drury et al. described that through the efforts of the U. S. Department of Labor in the 1930s a method of job analysis was developed to identify personnel qualifications, job redesign, vocational counseling, and training development.

A major contribution to JPA design occurred in the 1940s and 1950s during which military systems became more complex and sophisticated. Drury et al. (1987) described that the growing complexity of military technology was accompanied by a growing need for written operating and maintenance procedures. These complex technologies involved people in new kinds of relationships with systems and these new technologies sharply altered the nature of human tasks. Drury et al. reported that in 1953, the U. S. Air Force published A Method For Man-Machine Task Analysis which was developed by Robert B. Miller. This report described a method to analyze an operator's job in any human-machine system as a part of a system's linkages from input to output functions.

Rossett described three broad goals for task analysis applied to human performance as used in the field of instructional technology. Rossett (1992) maintained that the purposes of task analysis were:

1. To gather and disseminate information, perspectives, and recommendations regarding optimal and actual performance, the causes of performance problems, feelings, and solutions.
2. To involve key people and data; and
3. To model and employ a systematic process for improving human performance. (p. 99)

Swezey (1987) maintained that a task analysis, from a human factor's perspective, provided information necessary to identify: (a) when JPAs are and are not appropriate, (b) the functional characteristics of a proposed JPA, (c) physical JPA design requirements, and (d) evaluation criteria

Peter Pipe (1992), suggested specific steps to complete a task analysis for the development of JPAs:

> The initial steps involve describing the task, identifying where problems arise, and seeking the cause(s) of each problem. In most cases, this phase can be handled adequately by the usual methods of task analysis and a few extra questions. Nevertheless, it is usually not sufficient to study the routine task as performed by an expert. By definition the expert does not get into trouble, particularly with the routine. To find out where help is needed most, the HP technologist has to examine the expanded task, including emergencies and other problems that a less-than-expert operator may face. (pp. 360 – 361)

Other researchers have called for an expansion of traditional task analysis to the use of cognitive task analysis due to the substantial changes that have taken place in the last twenty years in the nature of jobs due to the increase in technology complexity and its associated risks.

Ryder and Reading (1993) maintained that "These changes have shifted the demands on human performance from primarily physical to primarily cognitive" (p. 75). This shift is evident in much of the literature which addressed human performance in HRHR systems (e. g. , Degani & Wiener, 1994b; Hawkins, 1987; Kjellen, 1987; Mosier, Palmer & Degani, 1992; Orasanu, 1994; Perrow, 1984; Von Glinow & Mohrman, 1990; Westrum, 1995). The literature reflected that the traditional task analysis was content driven and that a more in-depth analysis was required as argued by Richard Kern (1985):

> The task analytic techniques developed under the content perspective provide important tools for use in developing job manuals. However, it is important to emphasize that these techniques enable manual developers to model the task activities the user is expected to perform, not the users' knowledge base or expected information needs (p. 346).

Cognitive task analysis. Cognitive task analysis is a process that compares the cognitive structures and processes of expert performers with those having less proficiency. Its focus is on decision-making and problem solving, mental models of the job, and the relationships between job knowledge and job tasks (Redding & Seamster, 1995). William Winn (1990), an instructional technologist, stated that "cognitive theory requires that 'unobservable' tasks be analyzed. These are those mental tasks that must be mastered before observable performance is possible" (p. 57). Additionally, Ryder and Redding (1993) maintained that cognitive task analysis provided a means to address the operators' knowledge structure and information processing strategies involved in task performance; plus, they maintained that cognitive task analysis could provide useful information for structuring training.

Redding and Seamster (1995) in their discussion on the implementation of cognitive task analysis wrote, "A variety of techniques are used in CTA [cognitive task analysis], including interviewing, observation, protocol analysis, psychological scaling, neural network modeling, cognitive and performance modeling, and error analysis" (p. 171).

Research (Stewart, Roebber & Bosart, 1997) on the importance of identifying task properties towards analyzing expert judgment provided further support for the necessity of an in-depth task analysis. Based on an analysis of Hammond's social judgment theory and cognitive continuum theory, Stewart, Roebber, and Bosart (1997) argued:

> The focus of the study of judgment is the relation between the judge and the environment (or task), and that judgment cannot be understood without understanding the properties of the task. Task properties are important both because they can facilitate or limit judgmental accuracy and because they describe the environment in which the judgment process was learned. (p. 206)

Additionally, Stewart et al. specified three important categories of task characteristics based on cognitive continuum theory: (a) the complexity of the task structure, (b) the ambiguity of task content, and (c) the form of task presentation.

The importance of addressing the influence of cognitive processes on performance during the design process was addressed in much of the literature. Adelman, Cohen, Bresnick, Chinnis, and Laskey (1993) found that, "An increasing body of empirical research demonstrates that the design of information and decision technology can significantly affect operators' cognitive processes and, in turn, performance" (p. 243).

The Role of Procedures and Compliance in JPA Design

Two areas in the literature that were not often addressed regarding JPA design were the development and integration of procedures and the role of compliance.

Procedures. Ray Fuller (1994), a human factor specialist, defined procedures — referred to as standard operating procedures within the aviation industry — as a set of rules:

> Rules are specifications of how to behave or not behave under particular conditions. . . . The aviation industry is very familiar with this 'rules' solution, typically implemented in the form of standard operating procedures (SOPs). With this perspective, SOPs may be viewed as rules which prescribe required behavior independently of the existence of natural and reliable environmental controls. (p. 180)

Additionally, Degani and Wiener (1994b) examined the role of procedures used in HRHR systems:

> A complex human-machine system is more than merely one or more operators and a collection of hardware components. To operate a complex system successfully, the human-machine system must be supported by an organizational infrastructure of operating concepts, rules, guidelines and documents. . . . In high-risk endeavors such as aircraft operations, space flight, nuclear power, chemical production and military operations, it is essential that such support be flawless, as the price of deviations can be high. When operating rules are not adhered to, or the rules are inadequate for the task at hand, not only will the system's goals be thwarted, but there may be tragic human and material consequences. Even a cursory examination of accident and incident reports from any domain of operations will confirm this. (p. 44)

Within the aviation industry, procedures are presented by means of JPAs; consequently, it is necessary for a JPA design model to incorporate the development of accurate procedures. Furthermore, the literature indicated that procedural development must include the influence of management.

Degani and Wiener (1994b) argued that there was a link between procedures and management's philosophy and policies:

> Procedures do not fall from the sky, nor are they inherent in the equipment. Procedures must be based on a broad concept of the user's operation. These operating concepts lend themselves into a set of work policies and procedures that specify how to operate the equipment efficiently. There is a link between procedures and the concepts of operations. We call that link 'The three 'P's of cockpit operations': philosophy, policies, and procedures. (p. 47)

Degani and Wiener's argument suggested that the designer of JPAs must look beyond just the presentation of information. The designer must recognize the influence of management's philosophy and policies on the design, development, implementation, and revision of JPAs. Tilaro and Rossett (1993), instructional technologists, affirmed Degani and Wiener's three 'P' concept as they maintained that the creation of effective JPAs included incorporating the role of management. Tilaro and Rossett (1993) stated:

> Too often, job aid development has focused on capturing and delivering the facts, and nothing but the facts. While facts that employees need to do their jobs are obviously essential, they aren't sufficient. Planning, anticipating, coordinating with management, and following-up with workers are also what it takes to assure that the job aids matter to employees. (p. 19)

Compliance. Compliance refers to the validity of the information presented in the JPA. Validity means that the information is accurate and meets the guidelines set forth by regulatory oversight. Each HRHR industry has its own regulatory agency that oversees the industry's operations. And, it is the Federal Aviation Administration (FAA) that is the regulatory agency for the United States aviation industry (Adamski & Doyle, 1995).

The Flight Safety Foundation (Gross, 1995) reported that a number of job aids used in the aviation industry were required to meet compliance provisions either under the auspices of FAA Federal Aviation Regulations; FAA Air Carrier Operation Bulletins; equipment manufacture specifications; or in the case of major airlines with extensive experience, company developed procedures that were approved by the FAA.

The designer, however, must assure validity that goes beyond regulatory agency requirements. Degani and Wiener (1994b) argued that "procedures should not (1) come solely from the equipment supplier, or (2) simply written by the individual fleet manager responsible for the operation of a specific aircraft" (p. 51). Degani and Wiener (1994a, p. 5) stated that procedures specified, unambiguously, six things: (a) What the task is, (b) when the task is conducted (time and sequence), (c) by whom it is conducted, (d) how the task is done (actions), (e) what the sequence of actions consists of, and (f) what type of feedback is provided.

The literature review revealed little information regarding the role of regulatory compliance for JPAs; however, many job aids used within HRHR systems are required to meet some type of compliance provisions. It is argued that the components of compliance and validity are necessary components in a JPA design model for HRHR systems.

The Role of Message Design in JPA Design

The literature disclosed that a key component within the design domain of instructional technology was message design (Seels & Richey, 1994). Grabowski (1991) maintained that "Message design within the context of instructional technology has three main thrusts: message design for instruction, message design for learning, and general principles that span both" (p. 202); further, Grabowski stated that message design is the "planning for the manipulation of the physical form of the message" (p. 206).

Message design may take any of several forms, but its purpose is to provide the clear transmission of information from a sender to a receiver as explained by Romiszowski (1988), "The message is nothing else than the information which is being transmitted . . . . This message may be quite complex and may involve careful design in order to communicate the exact intent of its author" (p. 8).

Within the field of instructional technology, the literature on message design typically focused on the design of instructional messages for learning situations; however, the literature also indicated that the instructional technologist was often faced with design tasks that go beyond the realm of formal instruction such as the task of JPA design (Rossett, 1991). The literature from the field of instructional technology was found to rich in the topic of message design. The literature review indicated that perhaps the most often cited works on message design were the texts by Duffy and Waller (1985) Fleming and Levie (1993), Jonassen (1982; 1985), and Misanchuk (1992). Each of these texts reflected a number of principles, theory, and heuristics for the design of effective messages. The literature from the field of instructional technology focused on principles that addressed reader analysis, perception, typography, graphics, layout, and types of learning.

The literature from the field of human factors also addressed message design; however within this field, the literature primarily focused on message display factors and information processing research (e. g., see Altman, 1974; Degani, 1992; Fisher & Tan, 1989; Matthews, 1986; Sylla, Drury & Babu, 1986; Trollip & Sales, 1986).

Since the literature on message was so vast within each of the fields, the literature review for this study focused on the role of user perception, visual information structure, and display factors which the literature pointed to as major message design considerations for JPA development. Adamski and Stahl (1997) in their examination of aviation technical messages for the Flight Safety Foundation stated that message design principles began with:

> Analyzing the audience that will receive the message, their language-and visual-interpretation capabilities, their common experiences and their prerequisite skills; understanding the desired action(s) to be undertaken by the receiver following receipt of the message; understanding the display medium that will be used to transmit the message; and, knowing the circumstances under which the message will be displayed. (p. 1)

Perception. The role of perception was found to be a major factor in the effectiveness of message design. Both the fields of instructional technology and human factors identified the need to address user perception during the design process.

Foley and Moray (1987) defined perception in the context of human factors systems design as they stated:

> We define "perception". . . to involve consciousness. To perceive something is to be aware of it and as William James stated a hundred years ago, to pay attention to it. Perception is not, therefore, the same as pattern analysis. Both common experience and experimental research make the difference clear. . . . The contents of conscious perception are the result of operations by the observer on the output of the brain's pattern-analyzing mechanisms and are not the operation of those mechanisms themselves. Perception is constructed by the observer, not determined by the parameters of the physical signals that fall on the receptors. (p. 51)

Although Foley and Moray's research was directed at explaining the thresholds at which noticeable differences were recognized by the various human senses, their research led to an important design principle. Foley and Moray (1987) maintained that the designer's task was to ensure that sufficient physical properties of the designed product or equipment provided a means for effective user perception. Foley and Moray (1987) stated:

> The designer's task is to ensure that under the conditions in which the user will employ the equipment being designed the levels of physical energy falling on the receptors will be at least several orders of magnitude greater than the absolute physiological sensitivities. (p. 51)

William Winn explored perception principles for message design within the field of instructional technology. Winn (1993) maintained that effective message design required that the designer be aware of the users' perception processes as he stated:

> Perception can be thought of as a set of physiological and psychological processes by means of which we make sense of our environment. . . . However, for the message designer, the fact that the earliest stage of cognition, namely perception, predetermines much of what goes on in later stages is clearly an indication that the nature and effects of the earliest processes are important to consider and to influence. . . . The designer therefore needs to take all necessary steps to ensure that the message is constructed so as to make it easy to perceive in the way it was meant to be. (p. 57)

Furthermore, Winn (1993) argued that "human perception is only sensitive to changes in stimulation" (p. 59). In relation to message design Winn stated:

> This means that great care should be given to the structural properties of messages that affect perceptual organization. These include, but are not limited to, the relative placement, size, and dominance of objects in the visual field, and the way the eye is "led" over the image by various techniques of composition. The message designer cannot assume that people will see what they are told they are looking at, and cannot easily compensate for a poorly designed message with instructions on how it is to be perceived. (p. 56)

Winn's message design principles concurred with Foley and Moray's argument for a sufficient magnitude or level of physical energy that provided for a noticeable difference in human sensation or, to use Winn's terminology: stimulation.

Snow and Newby (1989) contended that a JPA which "is difficult to read or perceive while the user is on task may be totally ineffective, requiring too much effort to use" (p. 27). The points made by Foley and Moray, Winn, and Snow and Newby led to the conclusion that perception was a contributing factor in the design of JPAs and that perception involved the user's sensoritory mechanisms as well as the user's cognitive thought processes. Snow and Newby (1989) in their examination of ergonomically designed job aids summarized the important role of user perception:

> Perceptibility is influenced by the characteristics of the stimulus (the job aid), the user, and the environment. The user's visual acuity, contrast sensitivity, and arousal state all affects how well a stimulus can be perceived (Sanders & McCormick, 1987). The environment then interacts with these user characteristics by adding visual distractions, auditory noise, uneven lighting, glare, or other obstacles to perception (see Fleming, 1987, for review). Designing perceptible job aids requires one to take into account these user characteristics and all environmental factors that may hinder or mask its ready perception. (p. 27)

Corresponding with the physical properties of a JPA that provide for stimulation, the literature also addressed the user's cognitive processes in regards to message design and the use of JPAs. Winn (1993), based on his research on perception principles for message design, wrote that there were two phases of perception of which the designer should be aware: (1) the preattentive perceptual process which was not under cognitive control, and (2) the attentive selection process which was under cognitive control. Winn's findings were based on the research of David Marr. Marr (1982) found that as the neurophysiological processes on the retinal image took place, the images began to be organized by means of edge detection. Marr emphasized in his theory of vision the importance of edge-detection. He found that scenes were initially reduced to patterns of edges that formed what he termed primitives. Winn (1993) proposed that if the edges were not clear, neither would the formation of primitives be clear, and perceptual organization would not lead to well-structured and interpretable messages. Marr (1982) found that this initial process was not capable of control or able to be altered, and as a result, the early perceptual process was not under the control of the viewer's attention.

Winn (1993) wrote that once people became aware of what they were seeing, the process of focused attention took place. Winn also reported that an important change took place when percepts become available to conscious attention which provides important considerations for the JPA designer. Winn (1993) stated in regards to conscious attention:

> What we already know, what we expect to see, our various mental abilities and "perceptual" styles begin to influence our interpretation of the information before us. The interface between perception and cognition, thus created, is bi-directional; it operates top-down and bottom-up, in a way described by Neisser (1976). Our existing knowledge leads us to anticipate, top-down, what we see or hear in the data before us. Our anticipatory schemata guide our scrutiny of the data, which influence in turn, bottom-up, what we look for next. (p. 66)

Additionally, Winn (1993) maintained that "attention is drawn to the parts of a message that stand in contrast to the others. Such contrasts can exist in just about every aspect of the message's content, organization, and modality" (p. 67). Sanders and McCormick (1987) referred to this process as selective attention. The process of selective attention becomes a critical factor in message design for effective JPAs for HRHR systems which typically involve multiple and complex tasks and conditions of high stress. The designer must compensate for this human tendency of selective attention by providing sufficient stimulation for the appropriate elements of the JPA that are required at some specific point in time or sequence of events. Sanders and McCormick (1987) reported the following on the affects of selective attention:

> Selective attention requires the monitoring of several channels (or sources) of information to perform a single task. . . . When people have to sample multiple channels of information, they tend to sample channels in which the signals occur very frequently rather than those in which signals appear infrequently. Due to limitations in human memory, people often forget to sample a source when many sources are present, and people tend to sample sources more often than would be necessary if they remembered the status of the source when it was last sampled (Moray, 1981). Under conditions of high stress, fewer sources are sampled and the sources that are sampled tend to be those perceived as being the most important and salient (Wickens, 1984). (p. 65)

Snow and Newby (1989) maintained that the "perception of job aids can be enhanced in several ways" (p. 28). They reported that research by Kantowitz and Sorkin (1983) indicated that visual search times were reduced by 50% – 70% by the use of color coding. Additionally, Snow and Newby (1989) recommended that visual contrast between items displayed on a JPA could be heightened by shape and/or by color which facilitated perception of critical information.

Visual information structure. The literature indicated that one of the most effective ways to positively incorporate the influence of the pre-attentive and selective attentive perceptual processes into message design was by means of visual information structure (Keyes, 1993). Although the literature from the field of instructional technology primarily addressed the improvement of training materials by use of structured text design and visual information structure design, many of the principles and research findings were applicable to the design of JPAs.

Streit, Stern, and Collins (1986) wrote in an article which addressed structured text design that structure "is a process of writing that 'structures' the subject matter of the document into a format that guides the user with graphics and words" (p. 10). William Baker, a communication specialist, reported on the findings of a number of research studies that addressed the benefits of communicating with structured text. Baker (1994) wrote:

> Because research shows that well-structured expository writing produces better reader comprehension than does poorly organized writing, careful steps should be taken to help ensure good structure, particularly in long documents. . . . With a solid macrostructure as a foundation, writers can then use several cohesion techniques to help readers recognize this structure and thus increase the effectiveness of the overall communication. (p. 465)

The macrostructure called for by Baker referred to the application of hierarchical arrangements of the information to assist the reader to create a mental map. Baker (1994) argued, "Armed with a map or schema, of the text, readers know where the text is taking them and where in their own mental construct to place each new bit of information they encounter" (p. 462). Winn (1993) maintained that information is processed and remembered in chunks that are organized hierarchically and that message structure determines how chunks are formed and thus influences how memory for the content is organized (p. 71). The literature reflected that it was the structure and organization that made up the visual information structure which provided for a high-level framework that supported the reader's task of orientation, navigation, overview, comprehension, recall, and reference (Duchastel, 1985; Rude, 1988; Waller, 1982).

Additionally, it is argued that the use of visual information structure provides a link to systems theory. Richey (1986) discussed specific applications of system theory and wrote that system theory was based upon the notion that much of the world is ordered and rational; additionally Richey argued that there was a basic human belief in the value of order.

Mary Vroman Battle (1994), a communication specialist, made an argument for incorporating the skills of "knowledge engineers" into the development of technical communications (p. 81). JPAs in HRHR systems are technical documents and JPA development falls within the realm of technical communications. Battle (1994) maintained that technical communicators must break complex processes down into discrete components by analyzing masses of technical data and organizing the components into a logically sequenced arrangement. Battle's call for knowledge engineering skills provided for another link to the incorporation of systems theory into JPA design by means of breaking the whole into parts and organizing the parts into a logical sequence by means of visual information structure.

The literature reflected that the overall concept of visual information structure incorporated many of the principles of message design including typography, use of color, signaling, advanced organizers, graphics, and format (e. g. , Baker, 1994; Duffy & Waller, 1985; Fleming & Levie, 1993; Keyes, 1993; Streit et al., 1986; Winn, 1976).

Since it was found that many JPAs used within HRHR systems did not consist of short or abbreviated job aids such as aircraft checklists or trouble shooting guides but consisted of lengthy documents, such as policy and procedure manuals, the literature led to the conclusion that the JPA designer must incorporate the principles of message design in conjunction with systems thinking and visual information structure.

Display factors. A major task facing the JPA designer is the determination of the media used to display or convey JPA information. In some cases the selection of display media is left to the discretion of the designer such as when a job performance analysis indicates a need to develop a JPA. In other cases, such as when the JPA designer is tasked to develop an electronic checklist for an aircraft manufacturer, the display media is predetermined and it becomes the task for the designer to maximize the JPA information display. In either case, the effectiveness of the display is a result of incorporating human information processing factors.

Sanders and McCormick (1987) addressed the criticality of information processing for displaying information from the human factors perspective as they wrote:

> Human information input and processing operations depend, of course, on the sensory reception of relevant external stimuli. It is these stimuli that contain the information we process. . . . Typically, the original source (i. e. , the *distal* stimulus) is some object, event, or environmental condition. Information from these original sources may come to us *directly* (such as by *direct* observation of an airplane), or it may come to us *indirectly* through some intervening mechanism or device. . . . In the case of *indirect* sensing, the *new* distal stimuli may be of two types. First, they may be *coded* stimuli, such as visual or auditory displays. Second, they may be *reproduced* stimuli, such as those presented by TV, radio, or photographs. . . . The human factors aspect of design enters into this process in those circumstances in which *indirect* sensing applies, for it is in these circumstances that the designer can design displays for people. (pp. 46 – 47)

Chechile, Eggleston, Fleischman, and Sasseville (1989), human factor specialists, defined a major problem for designers in their research on the influence of cognitive quality of displays as they found:

> The problem of the human factors of display design is particularly crucial in work environments where the viewers (such as pilots or process control operators) are making decisions based on displayed information. . . . The higher order information content of the display, which determines the "cognitive quality" of the format, is generally assessed later in the detail design of system development. . . . We believe that cognitive quality is perhaps the most important level of analysis in considering the human engineering of a display. (pp. 31–32)

Sanders and McCormick (1987) defined two general types of information presented by displays which affected cognitive quality: (a) dynamic information, and (b) static information. Sanders and McCormick (1987) defined dynamic and static information as follows:

> We often speak of the display as being dynamic or static, although it is really the information that has the quality. Dynamic information continually changes or is subject to change through time. Examples include traffic lights that change from red to green, speedometers, radar displays, and temperature gauges. In turn, static information remains fixed over a period of time (or at least for a time). Examples include printed, written, and other forms of alphanumeric data; traffic signs; charts; graphs; and labels. (p. 48)

Sanders and McCormick also discussed the characteristics of computer displays and proposed that the distinction between dynamic and static information was easily blurred with computer displays; however, they maintained that even if static information was presented on a computer screen and replaced by other information, most of the information remained static. Sanders and McCormick (1987) maintained, "That is, the specific information does not itself change but rather can be replaced by other information" (p. 48).

Additionally, although Sanders and McCormick proposed that information could be generally classified as dynamic or static; they also described a detailed classification of information. The findings of Sanders and McCormick led to the conclusion that information classification was important to the development of the conceptual model. Their information classifications provide major considerations for the development of a conceptual model as the classifications present a "verbal description of a view of reality," and are "relevant and fully defined" as called for by Richey as criteria for a conceptual model (1986, p. 17). Table 1 presents the detailed classifications of information and a description of each classification.

Table 1

A Detailed Classification of Types and Display of Information

Classification	Description of Display Information
Quantitative	Reflects quantitative value of some variable, such as temperature or speed. In most instances the variable is dynamic as it is continually changing or subject to change.
Qualitative	Reflects approximate value, trend, rate of change, direction of change, or some other aspect of some changeable variable. Usually predicated on quantitative parameter but is used as more of an indication of a change in the parameter than for obtaining quantitative value.
Status	Reflects the condition or status of a system, such as on-off indications, or indications of one of a limited number of conditions, such as stop-caution-go lights.
Warning/signal	Indicates an emergency or unsafe condition, or to indicate the presence or absence of some object or condition. Information of this type can be dynamic or static.
Representational	Pictorial or graphic representations of objects, areas, or other configurations. Certain displays may present dynamic images (such as TV or movies) or symbolic representations such as blips on a radar screen. Others may display static information such as maps, charts, and diagrams.
Identification	Used to identify some (usually) static condition, situation, or object such as the identification of hazards.
Alphanumeric and Symbolic	Depicts verbal, numeric, and related coded information in many forms (e. g. , signs, labels, placards, instructions, printed and typed material, and computer printouts). Typically information is static.
Time-phased	Depicts pulsed or time-phased signals (e. g. , signals controlled in terms of duration such as Morse code).

Note. Adapted from Human Factors in Engineering and Design (p. 49), by M. S. Sanders and E. J. McCormick, 1987, New York: McGraw-Hill Book Company.

Automated Decision Aids and Expert Systems

Today within HRHR systems, JPAs also include the use of automated decision aids, and expert systems (Mosier & Skitka, in press). Such systems within the aviation industry include electronic aircraft checklists, aircraft flight management systems, the Air Traffic Control Advanced Automation System, and the all-electronic cockpit which is referred to as the glass cockpit. Consequently, the JPA developer is now faced with new emerging design problems that center on new technologies that involve changes in the human-machine interface (Patrick, 1987). Kathleen Mosier and Linda Skitka (in press), human factor specialists, wrote:

> The advantage of automated decision aids and expert systems in terms of increased efficiency and data monitoring and analysis capabilities are fairly obvious. Computers can process more and faster than humans. Ideally, the combination of human decision maker+automated decision aid should result in a high-performing team, maximizing the advantages of additional cognitive and observational power in the decision-making process. Thus far, however, the union between human decision makers and automated systems has been less than idyllic.

Perhaps one of the most comprehensive reviews of research and literature on the status of automated decision aids and expert systems within HRHR systems was completed by Kathleen Mosier, a senior research scientist, for the National Aeronautics and Space Administration (NASA), Ames Research Center. Mosier (Mosier, in press) explored research findings and "myths" about automated decision aids and expert systems. Her examination pointed to a number of factors of which the JPA designer should consider.

Mosier (in press) found that there were a number of potential negative consequences associated with the implementation of automated decision aids such as over or under reliance on the aid, confusion over or inefficient use of automated aids, misrepresentation of information due to the aid being designed with an inappropriate model of expertise, inadequate training or lack of familiarity, and misunderstanding of the design intent. Mosier (in press) wrote:

> The process of expert systems and automated decision aids, then, do not always correspond to those of real-world experts in complex domains, but rather are limited to the context-limited, rule based reasoning that Dreyfus and Dreyfus (1986) have described as the "novice" stage of expertise development.

Mosier, Palmer, and Degani (1992) conducted a field study into the factors affecting the successful and unsuccessful use of airline cockpit checklists. The study examined the factors affecting the successful and unsuccessful use of both a paper checklist and an electronic checklist. Although they found that the electronic checklist reduced the time to perform and signaled the specific item of the checklist in progress, Mosier, Palmer, and Degani (1992) found that the electronic checklist "may introduce new errors by virtue of its automaticity and the fact that crews rely on the checklist as an indicator of system state rather than as a procedural aid" (p. 7).

The implications based on the Mosier, Palmer, and Degani study for JPA design point to what the researchers termed salience which was the effect of the most obvious cues biasing the operator towards processing its diagnostic information content over other stimuli. The authors cited the work of Stokes, Barnett, and Wickens (1987) which found that time pressure, stress, or information overload could cause perceptual tunneling that caused the operator to focus on salient cues.

The literature reflected that if the JPA was going to encompass automated or expert systems, then the design must include the factors of salience, a real world model of expertise, user environment, and workload. The analysis of the literature led to the conclusion that these factors could be addressed by defining the functional characteristics of the JPA as described by Swezey (1987) and previously referenced in Chapter II of this study.

To review, the functional characteristics of a JPA were defined as "the operations that an aid must perform in order to accomplish the required improvement" (Swezey, 1987, p. 1051). Functional characteristics describe what the aid must do in respect to a task, not how to perform the task.

Blanchard, Smillie, and Conner (1984) reported on the results of a U. S. Navy program that provided an example of functional characteristics. The program known as the enlisted personnel individualized career system (EPICS) was used as a method to individualize the careers of enlisted personnel by distributing onshore training throughout a six year enlistment period rather than being conducted prior to the first shipboard duty assignment. The EPICS program featured the intensive use of JPAs to substitute for deferred training. The functional characteristics of the JPAs designed for EPICS included a means to address troubleshooting tasks to inexperienced technicians and facilitate their transition between directive and deductive JPA formats.

The literature pointed to the need to determine and accurately define the purpose of the JPA or its functional characteristics. Such determination can set the stage for the designer in regards to automated or expert system JPAs by focusing on what the JPA is intended to do. For example: is the automated JPA or expert system JPA's intent to provide quantitative information that depicts total flight time remaining based on fuel onboard, power settings, altitude, etc.; or is the intent of the JPA to provide warning/signal information and recommended emergency procedures in the event of a potential system malfunction?

The capability for a JPA to successfully serve as a system link between performance and training was demonstrated by the U. S. Navy's program EPICS. Additionally, the literature also indicated that the intent of the JPA (its functional characteristics), the limitations of the JPA, and the rationale for its use within HRHR systems must be provided through training.

The Role of Training in JPA Design

Although the literature reflected that training is not normally considered an actual component of traditional JPA design, the literature that involved HRHR systems emphasized the importance of training in order for a JPA to be effective. Consequently, the literature led to the conclusion that the JPA designer be able to provide key information to be used in training which included the functional characteristics of the JPA, the capabilities and limitations of the JPA, and rationale behind the development of the JPA.

Donald Bullock (1982) in his article on guiding performance with job aids discussed the relationship between job aids and training. Bullock maintained that this relationship affected job aid design in two ways. The first way was the reduction in the need and the cost of training; however, Bullock cautioned that there was a risk of making a job aid too unwieldy for effective use and it was necessary for the designer to strike a balance between how much information goes into the job aid and how much goes into training.

Bullock's second point was one that more fully fit design considerations for JPAs used in HRHR systems. Bullock (1982) wrote:

> Job aids require certain skills and knowledge. One must interpret the content and must have the skills needed to perform the guided actions or decisions. Generally, this means that to apply the job aid, the user will have to be trained in its use. Thus, a second issue is how much training will be needed for one to learn to apply a job aid beyond the training needed for things not included in the job aid. (pp. 39 – 40)

Kathleen Mosier provided a further argument on the need for training in regards to the implementation of JPAs consisting of automated decision aids or expert systems. Mosier (in press) wrote:

> . . . the importance of comprehensive training for system users cannot be overemphasized. Operators must have sufficient knowledge of what an automated system can do, what it "knows," and how it functions within the context of other systems, as well as knowledge of its limitations, in order to utilize it efficiently and exploit its real capabilities.

Walter Schneider(1985), in an article for the human factors community, examined various fallacies and guidelines for training high-performance skills. Schneider pointed out that training high-performance skills normally consisted of short-term training programs and long-term training programs and that certain assumptions that worked well in short-term training programs may be fallacious when extended to long-term training programs. Schneider (1985) wrote, "The training-program designer needs to understand the assumptions underlying each given training procedure" (p. 298).

JPAs within HRHR systems are intended to aid task performance that in many cases require high-performance skills, and Schneider's guidelines indicated that the assumptions which underlie the various design strategies used in the JPA design were key ingredients for effective training on the use of the JPA.

A potential fail point for the use of JPAs, based on assumptions, identified in the literature was a deviation between the operator's action logic and the action logic of the designer (Herry, 1987). In order to overcome this deviation, Herry (1987) argued that it was necessary to match the operator's mental representation of the process with the expert who devised the instructions. The need for training was inferred by Herry (1987) as he argued, "Deviations between work methods would therefore result not only from a lack of theoretical knowledge, but also from the implementation of action organization properties unsuited to understanding the bases of prescribed instructions" (p. 245). Herry maintained that it was necessary for the operator to know the relations between the various variables within the system as he found that most operators refused to "apply the prescribed instructions without a knowledge of their basis" (p. 241).

Herry's conclusions were substantiated by Zeitlin (1994), As previously reviewed, Zeitlin found that the user's subjective assessment of risk, attitude, and past experience often led to a deviation from safety instructions. Zeitlin argued that a motivational rationale for following instructions be presented to the user. Consequently, it is argued that the rationale behind the development of a JPA becomes an important factor in training on the use of the JPA and in JPA design.

Angie Tilaro and Allison Rossett, instructional technologists, integrated the Keller ARCS model of motivational design (see Keller, 1987) into designing motivational job aids (Tilaro & Rossett, 1993). It is suggested that the two of the four components which comprise the ARCS model (Attention, Relevance, Confidence, and Satisfaction) supported the conclusions of Herry and Zeitlin. These components are relevance and confidence.

Tilaro and Rossett (1993) described the application of the relevance component to JPA design by posing the question: "How can I link the goals of the job aid to employees' priorities and goals?" (p. 14) Additionally, Tilaro and Rossett (1993) applied the confidence component by asking: "How can I influence employees' perceptions that using the job aid will help them succeed at performing the task?" (p. 14)

Grau (1986) further substantiated the influence of relevance and confidence as components of training on the use of a JPA as he stated:

> The reliability of the job aid will—if properly explained—increase the worker's confidence of success and the amount of effort they are willing to invest in attempting the task. . . . the job aid must be introduced to users in a manner that stresses the importance of performance. (pp. 10 – 11)

Other training considerations identified in the literature review were the influence of "misguided notions" which Will (1991) described as the assumptions expert operators made about what their automated system can and cannot be expected to do, and the influence of misconceptions which Mosier (in press) described as "myths" that system users and designers may fall prey to concerning the nature and function of automated aids

The literature reflected a number of recommendations for training content to effectively implement a JPA into a HRHR system. As such, it is argued that JPAs can serve as an effective systems link between performance and training; however, it is also argued that for the link to occur, the JPA designer must define, describe, and provide specific training factors.

Furthermore, it is argued that the process of addressing these factors will enhance the overall design project by forcing the designer to incorporate these factors into the JPA design process. Based upon the literature review, the training factors identified included:

1. The functional characteristics and purpose of the JPA.
2. The capabilities and limitations of the JPA.
3. The user's performance skill requirements.
4. The knowledge base necessary for the user to understand the relationships between the JPA and the HRHR system's components.
5. The underlying assumptions of the designer and the user to include misguided notions and misconceptions.
6. The rationale that supports the need for and use of the JPA to include the factors of relevance and confidence.

The Role of Evaluation in JPA Design

James Moseley and Steven Larson (1992) described the need for evaluation of JPAs from an instructional technology perspective as they wrote:

> Evaluation is a fundamental part of the instructional design process. A job performance aid is certainly not the same as a workbook, CBT [computer-based-training] program, or stand-up presentation. Yet a job performance aid must be subject to the same standards and design principles as any other performance or instruction intervention. (p. 24).

Geis and Smith (1992), performance technologists, defined evaluation as the process by which the adequacy of effort was judged and they explained it was done to provide information about and influence a decision that must be made about the thing or process being evaluated.

Within HRHR systems, the evaluation of JPAs can have serious consequences if the evaluation is not conducted effectively. Flight Safety Foundation (FSF ICARUS Committee, 1996) argued that one of the most powerful tools for safety available to airline management was an honest and critical self-assessment. The Foundation's assessment process, called Project ICARUS, included the assessment of the various JPAs used within the airline.

Michael Scriven, a well known and respected evaluation expert, made a similar point regarding such consequences in his article on product evaluation which was appropriate to JPA evaluation. Scriven (1994) maintained, "Product evaluation is important for several reasons. The obvious one, which makes it sometimes a life-saving matter, arises because our lives, and the quality of those lives, depend on the evaluation. . . " (p. 45). Additionally, Scriven (1994) explained that the general formula for evaluation was to "identify and validate criteria of merit, determine performance on those criteria, and combine the two according to some valid principle of integration" (p. 47).

Snow and Newby (1989) stressed the importance of evaluation in regards to the implementation of JPAs as they wrote:

> A final step before implementation of the job aid should be a pilot test of a draft with the population who will actually be using it, under actual task conditions. . . . Appropriate testing of a job aid is crucial to its success, and cannot be over emphasized. (p. 29).

JPA evaluation criteria. The literature from the fields of instructional technology and human factors pointed to a number of factors for evaluating JPAs (see Table 2).

Moseley and Larson (1992) suggested a set of standards for evaluating a JPA using the following evaluation components: (a) analysis, (b) synthesis to information, (c) format, (d) job aid design, (e) evaluation, and (f) effectiveness.

Bullock (1982) identified a number of design factors to evaluate that included: (a) the match of the JPA to the work situation; (b) the identification of the characteristics of target job performance; (c) The suitability of the JPA with applicable equipment, tools, and systems; (d) training requirements for JPA use; and (e) organizational effects of implementation. Carlisle and Coulter (1990) added the factors of accessibility and durability partially based on the work of Bullock. Additionally, Grau (1986) expressed the importance of JPA information accuracy and reliability.

Duncan (1985) reported that the research conducted H. R. Booher for the U. S. Navy Personnel Research and Development Center in 1978 reflected that timely and accurate production, distribution, and updating of JPAs were the greatest weaknesses of job aid technology. The need for accuracy, effective implementation, and revision of JPAs were supported by the publications by Degani and Wiener(1994b), the Flight Safety Foundation (Gross, 1995), Fuller (Fuller, 1994), and Tilaro and Rossett (Tilaro & Rossett, 1993).

Swezey (1987) maintained that the criteria against which JPAs should be evaluated included comprehensiveness, degree of prescription, reliability and validity, user options, and cost. Additionally, Smillie (1985) contended that the merit of a JPA was based on technical content, why a particular JPA was useful, the validity of the data source used to generate the JPA, and the logic used to produce the JPA. Table 2 depicts JPA evaluation criteria based on the literature review and the table uses Moseley and Larson's (1992) six basic evaluation components plus the component of training as the major evaluation criteria.

Types of evaluation. There were three types of evaluation discussed in the instructional technology literature: (a) formative, (b) summative, and (c) confirmative (Hellebrandt & Russell, 1993). The research literature reflected that each type of evaluation judged the worth of similar things which included processes, products, and programs; however, each type served a different purpose and each was conducted at a specific time.

Human factor literature also emphasized the role of evaluation; however, the human factor arena referred to two types of evaluation: the developmental test and the operational test (Meister, 1987). The human factor developmental test was described as a similar process to the formative evaluation as used in instructional technology. Each process was used to determine weaknesses of that being evaluated to provide prescription for revision. The human factor operational test was described in a similar fashion to the instructional technology summative evaluation. Each process, conducted after design completion, was used to document strengths and weaknesses of that being evaluated in order to make a decision on adoption. (see Dick & Carey, 1996; Meister, 1987).

The analysis of the literature led to the conclusion that the three types of evaluation used in the field of instructional technology were the most appropriate elements to an evaluation component for the conceptual JPA design model.

Table 2

JPA Evaluation Criteria: Based on Literature Review

Criteria	Adapted From	Description
Analysis Factors	Moseley & Larson (1992)	Analysis of audience, environment, job, and organization.
Target Population	Dick & Carey (1996) Swezey (1987) Smillie (1985)	Confirm accuracy of analysis of user characteristics and determination of level of user.
Task Analysis	Stewart, Roebber, & Bosart (1997) Ryder & Redding (1993) Rossett (1992) Pipe (1992) Winn (1990) Swezey (1987)	Validate functional characteristics of JPA. Confirm analysis of task properties to include task elements for optimal performance in work environment. Assess appropriateness model-of-expertise used to present tasks. Assess fit of users' information processing strategies with JPA display. Identify unexpected outcomes.
Synthesis Factors	Moseley & Larson (1992)	Review JPA against job tasks, the users, the desired performance, the work environment, and the organization.
Procedures	Fuller (1994) Gross (1995)	Confirm accuracy of procedures used and regulatory compliance of procedures.
Organization	Degani & Wiener (1994)	Assess match of JPA with management philosophy and policy.
JPA Implementation	Tilaro & Rossett (1993)	Review and coordinate JPA implementation with management.
Format Factors	Moseley & Larson (1992)	Assess fit of JPA format to desired task performance in task environment.
Type of JPA	Rossett & Gautier-Downes (1991) Bullock (1982)	Assess selection of kind of JPA and match of JPA with work site.
Physical Characteristics	Swezey (1987)	Assess physical design characteristics to meet functions of JPA.

(table continued)

Table 2

JPA Evaluation Criteria: Based on Literature Review

Criteria	Adapted From	Description
Strategy	Smillie (1985)	Assess whether directive, deductive, or hybrid strategy is effectively integrated.
Display	Sanders & McCormick (1987)	Determine that display media meets functional requirement of JPA.
Design Factors	Moseley & Larson (1992)	Assess that effective message design standards are utilized in JPA display. Assess if JPA can be used in work setting.
Content	Mosier (in press) Chechile, Eggleston, Fleischman, & Sasseville (1989)	Confirm validity of information presented. Determine potential negative consequences to include misrepresentation of information or inappropriate use of JPA.
Message Design	Baker (1994) Duffy (1985) Fleming (1993) Keyes (1993) Streit (1986) Winn (1976)	Assess effective application of message design principles for type of JPA display to include typography, color, signaling, graphics, format, etc.
Motivation	Keller & Burkman (1993) Grau (1986)	Assess that JPA reflects a probability of success in users' performance, interests, and confidence.
Perception	Foley & Moray (1987) Winn (1993) Snow & Newby (1989) Stokes, Barnett, & Wickens (1987) Sanders & McCormick (1987)	Confirm that JPA is accessible and readable in work environment. Assess perceptual stimulation of JPA in work conditions. Assess influence of time, stress, and information overload on user during JPA use.
Visual Structure	Keyes (1993) Swezey (1987)	Assess visual layout of JPA display for organization and required information hierarchy.
Evaluation Factors	Moseley & Larson (1992) Swezey (1987)	Review testing procedures and validate that revisions were incorporated. Review training requirements. Field test with prototypes.
Effectiveness Factors	Moseley & Larson (1992)	Assess user performance under actual work conditions.

(table continued)

Table 2

JPA Evaluation Criteria: Based on Literature Review

Criteria	Adapted From	Description
Training Factors	Bullock (1982)	Assess balance between information presented in JPA and information presented in training. Confirm that users have necessary skills to perform task.
Rationale	Zeitlin (1994) Grau (1986)	Confirm that rationale and reliability of JPA is presented.
Relevance and Confidence	Tilaro & Rossett (1993)	Validate that relevance of JPA is presented to enhance user confidence.
Limitations	Mosier (in press) Herry (1987)	Confirm that capabilities and limitations of JPA are presented and validate that relationships between system variables are explained.

Although the types of evaluation identified in each field, with the exception of the confirmative evaluation, are similar in nature, it is argued that the evaluation processes described in the field of instructional technology more closely fit the needs of JPA design as: (a) JPAs are instructional in nature as they are repositories for information, processes, or perspectives (Rossett & Gautier-Downes, 1991); (b) the literature reflected that training (instruction) should be an integral component of JPA design (Bullock, 1982), and (c) JPA design effectiveness can be greatly enhanced by the application of principles found within the domain of evaluation as defined by Seels and Richey (1994).

Additionally, Jensen, Lau, Mills, and O'Kane (1982) referenced the value of formative and summative evaluation in their research report on pilot judgment training and evaluation conducted for the Federal Aviation Administration. Jensen et al. (1982) wrote:

> One may, and should, evaluate a program at several stages. If one evaluates at intermediate stages while changes can be made in the program it is called process or formative evaluation. Evaluation at the completion of the program is referred to as summative evaluation. (p. 37)

Formative evaluation. Dick and Carey (1996) defined formative evaluation as a "process designers use to obtain data that can be used to revise instruction to make it more efficient and effective" (p. 257). Tessmer (1994) explained that formative evaluation has long been used for instructional improvement and that the practice of evaluating draft versions of instructional materials started as early as the 1920s and was still very much part of the instructional design process. Hellebrandt and Russell (1993) explained that formative evaluation was normally conducted by the developer and that if design expectations are not met, it is the materials and not the users that are at fault.

Tessmer (1994) provided a detailed description of the methods used to conduct a formative evaluation that included expert review, one-to-one evaluation, small group evaluation, and field trials. Additionally, Tessmer (1994, p. 6) suggested alternative techniques that included dyadic evaluation, think-aloud protocol, computer interviewing, self evaluation, panel review, and rapid prototyping.

Summative evaluation. Hellebrandt and Russell (1993) wrote that summative evaluation is done after the materials have been developed and under conditions similar to those in which they will actually be used.

Dick and Carey (1996) explained that summative evaluation involved two phases: the expert judgment phase and a field trial phase. They described that the expert judgment phase involved the use of subject-matter-experts to determine whether the process, product, or program met the organization's defined needs, and that the field trial phase documented adequacy and effectiveness with a target group in the intended setting.

The literature also reflected that the methods used to conduct a summative evaluation incorporated the techniques used in formative evaluation; however, the summative evaluation provided data to make overall decisions on whether the completed design was effective in solving the performance problem.

Confirmative evaluation. Hellebrandt and Russell (1993) defined confirmative evaluation as, "the process of collecting, examining, and interpreting data and information in order to determine the continuing competence of learners or the continuing effectiveness of instructional materials" (p. 22). As applied to JPAs within HRHR systems, the confirmative evaluation is a critical process necessary to maintain technical accuracy and regulatory compliance.

Adamski and Doyle (1995) wrote that the Federal Aviation Administration (FAA) employs the process of surveillance, which is akin to confirmative evaluation, to conduct evaluations which are used to assess airline compliance with the Federal Aviation Regulations.

As many JPAs within HRHR systems fall under regulatory requirements, the aviation literature reflected the need to consistently evaluate the applicable JPAs for compliance with government requirements and equipment manufacturer requirements after the JPAs are in the field (see Degani & Wiener, 1994b; FSF ICARUS Committee, 1996; Gross, 1995; Turner et al., 1991).

Design Considerations: SME Interviews

The initial interviews with a panel of subject-matter experts (SMEs) provided additional information contributing to the development of a conceptual model (see Appendix D for the complete interviews). The following considerations for the development of a conceptual design model were based upon the interviews and are presented in the sequence of the questions that made up the initial interview. Although the interviews followed a predetermined set of core questions as presented in Chapter II, the SMEs were encouraged to augment their responses and discuss points that they felt relevant. The quoted SME responses are referenced only by the SME's last name as each SME is referenced in the fully transcribed and coded interviews which are presented in Appendix D.

Factors Identified

The factors that emerged during the interviews were categorized into the following topics: (a) model outcomes, (b) model linearity, (c) decision-making considerations, (d) JPA effectiveness, (e) model components and characteristics, (f) information processing factors, (g) performance time considerations, (h) the use of visual and textual displays, (i) training, (j), evaluation, and (k) anticipated problems.

Model Outcomes

Dick emphasized the need to differentiate between the traditional JPA and an electronic performance support tool and the he stressed the importance of identifying the performance needs. His responses on the topic of model outcomes included the statements:

> I think we're making a distinction between a traditional job aid an electronic performance support tool. If we are, the support tool has a broader range of characteristics including: kind of a media tool, or along with information on the tool, to training on the tool, to an information base that people can draw on. That's — that's one sort of grand job aid.
>
> . . . An extensive front end on the model which results in a clear indication of what the need is, what the gap is, and describes the environment in which the solution is going to have to operate, and some of the characteristics of what the tool is, what are the characteristics going to have to be in order for it to work effectively. . .

Dessinger spoke of a model as a means to focus on goals and objectives of JPA design, and she suggested that verification for the need of a JPA be an outcome of the conceptual model. Dessinger stated:

> It should help them focus on . . . keep their goals and objectives in mind as they go through designing it. . . to help them to focus on exactly why they are doing the job aid and what outcomes they expect. . . . I would think verification that a job aid is required. . .

Rowland addressed potential problems of a JPA conceptual design model. His concerns centered on the potential dire consequences of ineffective JPA design for HRHR systems and the possibility of a design model giving a designer a sense overconfidence in the model. Rowland suggested that the model caution the designer as he stated:

> You wouldn't want a model of your own creation here to give the designer overconfidence in any sense. . . So maybe it's going to be a heuristic device to get them thinking about various elements. . . things like that. But it's also got to be itself a reminder that "do not trust this model." Do not trust the user's ability to do this. You just can't overplay the criticality here.

Dessinger also spoke of the potential consequences of ineffective design as she stated:

> The problem is your outcome which is tasks or procedures that have dire consequences. . . if the job aid is not produced correctly. . .

Rowland also emphasized the need for a JPA model to stress reliability and clarity in the design of JPAs used in HRHR systems as he suggested that the JPA mirrors desired performance. Additionally he indicated the need for training of the JPA user.

The SMEs from the field of human factors addressed similar considerations for the conceptual model's outcomes. Altman suggested an outcome that centered on providing guidance by means of a JPA that effectively presented procedures in an aircraft emergency situation. He envisioned a design model to:

> Assist the user, like me, in coming up with an aid to provide the crew in an aircraft situation — looking at that as being a critical situation so that we could be more effective in the procedures necessary for a particular emergency scenario.

Mosier suggested that a model provide a means to identify and prioritize goals. Additionally, she stated that a model should lead a designer to define the purpose of the JPA in regards to its intended use, the user's expertise, and information requirements. Westrum perhaps provided the best summary of the potential outcome of a conceptual JPA design model as he stated:

> The key point is if you have a model you are going to do a better job of designing a job aid because we'll have some idea of what the key questions are and what the issues are in terms of putting the thing together. Without such a model, often you are using common sense principles instead of realistic, scientific principles.

The SME representing the field of graphics design spoke of consistency. Miller saw a conceptual JPA design model providing "some tried and true steps. . . point A, point B, point C to follow in order to continually and consistently repeat an effective model."

Discussion. Each of the SMEs addressed the outcomes of a JPA conceptual design model in terms of the model's purpose. The SMEs, regardless of their respective fields, collectively addressed the necessity to depict in the model a process to identify the purpose of the JPA, provide a means to focus on the goals and objectives of the JPA, and provide for consistent accuracy.

The point made by Rowland regarding overconfidence was one that was not addressed in the literature and his argument suggested that some type of caution be included in the completed model for the designer. Overall, the outcomes the SMEs identified were of a similar nature to the role of functional characteristics as discussed in the literature review. The analysis of the SMEs interviews reinforced the need for the JPA conceptual design model to provide a means to: (a) identify and clarify the purpose of the intended JPA,

(b) establish the goals and objectives of the design, (c) provide a process for design and development, and (d) provide a process to assure reliability, accuracy, and consistency.

Model Linearity

An issue that is debated by those who develop models concerns linearity. The question is should a model reflect its process in a step-by-step linear method, or should a model reflect its process in a recursive manner, or a combination of both? In regards to this topic, the SMEs differed.

The SMEs from the field of instructional technology stated:

> I would think of steps. I think people ultimately are linear serial processors, we do one thing at a time. We aren't multi-processors even though computers are. Ultimately, we may go back and do some things over again, and we may jump ahead in a model, but our actions are essentially linear and you can reflect the jump ahead and moving back in any model if you want to. (Dick)
>
> I kind of like the models that are linear and yet allow the user to move in and out of the various components. Maybe not at the beginning when they are first beginning to use it but because this is a situation where the outcomes can be dire. I think linear models are probably the best but even in that case a well trained expert user would need to be able to move in and out of the model — have some flexibility where a novice user would definitely need a very linear model. (Dessinger)
>
> So maybe that's a case where the linearity — if it helps somebody just to remind them of what's happening. For example: I think Walt's model is easier to use when you think about as what are you going to fire off on when — not necessarily you engage in those steps in sequence but you are going to fix your objectives before you fix your strategy — that kind of thing. (Rowland)
>
> The SMEs from the field of human factors stated:
>
> I believe that one step needs to be made before the next step is taken. In other words you need to know that I've accomplished one level successfully before you go to the next level. (Altman)
>
> . . . and I would think that whatever you come up with would have to not just be linear but would have to have some way of going back and iterating and perfecting or getting more information or re-prioritizing in the face of changing environments or whatever. (Mosier)
>
> I think the basic point is that the single linear model is probably not going to work because the features that are involved in the model interact in non-linear ways; for instance, you might have step functions and so forth or certain variables are present — variables will behave in a very different kind of way so it's hard to throw all this stuff together in an equation. I think a phrase you use is systematic and I think that's the key element and that is how all these things interact to shape the way the model is going to work. . . . You often have to go back and forth between the job aid and user and so forth and try to use feedback from the users to make the job aid better. But there may not be a single linear process that you go through and do this, in fact,

I don't think that's a very good idea, that linear process. (Westrum)

The SME representing the field of professional graphic design suggested a step-by-step model that allowed for change:

> I do in the sense of recreating it. It's not that there's not systemic areas that [in] one model that's not cast in stone. I mean it's a good model as a starting point and for many situations it can be repeated, but it should be ever evolving, depending upon feedback. (Miller)

Discussion. The points made by the SMEs led to the conclusion that some models, such as a procedural model, should primarily present a linear process, but at the same time be capable of providing a means to go back and evaluate what has been done. The literature and the SME interviews supported the view that a conceptual model should be of an iterative nature and provide design flexibility that is dependent on the expertise of the designer.

Decision-Making Considerations

Each of the SMEs agreed that JPAs influence decision making. Rowland made the point regarding human performance that "any stimulus in the environment is going to be of influence, particularly one that is designed in such a way to influence that performance." Westrum stated that one could build into a job aid suggested places to look for information, provide alternative courses of action and assist the user in selecting the best alternative.

Dick and Mosier made similar points regarding decision design strategy. Dick stated that "the strategy used in the job aid can either be visible or invisible to the user." Mosier spoke of transparency which her research has shown to be a major design consideration in developing automated decision aids. Mosier stated:

> One safeguard that is talked about a lot in decision aids is making the processes transparent to the user so not only does the user see what the aid is telling them, or what information, the user can see where it's coming from, and so a lot of times what happens in automation is that you can't detect these things because you can't see how the aid got to where it is. You can't trace the reasoning process and you can't understand why it switched to this mode or told you to do such and such, or recommended shutting down such and such a system.

Dick indicated that he did not feel it was necessary to make a great effort to have the user understand the decision strategy when a JPA was always used in a certain situation;

whereas, Mosier, maintained that within certain operating environments, it was critical for the JPA user to be able to trace how the aid arrived at its course of action. Mosier stated:

> What information you provide and how you provide it will influence how the information is absorbed for making decisions. We've had some evidence that presenting things in computerized or automated contexts kind of biases people towards processing that information and using it — sometimes to the exclusion of other stuff.

Miller and Mosier both suggested that the factors of format and information hierarchy used in design would influence decision making and risk assessment. Westrum suggested that the ease or difficulty of reading a JPA influenced the rate at which the user performed and an inappropriate rate could lead to error. Altman looked at JPAs as a form of programmed decision makers and Dessinger made the point that depending on the JPA design, some JPAs did not allow the user to employ individual heuristics.

Discussion. The points made by the SMEs led to the conclusions that it was important to include components in the conceptual JPA design model which addressed: (a) the requirement for transparency, (b) information hierarchy, (c) a design format that reflected the information hierarchy, (d) alternate courses of action when appropriate, and (e) the role of JPA user heuristics.

JPA Effectiveness

The SMEs identified a number of features of an effective JPA. JPA features were considered important factors to the development of the conceptual model as it is proposed that the features that make a JPA effective can point to important elements of a conceptual JPA design model.

Dick brought out the fact that an effective JPA would help a person make the right decision and that an effective JPA was based on a long term goal. The point he made regarding the goal centered on whether the JPA was to continue in use or eventually be discarded. Dick asked a question to make his point, "Is the goal of the aid to eventually disappear and have the user internalize or automatize — not need the aid anymore? If so, maybe you want to shape those decision strategies."

Dessinger stated that an effective JPA was "Simple, direct, accurate, complete and unambiguous." Dessinger and Rowland both stressed that JPA effectiveness depended on also incorporating the working environment into the JPA design. Rowland emphasized the role of context and environment for JPAs used in industry as he stated:

> I'm thinking of industrial context right now. It's got to be absolutely clear to a wide variety of users — at least a little beyond the range that going to be the user. It's got to be visible and that means you have got to do a very thorough examination of the environment so that you're not sticking it somewhere that the user has to be looking a different direction to actually apply it.

Altman and Miller argued for simplicity as a key to an effective JPA. Miller added accuracy to the factor of simplicity. Additionally, Miller cautioned that the designer must be aware of oversimplification as he discussed passenger safety information JPAs used in the aviation industry. Miller stated:

> Well, not just the simplicity of it, although that always helps, we like to make sure the things are accurate. . . . Therefore, getting rid of a lot of the detail to make things extremely simple can be detrimental in our situation when it may be a life and death or death threatening or harm threatening situation. . . . Simplicity without the abandonment of detail to make the objects recognizable.

Mosier maintained that an effective JPA would not present any conflict between courses of action in multiple fault situations. Westrum offered a similar point in that he argued, "An effective aid would be one that would be unequivocal so that there would be no way of misunderstanding it." Additionally, Westrum pointed out that an effective JPA would be compatible with similar job aids used within the work situation so that there would not be any interference effects. Westrum cautioned that when various job aids required different interpretations within the same work environment, it required the user to change psychological sets and that this was a disorienting process.

Miller discussed the use of appropriate message design as a major factor to determine JPA effectiveness. The factors he stressed were graphic realism, type size, and combining text with illustrations. Miller's perspective was supported by Rowland who stated that an effective JPA required "decent message design."

Discussion. The interviews with the SMEs pointed to a number of factors regarding JPA effectiveness. The role of the user was mentioned by five of the SMEs as an element of JPA effectiveness. Simplicity and accuracy were also stressed as important factors. The responses by the SMEs corresponded with the considerations found in the literature review and led to the conclusion that the conceptual design model should incorporate an examination of user characteristics and the user's environment.

The concern for defining the design goal as made by Dick and the concern for JPA interpretation made by Westrum suggested that the conceptual model reflect a means to focus on the purpose of the JPA, the JPA user, and the environment in which the JPA will be used. Additionally, the application of the principles of message design that were suggested by two SMEs, which was also emphasized in the literature, indicated that message design was a major element for the conceptual model.

Model Components and Characteristics

Model components. The SME interviews provided valuable recommendations for suggested components which supported the findings from the literature review. Dessinger, Altman, and Mosier stressed the need for an assessment that resulted in the establishment of goals and objectives. Four of the SMEs, two who represented the field of instructional technology and two who represented the field of human factors, emphasized the analysis of the user as a critical component of a conceptual model. The SMEs from instructional technology, however, looked at the user from two different perspectives. Dick approached the user as the person who would employ the design model, and Rowland approached the user as the person who would use the JPA.

Dick stated, "The question is what are the entry behaviors required of a person in order to use this model? And that should be perfectly clear so that you don't have a novice trying to use a model that calls for skills that they don't have." Rowland stated, "I think the first one and most important [component] that comes to mind to me is working with the user — the intended user." Each of these perspectives had merit.

The literature supported the need to analyze the intended user of the JPA; however, Dick's suggestion of addressing the qualifications of the user of the design model was a perspective not addressed in the literature. Consequently, it was determined that an element be incorporated into the conceptual JPA design model that addressed the level of expertise of the designer.

Mosier also maintained that the designer must consider the end-users' processing time. Mosier stated, "The designer has to consider whether they want the user to be able to process it very rapidly or whether they want to slow them down so they think about what's going on."

Westrum supported Mosier's concern as he addressed the requirement for the designer to gather information on the context of use in order to determine the amount of information the end-user needed to have available and how the amount of information affected the user's processing time. Additionally, Westrum discussed the criticality of the designer's conception of the end-user. Westrum stated:

> I think the data you have to gather has to do with what is it the user really has to know; in most cases you don't want the job aid to present more information than the person really needs to know. It will simply cause additional processing time, be confusing, and so forth. At the same time, that information should be readable or understandable in an unequivocal way so there is no doubt about what the information is. . . .
>
> The critical thing is obviously the mental model that the designer has of the user, and I cannot emphasize enough how important it is for direct contact with the user; rather then using common sense understanding or some sort of verbal reports.

Miller emphasized information gathering but he focused on the accuracy and consistency of procedures used by the aviation organization that were to be displayed in the completed JPA. Miller stated:

> So we go through an information gathering process first: what is in their manuals, training procedures that we must reflect because we need to not conflict with what the flight attendants have been taught, what's been written in the manuals, or what the flight attendants impart to the passengers. It all must be consistent, so what we do is gather information so that their actual procedures are visually reproduced and are complementary rather than [create] any kind of conflict.

Model characteristics. The SMEs provided insight into what general characteristics a conceptual JPA design model would exhibit including characteristics of what they felt were important to be reflected in a JPA..

Dick spoke of four characteristics that an effective model should exhibit: (a) an appropriate level of detail, (b) the skills necessary to use the model, (c) a means to interact with the client, and (d) a process to conduct formative evaluation. Dessinger spoke of simplicity and sound instructional design as she stated, "Simple. . . direct, accurate, complete and unambiguous. . . . I would parallel pretty much with the ISD model."

Rowland supported Dick's view on the importance of skills necessary to use the model as he cautioned:

> You don't want to dump a bunch of the knowledge on job aid development in this high risk environment on to an aid that somebody really doesn't know what they're doing and does zero testing and stuff that somebody is going to rely on.

Mosier spoke of the characteristics of an effective JPA that a model should produce as she stated, ". . . the transparency of the processes, a clear view of information requirements, some sense of prioritization or risk assessment, feedback, provision for feedback." Additionally, Mosier cautioned that the designer must determine if the completed JPA would be used as a substitute or as a supplement to other things.

Dessinger, Altman, and Miller maintained that simplicity was a primary characteristic both of a model and a JPA. Miller's discussion on the development of airline passenger safety information cards provided a number of key design considerations that related to the characteristics of an effective JPA and characteristics of a JPA design model. Miller stated:

> Well I think again we move back to simplicity, but also with a character about the information — a pictorial character about the information that's pleasing enough to want to read it. Using proper scale, using proper sequencing, compartmentalizing activities. . . .
>
> You know it's clarity. Try to get rid of extraneous information or what we refer to as visual noise. Try to keep your concepts clean; your steps to a minimum in order to accomplish it. . . .
>
> To do this you would have to be very thoughtful about clarity and the minimum amount of information to do the job correctly, and then test it. Something like that you're going to have to test. Get information and feedback from people who don't know anything about it. . .

Discussion. The interviews with the SMEs provided data led to the conclusion that the following design considerations be incorporated into the conceptual JPA design model:

1. An assessment component which results in the goals and objectives of the intended design.
2. An analysis component of the intended end user of the JPA.

3. A means to caution the designer on the skills required to use the design model.
4. Time as a component or sub-component of the design model that provides the designer a means to assess the time criticality of the desired performance.
5. An information gathering component that includes: (a) the context of use, (b) a means to assure accuracy and consistency of procedures reflected in the JPA, (c) the need for transparency, and (d) risk assessment.
6. An element within the design component that addresses clarity by means of a determination of actual information required.
7. A component of evaluation that includes feedback from intended end-users and management (the client).

Information Processing Factors

The SME interviews suggested that the end-users' information processing should be a consideration in the design of JPAs for HRHR systems. Dessinger maintained that "there's a strong tie between developing and designing a job aid and using some of the research and methodologies that's come out of information systems." Motivation was indicated as a major influence on the information processing process. Dessinger, Altman, and Miller each addressed design considerations to enhance the JPA users' motivation.

Dessinger stressed accessibility as she stated:

> You are not motivated to use a job aid that is not accessible on the job when you need it, and if you are — I've seen so many situations where the job aid is decent, good, but it's positioned so that nobody can read it, or that nobody can access it. . . so people aren't motivated to use it because it's just not around.

Altman spoke of the necessity of addressing the elements of human factors to achieve an effective design. Altman maintained:

> You have to think about everything from learning theory to perception to motivation, [and] stress management. You have to think about all of the human factors that come into play so that you can get to the end product to measure it.

Rowland spoke of similar bases of knowledge as he responded to the query about design factors of perception, motivation, relevance, and accessibility regarding information processing. Rowland stated:

> These are important bases of knowledge that the designer will have but not necessarily steps that the designer will take or activities — you know a lot of design is even unconscious so it's a lot of influence from your theoretical perspectives about learning and perception and all these things, but it's not that you sit there and you call up rule thirty-seven and then apply text based on that or something. It's much more dynamic than that and a lot [is] unconscious based on experience — case experience — that kind of thing.

Mosier addressed salience as a major factor to information processing. She stated, "One thing you can say is that the salience of it as far as where it appears on the display, how loud the noise is, how bright the light is; that is going to affect how that information is processed." Westrum spoke of the effect of information processing time required to use a JPA as he stated, "If the job aid requires the person to do too much thinking it may unreasonably delay their actions."

Miller emphasized the amount of information displayed was a key factor towards motivating the end-user to use the JPA. Miller cautioned, "If there is too much stuff. If there's too much information, especially in terms of writing, the motivation ceases to proceed any farther to what we are really trying to get across."

Discussion. The SME interviews indicated that information processing was an important consideration in the design of JPAs and that motivation was a primary ingredient to information processing. Furthermore, the literature supported the importance of the influence of motivation towards effective JPA design.

Although, the interviews reflected that motivation was an important design consideration, the SMEs spoke of it in general terms. The literature, however, pointed to specific elements to enhance end-user motivation. As examined earlier, Grau (1986) argued that JPA design should incorporate expectancy, valence, and instrumentality. Grau's (1986) recommendation to reduce the amount of effort required to use a JPA was supported by Mosier, Westrum, and Miller. Consequently, it was concluded that the JPA conceptual model should include the following factors to enhance end-user motivation:

1. A method to determine appropriate accessibility of the completed JPA.
2. An evaluation of salience to determine appropriate cues.

3. A determination of the amount of information displayed to prevent information clutter and information processing time. This element relates to Mosier's call for transparency to be present in automated job aids.
4. A training component that addresses expectancy, valence, and instrumentality.

Performance Time Considerations

Although the literature was found not to specifically address the factor of performance time in regards to JPA design, the SMEs when asked to comment on performance time identified important design considerations. Many tasks in HRHR systems, which are supported by JPAs, are time critical; consequently, the subject of performance time was addressed.

Five of the SMEs offered design considerations that addressed techniques to speed up performance time, and one SME spoke of the need to slow things down in certain situations. It is suggested that the consideration to slow things down, as proposed by Mosier regarding automated aids, could be critical in the design and effective use of a number of JPAs, which are not necessarily automated aids, used in HRHR systems. Mosier stated:

> If you design an automated aid that does a lot of things for you, you certainly get things done faster. The question is do you want that? I mean sometimes the question is not how do you speed it up but how do you slow it down so it's done carefully?

Dick spoke of task context as a factor to performance time which related to Mosier's caution to determine the need to reduce task performance time. Dick's response to the question on criticality of time indicated that the designer must make a thorough examination of the task in order to address the factor of time. Dick stated:

> I think it depends on what the task is. Some tasks are highly visible and again in terms of speed of use, they can show you things very quickly. But I think that the task in the context in which the aid is being used can — is the best guide in answering that question.

Dessinger and Rowland spoke of methods to expedite performance time that included JPA formatting, ease of use, and simplicity. Rowland made the point that simplicity was layered in that it could provide a means for the end-user to call up sub-routines of the required task. Altman supported Rowland's perspective on simplicity. Altman called for limiting the number of activities presented in a JPA in order to reduce decision making time.

Westrum maintained that the critical design point involved some form of evaluation as he stated:

> So I think the critical point about time is that the designer be acutely aware of this and check out his or her hunches and perception and so forth by actually giving the interface or whatever it is to the user and see how long they actually take to run through it.

Discussion. The SME interviews substantiated that end-user performance time was a major consideration for the design of JPAs used in HRHR systems. The techniques recommended by Dessinger, Rowland, and Altman provided design considerations to speed up the end-users' task performance time. Dick emphasized the need to assess the intended task and Mosier cautioned the designer to assess the requirement to speed things up or slow things down. Consequently, it was concluded that required performance time be a design element within the conceptual JPA design model.

The Use of Visual and Textual Displays

A key design factor addressed in the instructional technology literature was the use of visual information structure. Although JPAs within HRHR systems may incorporate audio as a means to transmit information, the aviation literature indicated that the majority of JPAs rely on pictorial and textual media. Consequently, the subject of visual and textual displays was discussed with the SMEs.

The SMEs provided a number of considerations regarding the use of visual and textual displays. Dick suggested that it depended on the visibility of the task. He argued that some tasks were highly visible and were conducive to rapid performance, and others were not. When queried on the use of visuals and text, Dick suggested that the use of visuals or text depended on the task. Dick stated:

> And other tasks, like five steps to follow in counseling someone who is applying for unemployment compensation — I don't think that visuals would make any difference at all — that's basically a verbal task. You might have little icons or that sort of thing, but I think that the task in the context in which the aid is being used can — is the best guide in answering that question.

Dessinger and Rowland cautioned the designer to be aware of barriers to effective communication. Dessinger stated, "I think maybe a combination [visuals and text] is necessary. Also, regarding language, if you're talking about situation where there is a language barrier, then graphics become extremely important." Rowland emphasized, "So if it's going to be a picture, it's got to be a very well designed picture that the user can really identify with very carefully and very easily; otherwise, it may be just as well be words."

Dick upheld Rowland's caution as he maintained that training on the use of icons was important to reduce "memory drift." Dick used a five step procedure as an example to explain the importance of training on the use of visual displays in the form of icons:

> If there is appropriate and sufficient training that precedes the use of the icons that assures that you have that linkage so when they see that icon it fires five steps. And the only problem I would see with that is kind of what you might want to call memory drift. That's not a technical term but its the fact that you train me and I learn these five things; I see that icon, those five things fire, but over time my memory tends to decay and I see that icon and now I do one, two, four, five and forget to do three.

Altman and Mosier discussed that the use of visuals and text depended on the purpose of the JPA. Altman related his perspective in regards to the design of corporate aviation passenger safety information cards:

> I think that in the high risk areas visual aids are easier to remember than verbal. So that if you're going to say — have to deal with a fire extinguisher — you are going to remember the picture, the visual image of that fire extinguisher and of pulling the pin, aiming it at the base of the fire, pulling the trigger, sweeping side-to-side a lot more clearer than if you had read it.

Mosier stated, "I think it depends on what you are trying to aid. I mean you couldn't do a checklist with visuals, it would have to be text. Graphic aids have been shown to speed up processing in some cases but it depends on what you're trying."

Westrum spoke of specificity and the importance of display interpretation. Westrum discussed a past accident that was a result of mis-interpreting a digital display which pointed to the need for the designer to address the technology used for a specific display within a JPA. Westrum argued:

> My personal preference is for analogue readouts because it gives the person a better idea of context. I mentioned the Strasbourg accident where an airplane crashed because people were — thought that the 33 on the screen was a descent rate of 3300 hundred feet per minute; whereas, actually it was 3.3 degrees of descent. There are

quite a number of things like this in the literature.

Additionally, Westrum augmented the position held by Dessinger and Rowland regarding the interpretation of visual and textual displays. Westrum stated:

> Text is desirable when you've got the leisure to digest it. For relatively quick decision making you can't beat graphics, but of course the problem with graphics is — well in many cases — what the graphics say will be easily grasped and so forth, and in other cases, graphics may be subject to cultural convention and may be difficult for people to understand who are not used to seeing things represented in that way.

Miller related the use of visuals and text to the design of airline passenger safety information cards and he discussed the advantage of visual displays and design factors. When queried about the use of visuals and text, Miller responded:

> Well, we know that it's a matter of space and clarity. The illustrations are better perceived and better understood when they are more of a stand-alone and isolated by color or white; and when you start wrapping text around objects it becomes hard to read. You have space constraints. Space constraints are a factor in designing the cards.

Discussion. The SME interviews provided additional insight to the use of visuals and text for JPA design. Dick's recommendation for an analysis of the intended task's visibility corresponded with the recommendations made by Sanders and McCormick (1987) regarding information types and displays as discussed in the literature review. Thus, it is concluded that the analysis component of the conceptual JPA design model include an analysis of the visibility of the intended task. The visibility factor corresponded with Westrum's call for context specificity which also pointed to the end-users' visual and textual literacy.

Consequently, it was concluded that a determination of textual and visual literacy on the part of the intended end-users be part of the conceptual model's analysis component as suggested by Dessinger, Rowland, and Westrum. The SME interviews substantiated the need for the designer to employ the use of visuals or text or combination of both in a systematic manner that provided for user feedback and ample opportunity for revision. Additionally, the caution offered by Dick concerning memory drift led to the conclusion that training was a critical element of the conceptual JPA design model.

<u>Training</u>

Rowland spoke of the erroneous traditional view that JPAs should stand on their own with no training required. Rowland stated:

> We've made the mistake over the years, this goes back to Allison Rossett's stuff of thinking that a job aid would stand on its own completely, but it's a message, it's an instructional message and if you can't understand how to use it in a flash then you're out of luck.

Dessinger spoke of the requirement for training from both the traditional view and Rowland's view. Dessinger stated:

> If it's a good job aid, training in how to use job aids should have to be minimal, a minimal factor, a minimal time. It really thwarts the use of a job aid if you have to have a lot of training involved. . . .
>
> There's another way of looking at training in job aids and that is if you are training someone to do a task, for example, that either they don't perform very often or that they must perform exactly right every time or something dire will happen, in those cases you then sometimes need the training up front and then they use the job aid to help them transfer it to the job and to help keep them consistent.

Dick discussed the need to determine if training was required to use a specific JPA and he maintained that certain JPAs required mandatory training.

> There are other aids that are so critical to their effective use — correct use — that training is absolutely mandatory, and that training not only on the use of the tool but there will be an attitudinal component that addresses why they should choose to use that tool in that situation.

Mosier supported Dick's perspective on training for certain JPAs as she discussed the training needs for pilots using automated JPAs in the aviation environment. Mosier stated:

> One of the things we've noticed in automated systems in airplanes is that pilots know what buttons to press to get what, but they don't have the really good conceptual idea of what — how — for example, the flight management system works and what they can expect it to know and do for them. And really more importantly, what they can't expect it to know.

Additionally, Mosier offered a caution in regards to the design and content of training on the use of JPAs.

> And one of the things that I see happens in training often, that is not a good thing, is that training is after the fact of the design, and training tells you how — it's kind of like a cookbook — I'm going to do this and that. But training does not include information about how this aid functions and what you can expect to be it's strengths and weaknesses.

Altman proposed an interesting perspective when queried on the role of training. Altman responded, "I would reverse that and say what role does the aid have in the world of training." Westrum's discussion on training provided an answer to Altman's question. Westrum stated:

> In instances where the job aid is likely to be used without training, it has to be idiot proof and has to be simple and understandable even to people without education or training. Where you have another group like air traffic controllers, who can be assumed to want to get the relevant training for the job aid and are probably going to get it simply because of their position, the amount of training can be quite impressive because the group will actually go through the training and the job aid will not be used without it. So, I think you have to — you have to have a judgment call which is more important, is it to make the thing idiot proof or to actually allow people considerable amount of discretion and therefore give them a lot of training on how to use whatever it is.

Miller spoke of the role of training in industrial situations and potential consequences of error. He stated:

> In other types of industrial situations or manufacturing situations, especially when the people are dealing with items that have possibly some form of harm — they could come into harm by using a piece of equipment or process or procedure incorrectly. So the training reinforces the aid and the aid is always there to refer to.

Discussion. Each of the SMEs substantiated the need for training on the use of a JPA designed for HRHR systems. Consequently, it was concluded that training should be a major component of the conceptual JPA design model. The interviews also suggested that the training component be part of the early design process and not left to be an afterthought. Although the SMEs only provided minimum content recommendations, the literature review substantiated the need for training and provided a number of recommendations for content.

Evaluation

Perhaps one of the most important components of the conceptual JPA design model was evaluation. Both the literature review and the SME interviews emphasized the need for a process of testing and measuring design effectiveness. The three instructional technology SMEs (Dick, Dessinger, and Rowland) emphasized the need for formative evaluation. One of the human factor SMEs (Altman) addressed measurable objectives, and another human factors SME (Westrum) spoke of evaluating systems. The graphic art specialist (Miller) referred to evaluation as testing.

Dick emphasized evaluation in relationship to the designer of a model; whereas, Dessinger spoke of evaluation as a component of design. Dick stated:

> I think that it's absolutely critical that the designer of any model to have tried it out themselves, done the formative evaluation, and then maybe have somebody else use the model — and revise that model so that its usable and produces the results you are interested in.

Dessinger maintained:

> You have to have formative evaluation that's kind of ongoing. You need to have a summative evaluation at the end of it and make sure that it really — it has done what you said it was going to do.

Rowland, when asked to respond on suggested critical activities of a JPA design model, spoke of evaluation in relationship to integrating the user into the JPA design process. Rowland stated:

> I think the first one and most important that comes to mind to me is working with the user, the intended user. You know starting formative evaluation from before you even begin designing in a sense. I kind of work that through — user design as a concept throughout the whole thing.

Altman emphasized the need for measurable objectives both in regards to a JPA and in regards to the design process. Altman stated:

> The end product [JPA] would be — or determination — in other words, whether the individual can get to the end and getting to the end in the least effort way and that it can be measured in some effective way like time or accuracy. . . .
>
> It's a circular event [design], meaning that it's a closed looped situation, and you're never out of the loop. You're constantly in the assessment and evaluation stage.
>
> You develop an approach that you think is going to work then you have to test it out. And then, that testing it out is evaluation and from that you go back and — to the drawing board and correct for your direction.

Westrum spoke from a more holistic approach as he discussed evaluation in terms of total systems, who made the best evaluators of such systems, and related his concepts to JPA design. Westrum stated:

> I think good training for designing future systems is to evaluate other people's systems and vice-versa unless you design something yourself, you're really not in a position to evaluate it. Furthermore, the best evaluators are people who have had a lot of experience on how job aids are used so they are likely to anticipate the things that are going to go wrong and so forth. In other words that have the requisite imagination as I put it to imagine the ways that the job aid might be misused or misconstrued.

Miller discussed the need to test JPA displays when designing a new JPA that presented critical information. The example Miller used was the design of a JPA that displayed how to use a defibrillator. Miller explained the factors for such a design:

> To do this you would have to be very thoughtful about clarity and the minimum amount of information to do the job correctly — and then test it. Something like that you're going to have to test. Get information and feedback from people who don't know anything about it. . .

Discussion. The SME interviews substantiated the findings of the literature review regarding the importance of evaluation. The analysis of the interview data led to the conclusion that additional factors should be incorporated into the conceptual JPA design model to include: (a) the use of formative evaluation be integrated into the conceptual model as early as possible, (b) the evaluation process be depicted throughout the conceptual model, and (c) an element of evaluation that provided the designer a means to anticipate JPA user problems.

Anticipated Problems

During the course of the SME interviews, the SMEs occasionally referred to potential design problems. Although potential problems were not a subject of the actual interviews, the SMEs identified a number of design concerns.

Dick brought out that a JPA design model as discussed in the interview was "one sort of a grand job aid." The point Dick made was that there were many types of JPAs used in HRHR systems and various display media employed. Consequently, Dick stressed the need for the designer to know what exactly what was required prior to the actual design and development phase in order to modify the conceptual model to meet the needs of the design task. Dick stated:

> The major problem or task that I see facing you is: one, modifying that model to accommodate your needs with regard to the aid, but also to determine what kind of front end is required from that model in order to come up with a specification that will then allow a person to move into the design and development phase.

Rowland offered the author a caution regarding the conceptual model. Rowland stated, "You wouldn't want a model of your own creation here to give the designer overconfidence in any sense. . ."

Dessinger related that a conceptual JPA design model would be complicated. One such complication was brought out by Mosier as she discussed JPAs used in airplane cockpits:

> For example, a lot of times when you use a paper checklist a lot of times in airplanes — and there are sometimes when you have multiple faults — what one checklist tells you to do contradicts what the checklist for the other fault tells you to do. . . . You know some way of showing you the why behind the procedure so that if you do have to interpolate you've got some information to base it on.

Mosier also cautioned on the use of a generic JPA. Mosier stressed the importance of identifying the specific task for the specific user. Mosier's concern was akin to Dick's recommendation for the need to carefully identify the JPA requirement.

Westrum discussed past system design failures and described reasons systems broke down. Westrum stated:

> We know in the past often things have been sent to the field and rejected by the users, because the stuff was introduced in the wrong way or didn't really respond to the users' needs — broke down easily or seemed non-intuitive for whatever reason.

Miller's responses pointed to the need to assess the amount of information displayed which in many cases is a result of regulatory requirements. Miller spoke of the problems associated with designing effective aviation passenger safety information cards and meeting regulatory requirements:

> And these cards are literally covered with this litany of governmental regulation on the outside. What that does — all I'm bringing this to is that people will pull that out of the seat back pocket, they will do either of one of two things: they'll either bypass it completely and go right to the card, or they will take one look at the information and put it right back in the seat back pocket.

Discussion. The analysis of the SME interviews identified various problems that could affect the quality of a conceptual JPA design model:

1. JPAs for HRHR systems, as previously discussed, are unique when compared to traditional job aids. The need to carefully determine the purpose of the JPA was strongly emphasized by Dick.
2. The need to caution the designer on the use of the conceptual model was stressed by Rowland. He warned of building a feeling of overconfidence into the model.

3. The need to address the potential of multiple faults in certain situations was emphasized by Mosier. She suggested that, in these cases, it was necessary for a JPA to depict the why of a procedure in order to provide the end-user a means to interpolate guidelines in the event of conflicting procedures.
4. The value of confirmative evaluation was eluded to by Westrum as he spoke of systems breaking down even when there was little apparent cause.
5. The need for the designer to be aware of regulatory requirements and to address potential display problems that result from such requirements.

Chapter Summary

The purpose of Phase I was to examine the literature that addressed JPA design considerations from the fields of instructional technology and human factors, and collect and synthesize the data from working instructional technologists, human factor specialists, and a professional JPA designer in order to establish the foundations to develop a JPA design model for use in HRHR systems.

Based upon the notions and roles of design, use of models, and developmental research, the analysis of the literature led to the conclusion that due to the nature of JPAs used in HRHR systems that the development of a conceptual JPA design model was a necessary step in the development of a task-specific procedural model.

It was found that there were a variety of JPAs used in HRHR systems ranging from paper checklists to automated decision aids. The analysis of the literature and SME interviews reflected that there were a number of design factors to consider in order to select the appropriate design strategy and to develop an effective JPA. Consequently, it was concluded that a conceptual JPA design model which identified the variables that influenced JPA design would provide the criteria necessary to formulate a procedural model from which a task-specific model could be drawn.

The development of the conceptual JPA design model and a JPA procedural design model are presented in Phase II of this study.

CHAPTER IV

PHASE TWO: THE CONCEPTUAL AND PROCEDURAL JPA DESIGN MODELS

Phase Two of this study encompassed the development of two JPA design models and associated definitions. The first model was the development of a conceptual JPA design model, and the second was the development of a procedural JPA design model that was based upon the components of the conceptual model.

The conceptual model provides an explanatory representation of variables that affect JPA design and influence JPA design in any application or work setting. Consequently, the conceptual model is applicable to a wide range of JPA design projects regardless of the work setting. The procedural model, however, depicts the activities to design JPAs for use specifically in HRHR organizational systems.

The models were developed using the following data: (a) JPA design factors identified in the literature, (b) recommendations taken from the SME interviews conducted during Phase One, and (c) a formative evaluation . The formative evaluation consisted of a two-round expert review process with the SME panel. The formative evaluation data were used to revise the models and definitions.

JPA Model Development

It was determined during the initial research that in order to develop a procedural model which depicted the activities for effective JPA design, it was necessary to first identify the variables that influenced JPA design.

The factors identified in the literature review were categorized as either a design variable or a design activity. This information was then clustered into model components and elements (sub-components) based upon an analysis of their relationships. The variables and activities identified in the analysis of the literature are presented in Table 3. The variables and activities identified in the analysis of the SME interviews are presented in Table 4. Each table reflects: (a) the source of the data, (b) the variable that influences a design activity if applicable, and (c) the identified design activity if applicable.

Table 3

Literature Review: JPA Design Variables and Activities

Source	Variable	Activity
Altman (1974) Degani (1992) Fisher & Tan (1989) Matthews (1986)	Information processing	Display specifications
Baker (1994)	Perception	Information structure
Battle (1994)	System complexity	Sequencing
Blanchard, Smillie & Conner (1984)	Functional characteristic	Definition of purpose
Bullock (1982)	Standards	Needs assessment Job/task analysis
Bullock (1982)	JPA/training relationship	Training design
Carlisle & Coulter (1990)	JPA accessibility and durability	Assure accuracy and reliability of information
Chechile, Eggleston, Fleischman & Sasseville (1989)	Cognitive quality of display	Information analysis
Degani & Wiener (1994a)	Management	Utilization
Degani & Wiener (1994b)	Organization infrastructure Management philosophy Management policy	Procedural specifications JPA implementation
Dick & Carey (1996)	Target population JPA effectiveness	Population analysis Expert evaluation Field trial
Duchastel (1985) Rude (1988) Waller (1982)	User orientation, comprehension, and recall	Visual information structure
Duncan (1985)	Time and accuracy	Implementation
Foley & Moray (1987)	Perception; Noticeable differences	Specifications of physical properties
Fuller (1994)	Compliance	Rule specifications
Grabowski (1991) Duffy & Waller (1985) Fleming & Levie (1993)	Perception Information processing Display	Message design Reader analysis

(table continued)

Table 3

Literature Review: JPA Design Variables and Activities

Source	Variable	Activity
Grau (1986)	User motivation Relevance and confidence	Training
Gross (1995)	Compliance	Regulatory approval Content organization
Hawkins (1987)	Information processing User attitude	No activity identified
Hellebrandt & Russell (1993)	Adequacy of effort	Summative evaluation Confirmative evaluation
Herry (1987)	Action logic User knowledge base	User and expert synthe- sis; Training
Jonassen (1982; 1985) Misanchuk (1992)	Perception Information processing Display	Message design Reader analysis
Keller (1993; 1987)	Motivation	Audience analysis
Kern (1985)	User knowledge base	Cognitive task analysis
Matthews (1986) Sylla, Drury & Babu (1986) Trollip & Sales (1986)	Information processing	Display specifications
Moseley & Larson (1992)	JPA standards	Evaluation
Mosier & Skitka (in press)	Man/system interface	No activity identified
Mosier (in press)	No variable identified	Training design
Mosier, Palmer & Degani (1992b)	Degree of automaticity	Use of salience
Pipe	User motivation User expertise	Task analysis
Rossett & Gautier-Downes (1991)	Strategy	JPA/worksite match
Rowland (1993)	Designer expertise Design task Management	Design

(table continued)

Table 3

Literature Review: JPA Design Variables and Activities

Source	Variable	Activity
Ryder & Redding (1993)	User knowledge structure Information processing	Cognitive task analysis
Sanders & McCormick (1987)	Selective attention	Message contrasts
Sanders & McCormick (1987)	Type of information	Classification of information
Smillie (1985)	Design strategy User expertise User motivation Target population	Select strategy Audience analysis Evaluation by user
Snow & Newby (1989)	User perception; Environment	Shape & color selection
Stewart, Roebber & Bosart (1997)	Expert judgment	Task properties analysis
Swezey (1987)	Task performer Functional characteristics	Task analysis Training
Tessmer (1994)	Adequacy of effort	Formative evaluation
Tilaro & Rossett (1993)	Management User motivation	Coordination Matching of goals
Winn (1993)	User perception; Stimulation	Specifications of structural properties of message
Zeitlin (1994)	Risk assessment	Training

The data from the SME interviews were used to identify variables and activities for the development of a JPA conceptual and procedural design model based upon the SMEs' past experiences and expertise. Table 4 reflects the variables and activities identified. The findings were compared with the data obtained from the literature review (see Appendix D for complete initial SME interviews). The results of the comparison provided the framework to draft a set of initial models which are presented in Figure 4 and Figure 5.

Table 4

SME Interviews: JPA Model Variables and Design Activities

Instructional Technology SMEs	Variable	Activity
W. Dick	Need for JPA	Front-end analysis.
	Environment	Front-end analysis.
	Model linearity	Step-by-step design.
	Designer's experience	Training.
	Level of model detail	Chunking of steps.
	Client	Client interaction.
	Outcomes	Formative evaluation.
	Strategy	Define goals of JPA.
	Task visibility	Task analysis.
	Display	Context analysis.
	Memory drift	Training.
J. Dessinger	JPA requirement	Verification of need.
	Focus	Define goals and objectives.
	Model linearity	Provide flexibility.
	Purpose	Situational assessment.
	Adequacy of design effort	Formative evaluation.
	Adequacy of project	Summative evaluation.
	JPA accessibility	Provide for JPA availability.
	User motivation	Address ease-of-use.
	Time	Formatting.
	Audience	Audience analysis.
	Display methods	Audience analysis.
	Performance consequences	Training.
G. Rowland	JPA reliability and clarity	Environmental analysis, message design, multi-modal design, end-user training.
	Designer expertise	Designer cautions.
	Model linearity	Define objectives and strategy.
	JPA environment	Assess job performance situation and end-user.
	End-user	User interaction via formative evaluation.
	Idea generation	Define purposes.

(table continued)

Table 4

SME Interviews: JPA Model Variables and Design Activities

Instructional Technology SMEs	Variable	Activity
	Task	Task analysis.
G. Rowland, continued	Information processing	Review design experiences.
	Time	Layer information display.
	JPA comprehension	Training.

Human Factor SMEs	Variable	Activity
	Results	Measure outcomes.
	Model Linearity	Step-by-step accomplishment.
	Design step success	Define measurable objectives.
	Work situation	Determine display media.
H. B. Altman	User comprehension	Reduce complexity.
	Performance objectives	Measure time and accuracy.
	Needs	Needs assessment and evaluation.
	Information processing	Integrate human factors.
	Performance time	Limit task activities.
	Information display	Testing and revising.
	JPA effectiveness	Training.
	Information needs	Define and prioritize goals, define user, define purpose.
	Information requirements	Provide feedback to user.
	Model Linearity	Provide for iteration and reprioritizing.
	User decision making	Formatting and sequencing.
K. Mosier	Information transparency	Determine level of detail required, provide source of information.
	Tracing	Provide rationale for procedures
		Provide for feedback.
	Model transparency	Risk assessment.
	Risk	User analysis.
	End-users	Match to user expertise.
	Level of information	Determine expertise of user.
	Information processing	

(table continued)

Table 4

SME Interviews: JPA Model Variables and Design Activities

Human Factor SMEs	Variable	Activity
	Environment	Environmental analysis.
	Display salience	Cue analysis and integration of cues.
K. Mosier, continued	Performance time	Assess need to reduce or increase response time.
	Display media	Specific task analysis.
	JPA functions	Training.
	JPA limitations	Training.
	Model linearity	Systematic and iterative application, use feedback from user.
	Decision making	Assess alternate courses of action, provide where to look for information.
	JPA effectiveness	Design for compatibility, reduce interference effects.
	Disorientation	Standardize JPA displays for compatible interpretation.
R. Westrum	Context of use	Information gathering, determine level of necessary information, determine urgency.
	Design effectiveness	Evaluate other successful JPAs, use of requisite imagination.
	Time	Pilot test with user.
	Information processing	Assess users' decision making ability, determine need for alternate courses of action and data.
	Display	Assess text versus graphics, determine cultural effects.
	Level of training	Exercise good judgment.
	Assumptions of user	Evaluate by direct contact with user.
	Implementation	Evaluate introduction process, re-evaluate users' needs.

(table continued)

Table 4

SME Interviews: JPA Model Variables and Design Activities

Graphic Designer SME	Variable	Activity
G. Miller	Model effectiveness	Use proven design steps; use feedback.
	Decision making	Use pictorials.
	JPA effectiveness	Use sufficient level of realism in pictorials.
	User comprehension	Compartmentalize performance activities, frame sequences.
	Design effectiveness	Gather information, assess for procedural conflict.
	Consistency	Visually display procedures in complementary manner.
	Motivation	Reduce clutter, evaluate amount of information presented, provide pleasing display.
	Decision making	Place most important information first, determine user familiarity with performance.
	Time	Provide for accessibility.
	Display	Maximize use of illustrations, minimize use of text.
	Training	Assess consequences of improper use.
	Clarity	Remove extraneous information; reduce number of performance steps; test JPA with users; get feedback from novice users.

Note. See Appendix D for complete interviews.

The Initial JPA Conceptual Model

The identified variables were clustered into eight major model components and were labeled: (a) JPA requirement, (b) designer expertise, (c) management, (d) analysis, (e) strategy, (f) display, (g) implementation, and (h) evaluation (see Figure 4).

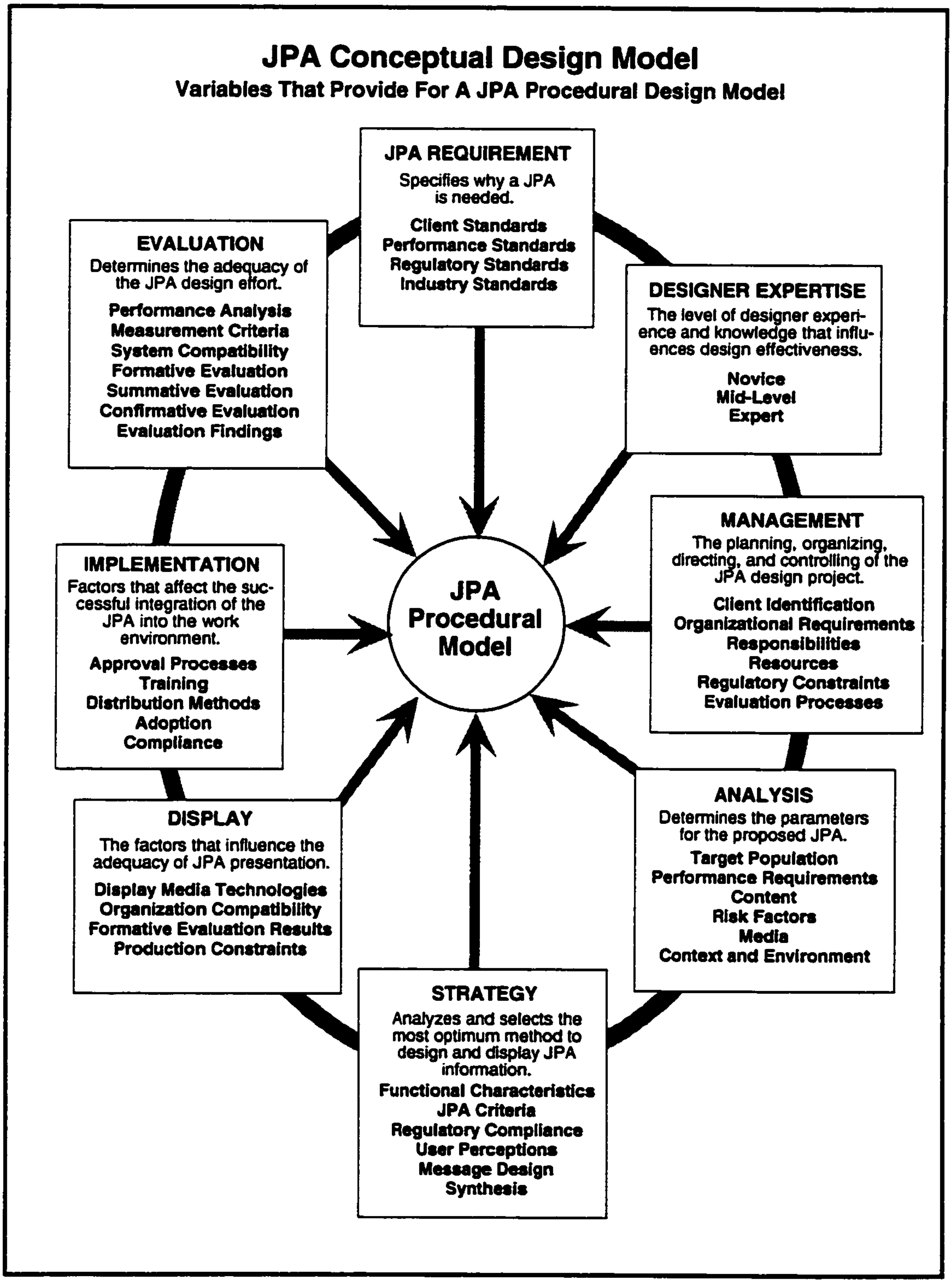


Figure 4. Initial draft of conceptual job performance aid design model.

The model was drawn in a circular method to reflect that the model is systemic in nature. An eight-point, 40 % gray, oval line was drawn to connect each model component. The line symbolizes that an interaction exists between each of the variables. A five-point, 40% gray arrow connects each model component to the center of the model which represents the JPA procedural model. The initial JPA conceptual model is presented in Figure 4. The following provides the definitions of the major components and elements that make up the components of the initial JPA conceptual design model.

JPA Requirement

The analysis of the literature and SME interviews pointed to the need to accurately determine the requirement for a JPA. It was concluded that the necessity for a JPA was based upon four major requirements or standards which were labeled: (a) client, (b) performance, (c) regulatory, and (d) industry.

1. The client standard refers to the request for a JPA design that originates from an organizational requirement. In this case the need for a JPA is pre-determined such as a need for an electronic checklist for a new aircraft by the manufacturer.
2. The performance standard refers to an identified gap or performance failure within the workplace that analysis indicates can be eliminated by the use of a JPA.
3. The regulatory standard refers to the requirement for a JPA called for by regulatory agency regulations such as the Federal Aviation Administration's (FAA) requirement for an aircraft cockpit checklist for large airplanes.
4. Industry standards refers to the requirement for a JPA based upon standards established by a specific segment of an industry. An example is the corporate aviation industry's call for a flight department operations manual which is not an FAA requirement.

Designer Expertise

As reviewed in Chapter 2, the expertise of the designer was identified as a major factor in the design success of a JPA. This variable signifies that the level of designer expertise plays a strong role in effective design. It represents the need for the novice designer to address each element presented in the JPA procedural model and it represents the flexibility available to the expert designer to address the applicable procedural elements that experience has shown necessary.

Management

The literature and SME interviews substantiated that the success of any design project involves planning, organization, direction, and control. The management variables that were found to be applicable to JPA design included the following: (a) The influence of the client who holds ultimate project approval authority, (b) the influence of organizational requirements including policies and procedures which control the design project, (c) the influence of how responsibilities of the JPA design project participants are assigned and met, (d) the influence of the availability of and accuracy of resources, (e) the influence of laws, rules, regulations, and policies which control the JPA design project, (f) and the influence of any evaluation processes integrated into the JPA design project.

Analysis

The analysis variable reflects the factors that influence the functional characteristic of the JPA and the JPA's design parameters. The literature and SME interviews identified six variables involving analysis. The six variables were: (a) The analysis of the target population —- the end user — which includes the target population's knowledge-base, experience, attitude, and task-related skill; (b) the analysis of the desired performance to be reflected or guided by the JPA; (c) the analysis of content which determines the level of information to be displayed; (d) the level of risk involved on the part of the user of the JPA which may influence design parameters and project management; (e) the affect of media alternatives; and (f) the impact of the context and environment on the effective use of the JPA.

Strategy

The strategy variable addresses the influence that the various methods and means to display information have upon JPA effectiveness. The variables identified in the literature and SME interviews that fit the model component of strategy variable included: (a) The influence of the purpose or the functional characteristic of the JPA on the overall design project; (b) the influence of the work site and work environment that determines the necessary design criteria; (c) regulatory compliance factors that but only influence but also mandate JPA design parameters; (d) the perceptions of the end-users that influence information display; (e) the influence of message design principles on user comprehension and JPA acceptance; and (f) the influence of the synthesis methods employed to match the goals of the organization, the end-user, and performance objectives.

Display

The display variable encompasses the factors that influence JPA design considerations which address information presentation. Although elements of the display variable that were identified in the literature and SME interviews did not use the specific terminology as depicted in the conceptual model, the elements were labeled with terms that synergized the variables identified. The elements of the display variable were labeled display media technologies, organizational compatibility, formative evaluation results, and production constraints.

1. Display media technologies refer to the many technologies available to the JPA designer to present information. They include print technologies such as paper checklists and trouble-shooting guides, aural and visual warning systems such as aircraft status warning systems , electronic decision aids such as flight management systems as used in modern commercial aircraft, and computer display systems such as used in air traffic control centers.
2. Organizational compatibility refers to interference effects that result from the use of similar JPAs used within the work environment. This variable represents the possible different interpretations that a JPA display could present if sufficient differentiation between similar JPAs was not available.
3. Formative evaluation results refers to the integration of evaluation findings into a revision process.
4. Production constraints refer to the capabilities and limitations of JPA production. this variable addresses the influence not only of the display technology selected

but also the limitations of the technology itself in relation to the intended functional characteristic of the JPA.

Implementation

The identified factors that affect the successful integration of a JPA into the work environment included: (a) The approval process by which the JPA is accepted by the decision maker, (b) the level of training necessary to achieve desired performance, (c) the distribution methods used by the organization to place the JPA at the work site and achieve user accessibility, (d) the process of adoption by the organization and the end-user, and (e) the level of compliance required to assure regulatory and organizational requirements.

Evaluation

Both the literature and the SME interviews pointed to the importance of evaluation. The evaluation variable addresses the adequacy of the evaluation process. It is argued that the success of the JPA design hinges on an effective evaluation that addresses: (a) The accuracy of the performance analysis, (b) the measurement criteria selected, (c) the compatibility of the JPA with the system with which it is intended to enhance user performance, (d) the level of revision based on formative evaluation findings, (e) the level; of acceptance of summative evaluation findings, and (f) the rate and level of confirmative evaluations to assure JPA regulatory compliance and effectiveness.

The Initial JPA Procedural Model

Based upon the analysis of the data and the development of the JPA conceptual design model, a JPA procedural model was developed that synthesized the JPA design activities identified in the literature and SME interviews (see Figure 5).

As substantial revisions were made to the initial definitions for each of the procedural model's components and elements, the initial definitions are presented in Appendix E, the SME first-round evaluation package. The revised models are presented following the SME formative evaluation comments and analysis and the revised definitions are presented in the second-round SME evaluation package (see Appendix G).

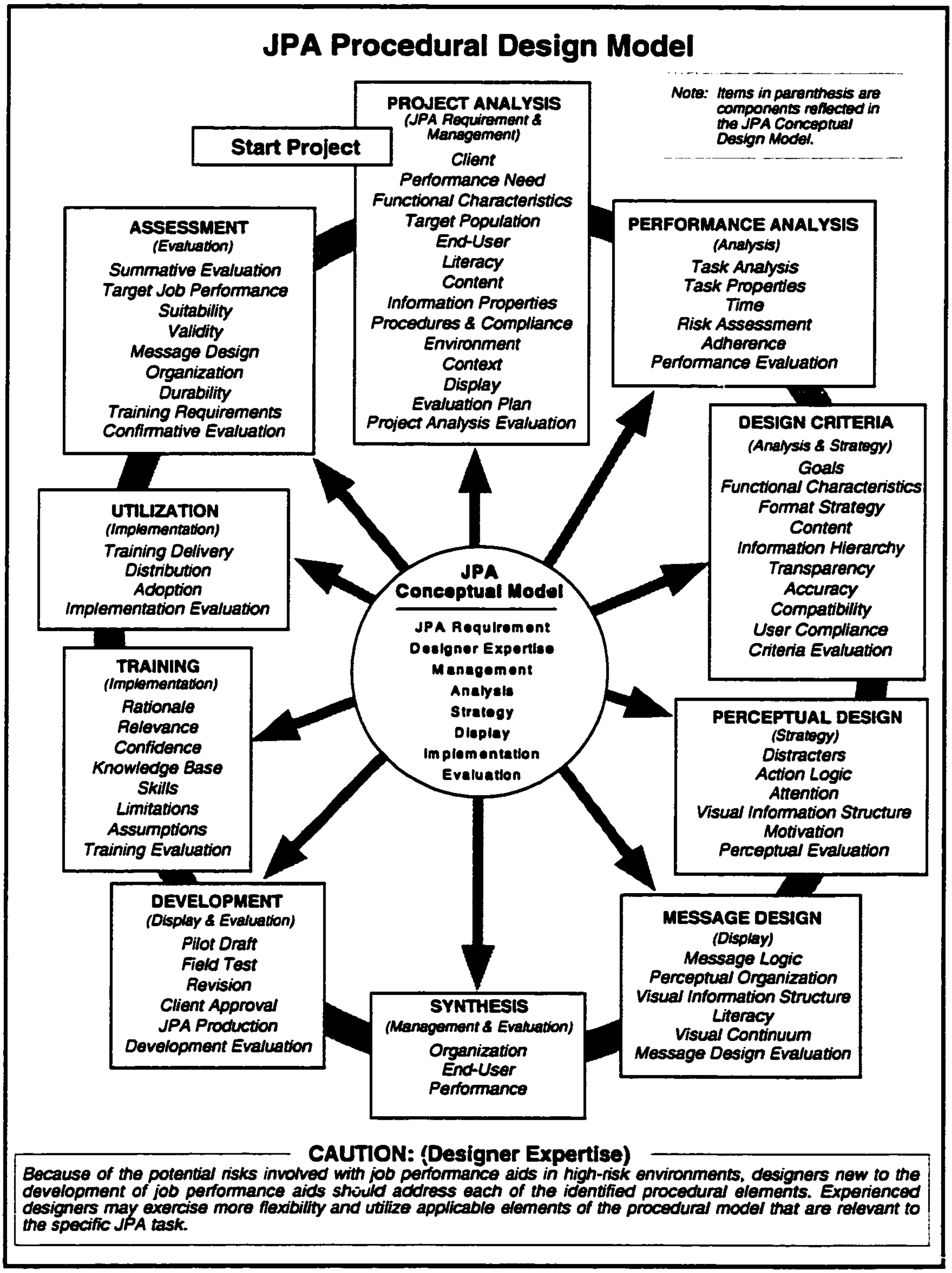


Figure 5. Initial draft of procedural job performance aid design model.

First Round SME Formative Evaluation

The SME formative evaluation interviews provided a number of recommendations regarding the initial models and definitions. The SME interviews were transcribed and examined for common themes. The comments and recommendations were categorized into three common themes: (a) the conceptual model, (b) the procedural model, and (c) definitions. This findings were used to revise the JPA conceptual design model, the JPA procedural design model, and procedural model definitions. The interview and analysis data are presented in Appendix F. The initial JPA Procedural Model is presented in Figure 5.

SME Evaluations: The JPA Conceptual Design Model

The analysis of the SMEs' evaluations of the JPA conceptual design model pointed to five major areas of consideration for revision: (a) terminology, (b) expertise, (c) target population, (d) analysis, and (e) model component relationships. Appendix F presents the key terms that were highlighted in the information-management-system database that were used to identify the major ideas or themes expressed by the SMEs and which provided a rationale for revision.

Terminology

Dick stated the need to re-evaluate the sub-title of the model which stated, "variables that provide for a JPA procedural design model." Dick asked, "Is it variables that determine the model, influence the model? Provide for didn't seem correct." Dick also argued that the strategy component does not actually select the most optimum method. He stated, "Under strategy, I differ with you on most optimum. I think if something's optimum, there's nothing more optimum. Select the optimum method, that means that's it. Its the very best."

Dessinger maintained that since the intent of the conceptual model is generic and applies to a wide range of JPA design projects, the title should reflect the intent. She stated, . . . "since your conceptual one is more generic I'd indicate at the top that it's a more generic model. . . "

It was concluded that the recommendations were sound and added clarity to the model. Consequently, these recommendations were incorporated into the revised JPA conceptual design model (see Figure 6). Additionally, based upon Dick's evaluation, it was concluded to revise the descriptors to model components to emphasize each component as a variable.

Expertise

Four SMEs addressed expertise. Dick suggested that management expertise was an important variable which influenced the JPA design. He stated, ". . . the effectiveness of the model would depend on the expertise of the manager." Additionally, Dick stated:

> Sure, the person who has more expertise is probably going to produce a better product but I don't know that the design is going to be that different — the model, the process. Yes, an experienced manager will probably do a better job of running a job than a first timer. But I don't know that the things that you tell them to do would be that different.

Although Dick pointed out that various experience levels of managers would most likely follow similar project management steps, management expertise would remain a variable on a JPA design project. Dick, however, emphasized that the steps to design, as reflected in the JPA procedural model, would not change based on management expertise.

Dessinger addressed the level of expertise in regards to the JPA user. She argued that the level of user expertise was also a factor towards effective JPA design. Dessinger stated:

> Coming from a user point of view. You talk about designer expertise as novice, mid-level, expert and I didn't see that break down for the user. That's kind of an important breakdown as well because one of the issues with job aids, and maybe its also and affect issues as well, is who is it going to be geared towards, the novice, mid-level, or the expert?
>
> You also have to think about it in terms of design because you have to know whether you may in fact be gearing it for several different levels because actually people at different levels of expertise can use the same job aid; they just use it differently.

Miller addressed expertise in the form of client bias. He suggested, based upon his experience as a professional JPA designer, that there will be times when the bias of an authority within a JPA design project will overrule a sound and proven JPA design. Miller recounted his personal JPA design experience:

> You know and then all of a sudden you have to go back and change a perfectly good drawing because you're not going to sit there and get into an argument with this person. So there's an effect on a communication device, meaning this illustration, that really isn't relevant. It's strictly interpretation and personal opinion but the level of which it comes from forces the change.

Westrum also addressed a concern similar to Miller's comment. Westrum, however, looked at the situation from an organization's past history. He stated:

> In some cases you might even think about institutional or organizational history. Because that may affect how they respond to stuff that they get. Then all of a sudden......boom! You know, somebody comes up in authority, lets put it that way you know. Beyond just a customer thing. . .

Additionally, an element titled "requisite imagination" was added to the designer expertise component. This variable addresses the influence that the designer's imagination has in the design process. This element is more fully discussed in the procedural model's formative evaluation analysis.

A careful review of the SMEs' input regarding expertise led to the conclusion that management expertise, user expertise, and client bias were factors that influenced JPA design and should be incorporated into the revised JPA conceptual model. Management expertise and client bias elements were added to the management component.

Target Population

Dick stated that the term "target population" was too broad and needed a more definitive presentation. He suggested that a distinction be made to reflect skills and attitudes. Dick stated:

> . . . just a distinction between target population, present skills and maybe attitude or something like that, that its, you know what about its target population, I guess? It just seemed really, really, really broad.
>
> Well, skills and attitudes or — but I'm thinking all those things that Rita [Richey] identified in her research that she did over there at Ford. Which kind of really opened up my eyes to the factors that are involved when you look at any part of population. That's frankly what went through my mind when I saw this. And maybe it is, see if anyone else comments on it. It just seemed really broad to me.

Westrum also called for more elaboration which corresponded with Dick's evaluation. Dessinger agreed with Dick and Westrum as she stated in regards to the JPA's design and user expertise, ". . . You may in fact be gearing it for several different levels."

The suggestions by Dick, Westrum, and Dessinger led to the conclusion that skills and attitudes should be sub-elements of the target population reflected in the JPA conceptual design model.

Analysis

Three SMEs addressed performance analysis. Dick suggested that the analysis component also incorporate performance failures. The point he made was that some JPAs will have to reflect a task in which standards have not been established. Dick stated:

> Well, what I was thinking about is there are certainly situations where you're creating a new curriculum for a particular job and that job has standards that have been established say by federal agency or by, well you've got that regulatory standard — corporate standards for example. And that's one situation, but the other situation is one in which you're already, somebody's performing on the job, a number of people perform on the job and there are performance failures. And you need to look at why is this happening?

Dessinger also stated that there were situations in which standards did not exist. She stated:

> The idea very often is there is no standards and that's one of the problems. There are no standards for the job or for the performance. And I know the industry that you're primarily interested in tends to hit standards. But in general I think most industries don't.

Based upon the arguments of Dick and Dessinger, it was concluded that an element termed "performance failure" should be added to the JPA requirement component.

Model Component Relationships

Areas that were addressed by Rowland and Westrum included the methods used in the model to reflect relationships. Rowland spoke of the difficulty of visually depicting relationships and Westrum spoke of the model's representation. Rowland stated:

> We have instructional systems that have components and you know you can boil it down to who, what, when where, why and those sort of things. But the only representation, to my knowledge, that have relationships shown, tend to be just linear procedural models. And I'm not satisfied that that is what represents a system in the thinking of an experienced designer. . . . And I'm finding that there's some very interesting relationships the experienced designers come up with. They are not clear from arrows. You know sort of like this arrow doesn't mean the same as that other arrow there. That kind of thing.

Although Rowland did not suggest to make changes to the visual representation reflected in the initial JPA conceptual design model, he cautioned that arrows and boxes do not necessarily mean the same thing to every designer. It is argued that Rowland's comments emphasizes the need for the caution note made on the JPA procedural design model.

Westrum was concerned with the gray circle that connected the conceptual model's components. He argued that since the conceptual model did not reflect a linear process it was not necessary to connect them. Westrum stated:

> Well, I would eliminate the circle altogether then. I'd just have the arrows going into the JPA procedural model. . . . You've got part of a diagram which doesn't mean anything and that's why its good to eliminate.

Additionally, Westrum addressed the display component and suggested that the arrangement of information played an influential role. Westrum referred to the message design component of the procedural model and he related it to the conceptual model as he stated:

> Because you've got visual organization and structure below it [the message design component of the procedural model]. But under visual organization structure you have everything but what I would call the arrangement and flow of messages. . . . You've got things like fonts and type sizes and so forth and headings and so forth but it doesn't talk about the special arrangement of the stuff on the page or the tag or whatever you've got.

Based on Westrum's suggestions, the gray circle that connected the model's components was removed. It was felt that this revision eliminated clutter and made for a cleaner presentation. Additionally, it was concluded that Westrum's argument for addressing information arrangement was well-founded and the element of information arrangement was added to the display component.

A summary of the critique items identified by the SMEs and revisions made are presented in Table 5. The revised graphic representation of the JPA conceptual design model is presented in Figure 6.

SME Evaluations: The JPA Procedural Design Model

The analysis of the SME's formative evaluations of the JPA procedural design model identified model flow, the possibility of including rapid prototyping into the model, error, and imagination as areas of consideration to revising the model. Critique areas that were identified during the examination of the SMEs' interviews are presented in Appendix F.

Table 5

Summary of Revisions To The JPA Conceptual Design Model

Critique Items of Original Model	Revisions
Title and purpose of model	Revised to reflect a model that's generic to a wide variety of JPAs. Changed subtitle to "variables that influence. . ." to state purpose of model.
Gray circle used to connect components.	Removed gray circle as no direction is reflected and to eliminate clutter.
JPA Requirement component	Added "performance failure" to elements.
Component descriptors.	Revised to state "variables" in place of "factors."
Designer Expertise component did not address imagination.	The element of 'requisite imagination" was added.
Management component did not address management expertise and there was confusion on evaluation.	The element of "management expertise" was added. The element of "evaluation processes" was removed.
The variable of bias was not addressed.	The element of "client bias" was added to Management component.
The element of "target population" was found too broad.	A sub-element of "skills and attitudes" was added to Analysis component.
The descriptor for the Strategy component indicated a "most optimum method" which did not match sub-title of model.	The descriptor was revised to state "variables that influence the selection of methods. . ."
Evaluation Component was confusing.	The elements for Evaluation were revised to simplify presentation.
Display component did not address the arrangement of information.	The element of "information arrangement" was added to Display component.

Note. Critique items obtained from the analysis of SME interview data (see Appendix F).

Model Flow

Dessinger strongly advised to indicate that the procedural model was developed for the design of JPAs in high risk environments. Although not directly stated, the overall sense of the other SMEs' interviews suggested that there was a need for the model to better to state its purpose.

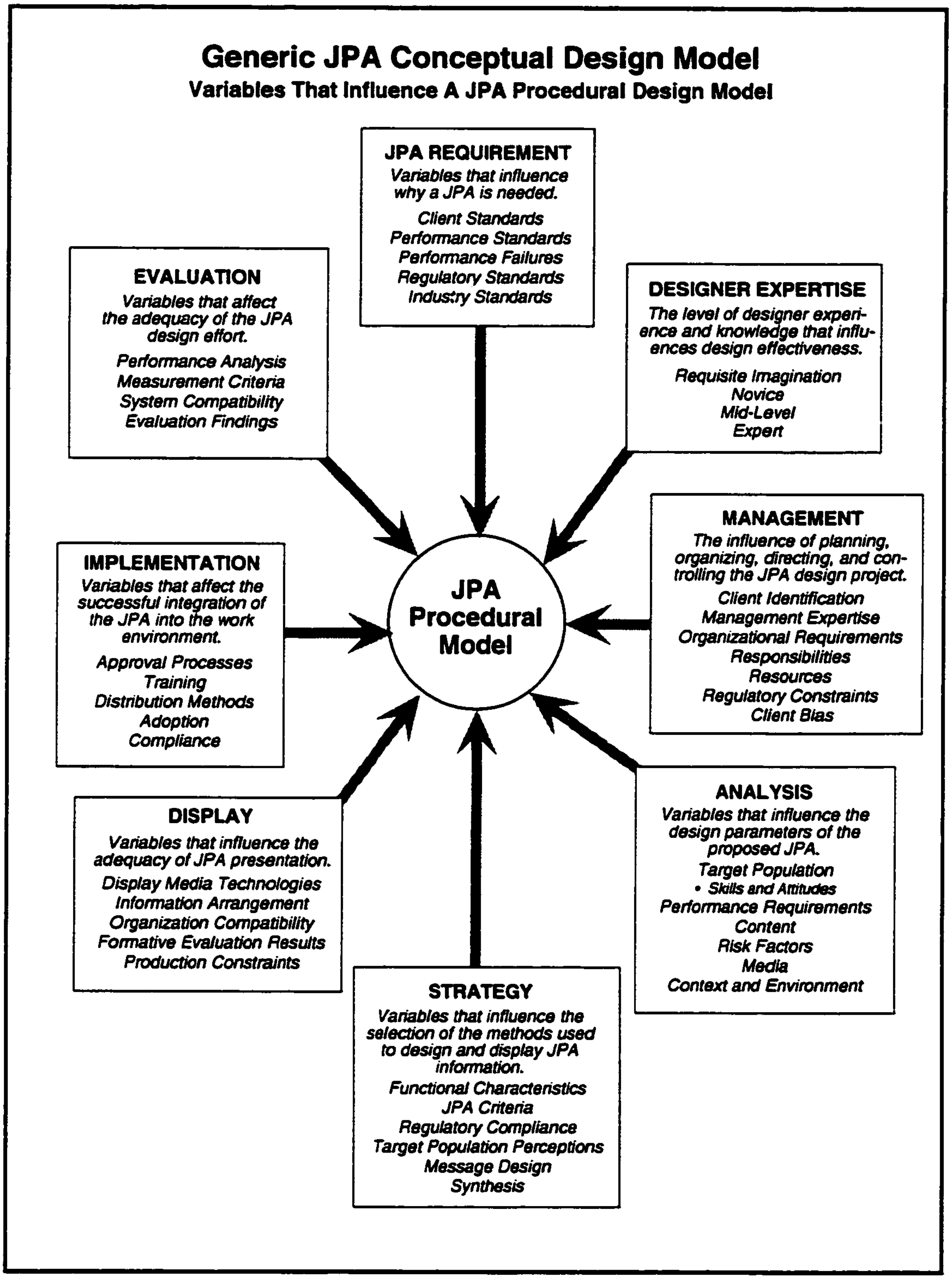


Figure 6. Revised conceptual job performance aid design model.

Mosier stated, "Well one thing (in reference to the procedural model] is you never say anywhere that a JPA is an automated aid. Is it always automated?" Mosier also questioned the use of arrows as reflected in the model. She pointed out that a flow was not indicated between the components. Mosier asked, ". . . are the steps meant to sequential or conducted in parallel?" She also stressed a need to reflect an iterative process between the procedural components and the conceptual model as she stated, "What you might want to do is. . . have the arrows that go from the center, perhaps they should go both ways, to and from the center. Then that would make it, you know more iterative to go back."

Altman, however, found little problem with the model's flow path. He stated, "I didn't see any problem with them. You know probably because I'm assuming this is kind of like a closed loop thing and maybe on your wheel, your shaded wheel, you need a beginning and an ending." Altman's comment indicated that the model did, as argued by Mosier, need a clearer depiction of the intended flow.

Mosier also commented on the model's project analysis component. She indicated that since it contained so many elements that the elements should be more visually organized. Mosier stated, "I think because there are so many things under project analysis, I might want to organize that into characteristics of people versus characteristics of the aid versus characteristics of the context.

Rowland questioned the use of the term perceptual design. He found the distinction between the component of perceptual design and the component of message design confusing. Rowland stated:

> All right, here are a couple of other comments on the procedural design model that I noted here. I think the first time I saw it I didn't quite capture the difference between perceptual design and message design. After I read the stuff later on, I came back to it and I noted to myself, I wonder if it would be better to call it perceptual factors rather than message design, and that seemed to help me solve that distinction problem at first. . . . . And when I got to the follow up information, the more detail in there, I realized what that distinction was. Or I wondered whether perceptual design might be better called perceptual factors. Something different, because it wasn't really a design kind of thing.

Additionally, Rowland expressed a caution concerning the complexity of the model. His concern dealt with the wide range of potential users of the model and the importance of sufficient background information to accompany the graphic representation of the model. His concern involved the comparison of the Dick and Carey of instructional design with the JPA procedural design model. Rowland stated:

> But when you bring up something like Dick and Carey's model. My experience has been with novices, that they are better off without it if they don't have the whole book explaining it. That is it gives them this sense that all they got to do is X, W, and Z. They got to [will] come up with some quality instruction from it. And I find that to not be the case at all. They start appealing in their search for quality to the process rather than to the product. So that's a caution I would just raise when you said that the audience is that wide.

As a result of these comments it was concluded to revise the title of the procedural model to indicate its application to high risk environments. The model's application to both automated and non-automated JPAs is reflected by the display technology element of the project analysis component. Furthermore it was decided to more fully depict the flow of the model by the use of arrows; however, it was also concluded not to use two-way arrows between the procedural components and the conceptual model. This conclusion was based on the reasoning that the variables depicted in the conceptual model influence the design process reflected in the procedural model and not vice versa. Consequently, the conceptual model's depiction was revised to be presented as a model centered in the procedural model that radiates influence to the entire procedural model.

It was decided to adapt Mosier and Rowland's comments regarding the elements of the project analysis component and the term for the perceptual design component. The elements used in the project analysis component of the model were revised for better visual organization and the term perceptual design was changed to perceptual factors. Lastly, Rowland's concern about the wide range of users is addressed by enhancing the definitions used for the model's elements.

Rapid Prototyping

A possible consideration to the JPA procedural model that was discussed by four of the SMEs was rapid prototyping. T. S. Jones (E-mail, September 30, 1997), a doctoral candidate who is conducting research into rapid prototyping, provided the following definition:

Rapid Prototyping is the acceleration of the instructional systems design process by introducing an executable version (i.e., a working model) of the final product to users early in the design/development process. The first version of the prototype is introduced after some analysis is conducted and early in the design phase. The user's assessment of the prototype provides input, including significant modifications, that can be made prior to product completion without incurring significant cost and time. The rapid prototyping process allows for multiple iterations and fine tuning to meet the needs of the user and ensure product usability.

Dick made a strong argument for incorporating rapid prototyping. He stated:

In the procedural model, I have only one major suggestion and this may be worth spending a little time talking about. This has to do with, does your model, should your model include the concept of rapid prototyping and this, as I looked at the model, I looked at the assessment activities coming — you know, I realize this is in a circle and you say they can jump around. But most people think of assessment coming after the product is out there. And you also do talk about implementation evaluation, training evaluation, the . . . evaluation. So you're imbedding the formative evaluation concepts as well. But the, I wonder, well I throw it out for your consideration. Where that somewhere around between message design and synthesis, which looks like a kind of an end process evaluation, in order to do that evaluation, you need at least a part of the tool available.

Dick went on to say that the synthesis component really should be a rapid prototype component, but Dessinger suggested otherwise. She stated:

Since this is a procedural model, I was assuming that this really is synthesis which I think of as being different than rapid prototyping and I wouldn't put it as rapid prototyping. . . . Maybe rapid prototyping would start way up with analysis and all of that would become part of rapid prototyping so that by the time you got to development, development would kind of fall out . . . That is rapid prototyping in my, the way we do it for [a] project, generally [for] job aids is that we immediately with analysis do design and development so I don't see that it [replace synthesis], I think it might be an alternative or it could be or you could say that this is what you want to do but it would have to come up front.

Rowland also questioned the synthesis component and he replied when queried about replacing it with rapid prototyping stated:

It's not something you can just put a rapid prototyping step in a linear model like this. It's a different conceptual framework, it's a different way of approaching the task. So I wouldn't choose to place it in this. It's almost like you're trying to reflect all design processes with a single procedural model. And I just don't think that's possible or wise even.

Dessinger also referred to the synthesis component, rapid prototyping, and possibility of complicating the model as she stated:

You could impose a — I don't know if that would complicate things. Impose an alternative rapid prototyping that you could go through all these stages as separate and distinct stages, ending with symptoms that evolve the material before you actually go into development. Or you could indicate that the alternate way is to develop as you

> go, literally. . . . almost a dotted box or something that indicates that really from project analysis through synthesis can be done using a rapid prototyping model as well. Or it can be done as a separate unit.

Dessinger's analysis of rapid prototyping corresponded with Rowland's perspective that rapid prototyping required a different framework as she called for a separate unit. Mosier indicated that rapid prototyping might be feasible but she was unsure of implementation. Mosier cautioned that rapid prototyping might "leave out the issues about the goals and objectives and organizations."

Westrum, when queried about rapid prototyping replacing the synthesis component stated, "Synthesis is a bad word for it, it also appears to me that this particular step, at least my impression was that this particular step was not as well thought out as some others."

Consequently, after consideration of the various SMEs' comments about rapid prototyping, although there was a sound argument to incorporate rapid prototyping into the procedural model, it was decided to follow Rowland's recommendation which was not to incorporate rapid prototyping into the procedural model. This conclusion was based on the reasoning that the procedural model was basically a linear process and rapid prototyping called for a different conceptual framework. Furthermore, the component of synthesis was eliminated.

Error

An area that emerged during the SME formative evaluations which was not part of the original design parameters concerned error. As stated in Chapter I, error provides for the possibility of catastrophe in HRHR organizational systems; consequently, it is an area of major importance in JPA design as brought out by three of the SMEs.

Rowland addressed the possibility of a JPA itself creating a new potential for error which calls for effective design by doing things right. He stated:

> What if the JPA actually creates a new task? That if it's not just making one safer, easier, faster, etc.? That the institution of this aid actually changes the situation of human performance. So I guess I'm again reflecting on this sense of doing everything right all along the way, almost opens you up to an error process. You know a process of error accumulation.

Mosier, based upon her work in decision-making by air crews, brought out the importance of the risks associated with violating operational constraints. She suggested that operational constraints somehow be included in the element of risk assessment which is a sub-element of the model's performance analysis component. Mosier asked, ". . . With respect to risk assessment, do you want to have anything about risks of violating operation constraints?"

Westrum addressed the need for redundancy in the message design component of the model to identify errors.

> You've got message logic, perceptual organization, visual information structure which is essentially what I said previously. Literacy — but it doesn't really talk about redundancy, let's see and again what I said, self checking properties of the stuff. That would make an error stand out.

When asked if "standardization" (a term used in the aviation industry that means methods used to achieve consistency and accuracy) would fit the mold of redundancy, Westrum replied:

> No, because standardization simply implies this is the same between apparatuses in separate places. What you really want. . . standardization is a big issue, but that's a different issue than the one I mentioned. The one I mentioned essentially would allow you to spot if different parts of the message or different parts of the — the job aid should encourage the person to make a check about the decision they've made so that the one part of the job aid would call for them to do something and the other part would allow them to check. . . . In other words you want to get away from the single thread design. Where everything has to go exactly right and there's no step to check exactly what you've done.

<u>Imagination</u>

An area mentioned by two of the instructional technology SMEs was the use imagination to foresee potential problems. Each of these SMEs have done major work in the areas of design and commented on the need for a designer to imagine the JPA's content and context.

Dick spoke of this area in regards to rapid prototyping as he used the example of the designer's experience to imagine a final product. He stated:

> I've gone to conventions and I've heard people say "Instructional designers have really got to get on the rapid prototyping band wagon. . . and then you go to the literature and there's almost nothing in the literature in our area. I mean, there are in other areas but not in ours about what rapid prototyping really would be like and how

> people might do it. So it's, you know I think if you kind of take your own experience and say what it would be, but I think it doesn't mean to me that you have to generate the whole product. It says to me that you might create a screen display. For example that had nothing behind it. None of the intelligence behind it but it may be just 2 or 3 buttons. But they could see what it looked like. They could see the environment in which the person would have to be using it and see how a couple of the buttons might work. So that they get a sense of what the tools are going to be like.

Rowland also addressed imagination in the form of a mental trip into the future by referring to Jack Carroll's work in scenario descriptions. He stated:

> Well you see, this is what Jack [Carroll] is saying, you can do something up front if you don't buy into a straight requirements analysis process up front. If you base it on scenarios of use, and you treat it as an imagination, a mental trip into the future here, you can sit down with experts and say, "OK, we can imagine this situation. We can imagine this aid being there." Now how is the scenario going to play out differently than it currently does?

Although not mentioned by Westrum in the formative evaluation interview, he did address the importance of imagination during the initial interview. He spoke of design, evaluation, and potential JPA use. Westrum stated:

> Well I think good training for designing future systems is to evaluate other people's systems and vice-versa — unless you design something yourself, you're really not in a position to evaluate it. Furthermore, the best evaluators are people who have had a lot of experience on how job aids are used — so they are likely to anticipate the things that are going to go wrong and so forth. In other words that [they] have the requisite imagination as I put it — to imagine the ways that the job aid might be misused or misconstrued.

Consequently, it was concluded to add an element termed "requisite imagination" to the designer expertise component of the conceptual model and not include it in the procedural model as it is argued that designer's imagination is a variable that influences the outcomes of JPA design and it is not a procedural step in design.

The SME formative evaluation critique items and revisions to the model are presented in Table 6. The revised JPA procedural design model is presented in Figure 7. The revisions include the reduction of graphic clutter, a better representation of model flow, and the incorporation of the formative evaluation findings regarding the definitions of the model's components and elements.

Table 6

Summary of Revisions To The JPA Procedural Design Model

Critique Items To Original Model	Revisions
Purpose of model unclear in title.	A sub-title was added to title to reflect use in high risk environments.
Direction or model flow unclear.	The gray circle was replace with arrows that reflect model flow. An "end project" step was added.
The element of "evaluation" in each component was confusing.	Evaluation elements were removed and processes reflected graphically.
JPA conceptual model relationship unclear.	Arrows removed and detailed representation revised to reflect an overall relationship with procedural model.
Synthesis component confusing.	The Synthesis component was eliminated.
Training component required amplification and clarification.	The Training component was repositioned to precede the Development component. The element of "practice" was added.
Visual organization of Project Analysis component is confusing.	The elements were revised to visually organize the elements.
The elements of the Project Analysis component required clarification.	The elements of "project initiation, task identification" and "population characteristics"
Project Analysis component continued. . .	were added to component. The elements of "performance need, end-user," and "literacy" were removed.
Elements of the Performance Analysis component requires further explanation.	Elements revised to address definition of task, performance criteria, and time dependence of task.
The elements of the Design Criteria component are confusing.	Elements revised to more accurately depict procedural steps. The element of "format strategy" was repositioned to the last step.
The term Perceptual Design for this component does not meet intent of component.	Revised to Perceptual Factors which more accurately meet intent of this component.
The element "action logic" needs clarification.	The element of "action logic" revised to "task logic."

(table continued)

Table 6

Summary of Revisions To The JPA Procedural Design Model

Critique Items To Original Model	Revisions
The elements of the Message Design component appear confounding.	The element of "visual information structure" was removed. The element of "redundancy" was added.
The Training component does not address practice.	"Practice" was added as an element of the Training Component.
Evaluation processes are confusing and redundant.	The various "evaluation" elements were removed from each component. The element of "formative evaluation" was added to the Development component.
The Assessment component is not appropriately titled. The elements are confusing.	Assessment was revised to Evaluation. The elements were revised to more accurately reflect the steps and simplify presentation.

Note. Critique items based on SMEs' interview analyses (see Appendix F).

JPA Procedural Model Definitions

The SME formative evaluation of the definitions of the procedural model's terms provided a number of considerations for revising the definitions which had an effect on the presentation of the JPA procedural model. Due to the extensive nature of the revisions, the original definitions are presented in Appendix E, the first-round SME evaluation package. The revised definitions, which are based on the first round evaluation, are provided in Appendix G, the second round SME evaluation package. The final revised definitions, which are based on the second-round SME formative evaluations, are presented in Table 8 following the discussion of the second-round findings.

A problem associated with the development of any conceptual or procedural model is the explanation of the terminology used to define the model's elements. The SMEs addressed the definitions based upon their respective disciplines and the comments led to the conclusion that a need existed to synthesize the SME concepts into one that met the intent of the JPA conceptual and procedural models.

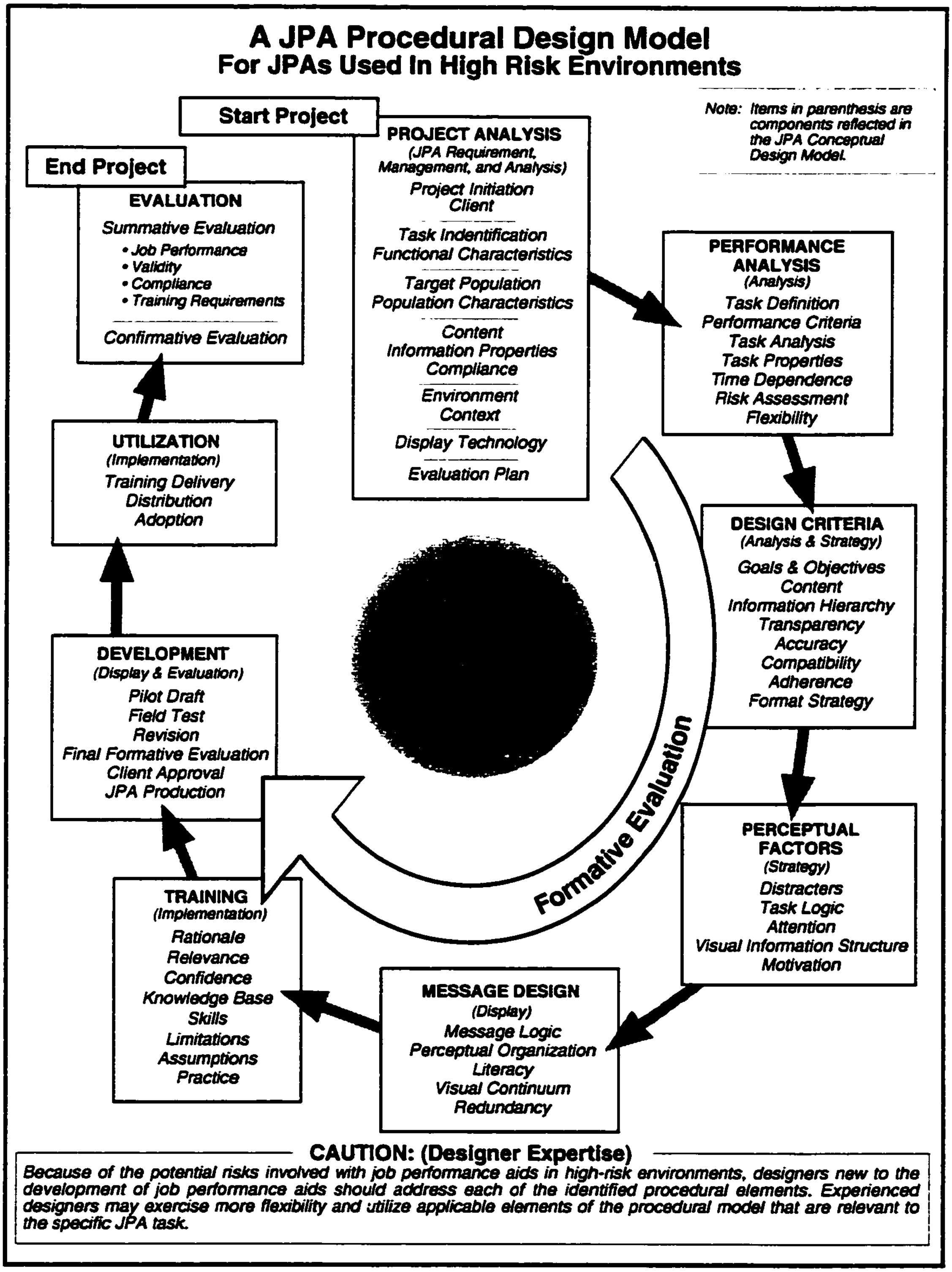


Figure 7. Revised procedural job performance aid design model.

Altman, representing the field of human factors, made an argument to simplify the definitions in order to make them more user oriented. He argued that some of the definitions were too academic and needed to be refined for users outside the academic environment. Using the definition of "client" as an example, Altman stated:

> So then, the client. . . you're defining the client as who the decision makers are. And what I wrote here was the client is the originator of the need, the client has a problem, a task function requiring a JPA. . . . Because, what I was not feeling comfortable with is some of the definitions. You know, I felt like some of the definitions were a little bit too academic and not quite enough user oriented.

Although not mentioned by other SMEs, Altman's argument has merit. The problem is that from a developmental research perspective it is necessary to provide as complete a definition as possible and to define specific terms within the context of instructional technology and human factors which meet the definitions' intent of the items as used in the JPA model. Consequently, during the analysis and revision stage of Phase Two, each definition was reviewed to incorporate the SMEs suggestions, when applicable, and to re-evaluate the complexity of the definition as suggested by Altman.

Two terms that created great confusion were "target population" and "end user." The initial definitions were found to be too similar and confounding. The confusion was summarized by Dick as he stated, ". . . target population, end-user — I'll be darned if I could tell the difference. I went back and forth between those two definitions. Target population defines the end-user. The end-user is a member of the target population."

Altman also expressed confusion as he perceived the terms in a different perspective. Altman stated:

> The target population to me, refers to the growth group. The people that are going to be affected. End-user reflects to me the individual who is actually going to complete the task, you know complete the task or the, no lets see, not the task. The end-user is the one who is going to use the document in order to accomplish the project. . . . Then on target population, I felt like that those should actually be reversed. I think that end-user and target population should be flipped.

This confusion was discussed with the remaining SMEs to determine a consensus on terminology. The three human factor SMEs preferred the use of target population and the three instructional technologist SMEs preferred the use of end-user. The professional designer SME preferred target population. Consequently to avoid confusion, it was concluded to eliminate the term end-user from the model. Although either term would have been acceptable, it was decided to use target population as, from a deductive perspective, it appeared to more closely meet the intent of the model's presentation.

There were a number of SME comments that addressed the definitions. Each SME comment was analyzed to determine if similar or related comments were made by the other SMEs. The comments were analyzed by means of highlighting key words and concepts in the information-management-system database.

There were a total of 93 critiques items and 161 key terms identified in the information-management-system database and used to develop a rationale for revision. The critique items and key terms were based on the common themes identified in the analysis of the SME formative evaluation interviews. Appendix F presents the SME interviews and the highlighted key terms which were used to cluster common areas. The decisions to revise the procedural model's definitions were based on the SMEs' comments, arguments, and number of times the issue was addressed.

It was also found that some definition revisions required a change to the graphic representation of the model. This was necessary when the formative evaluation indicated that elements should be added to or deleted from a component of the procedural model.

The SMEs' critiques of the definitions and the subsequent revisions are summarized in Table 7. The critique items are clustered and presented in relation to the graphic representation of the components and elements of the procedural model. The revised models and definitions were then sent to each SME for a second-round formative evaluation.

Second Round SME Formative Evaluations

The second-round SME formative evaluations provided a means for closure to developing a synthesis between the instructional technology and human factor perspectives. The SME comments were minimal and primarily focused on the fine tuning of the JPA models and associated definitions.

Table 7

Summary of Revisions To The JPA Procedural Model's Definitions

SME Critique Item	Revision
Confusion between "target population" and "end user" in the Project Analysis component.	Eliminated term "end user" and redefined "target population." Added "population characteristics" to more fully describe "target population."
Definition of "environment" in the Project Analysis component does not address social environment nor does it address a range of conditions.	Added "social" factor to definition and revised definition to address a range of potential environmental conditions.
Determination of task unclear.	Added "project initiation" and "task identification" to Project Analysis component.
The "time" element of the Performance Analysis component lacks performance level desired.	Revised element name to "time dependence" and included level of desired performance in definition.
Formative evaluation definition.	Revised to define formative evaluation as process used to determine need for corrections.
The "message logic" element of the Message Design component fails to reflect relationships.	Revised and amplified "message logic" definition.
The Performance Analysis component fails to identify task.	The elements of "task definition" and "performance criteria" added to component.
The element of "time" of the Performance Analysis component does not address level of performance required.	This element revised to "time dependence" and defines time and level of performance as potential constraints to effective performance.
The element of "format strategy" of the Design Criteria component is not clear.	Revised definition of "format strategy" to include physical and content specifications.
Practice is not addressed in Training component.	The element of "practice" was added to Training component.
The "evaluation" elements of the model's components were confounding and need clarification.	The elements of "evaluation" were removed from applicable components. The definitions for the elements of "summative evaluation" and "confirmative evaluation" were revised to include job performance.

(table continued)

Table 7

Summary of Revisions To The JPA Procedural Model's Definitions

SME Critique Item	Revision
The component of Perceptual Design does not meet intent.	The term was revised to Perceptual Factors and the elements were revised for clarity.
The element "functional characteristics" reflects a different meaning between the Project Analysis component and Design Criteria component.	The definition was revised and amplified for clarity. Additionally, it was removed from Design Criteria component to eliminate confusion.
The use of "literacy" is confusing between the Project Analysis component and the Message Design component.	Literacy was removed from Project Analysis and revised for clarity in the Message Design component.
The element "information properties" of the Project Analysis component is unclear.	The definition was revised to more fully explain examples used. Additionally, the requirement to update information was added.
The "display" element of the Project Analysis component fails to address technology and previous analyses data.	The definition was revised to address previous analyses and types of display technology.
The element "task analysis" of the Project Analysis component is confusing.	The definition was revised for clarification and the relationship to JPA physical characteristics was eliminated.
The element "risk assessment" of the Project Analysis component needs clarification.	The definition was revised to include types of risks and risk to flexibility in performance. Additionally, a factor of value was added to definition.
The element "adherence" of the Design Criteria component is unclear.	The definition was revised for greater clarity.
The definition of the element "goals" of the Design Criteria component was incomplete and used in confusing manner. Confusion exists between purpose, objectives, and "functional characteristics."	The element was changed to "goals and objectives" and each term was specifically defined. Functional characteristics was eliminated from the Design Criteria component.
The element of "action logic" in Perceptual Design component was unclear.	The term was revised to "task logic" and more clearly defined. The component was renamed Perceptual Factors.

(table continued)

Table 7

Summary of Revisions To The JPA Procedural Model's Definitions

SME Critique Item	Revision
The element of "motivation" of the Perceptual Design component lacks the factor of personal values.	The definition was revised for clarity and to include personal values as a motivational factor. The component was renamed Perceptual Factors.
The element "motivation" is not clear with use of term "effective use."	The definition was revised to clarify effective use.
The element of "knowledge base" of the Training component is unclear.	The definition was revised to reflect pre-requisite knowledge.
The element of "limitations" of the Training component is unclear in regards to selective attention and salience.	The definition was revised for clarity and the terms selective attention and salience were eliminated.
The sub-element of "target job performance" is confusing as used in the element of "summative" under the Evaluation component.	All definitions related to evaluation were revised for clarity and to simplify presentation. The sub-element of "target job performance" was changed to "job performance" and redefined.
Suitability element of the Evaluation component is not necessary.	This element was eliminated.
The "compatibility" element of the Design Criteria component is unclear.	The definition was revised to clarify definition.
The element "user compliance" of the Design Criteria component needs to be simplified.	The element was changed to "compliance" and the definition revised to address rules and regulations.
The element of "context" of the Project Analysis component needs clarification.	The definition was revised to address a range of circumstances instead of possible circumstances.
The element "adherence" of the Performance Analysis component requires clarification.	The element was changed to "flexibility" and the definition was revised to address task deviation. The term "adherence" was moved to the Design Criteria component and the definition revised to reflect a specification of the desired level of performance.
The definition for the element "perceptual organization" of the Message Design component needs simplification and focus.	The definition was revised to focus on visual information structure, message arrangement, and message flow. The descriptor "Gestalt" was eliminated.

(table continued)

Table 7

Summary of Revisions To The JPA Procedural Model's Definitions

SME Critique Item	Revision
The element of "visual information structure" of the Message Design Component is confounded with the "perceptual organization" element.	The element of "visual information structure" was eliminated and the definition's descriptors were integrated into the "perceptual organization" element.
The definition for the "revision" element of the Development component refers to revising discrepancies.	The definition was changes to reflect "revising" discrepancies.
The element of "compatibility" of the Design Criteria component needs to address other JPAs.	The definition was revised to stress potential conflict with other JPAs in same work environment.

Note. Critique items based on SME interview analyses (see Appendix F). See Appendix G for the revised procedural model's definitions which are based on the first-round SME formative evaluations.

W. Dick (E-mail, November 6, 1997) made the following comments in regards to fine tuning the final revisions to the models and definitions.

> Generic JPA Conceptual Design Model: All the boxes refer to variables except Designer Expertise and Management. Aren't these variables that effect the quality of design and management?
>
> Under designer: novice, mid-level and expert are not separate but rather are levels of expertise, just as you have listed management expertise in the Management box.
>
> Under Strategy I find the descriptors too brief. It is the functional characteristics of what that influences the strategy; it is the synthesis of what that influences the strategy?
>
> Context and environment under Analysis. I have looked at your definitions of these terms and frankly, can't tell the difference.
>
> Procedural Design Model: I have no additional comments here other than to say that it certainly looks like the ISD model to me. In your write-up will you indicate how the model is similar to and different from the ISD approach?
> . . . . Will you be doing a formative evaluation of your model? Does it work? Can you use it? Can anyone else use it? I think that the answers to these questions are much more important that what I think of the model.
>
> By the way, I thought that your whole rationale was needed to deal with specifically high risk situations. What happened to this dimension of the study. If this model [conceptual model] is now generic, how does it differ from the one used by Allison Rossett in her book?

Dick's comments led to an even closer look at the JPA conceptual model's presentation of the Designer Expertise component. R. Westrum (personal communication, Nov. 11, 1997) and H. B. Altman (e-mail, Nov. 16, 1997) also agreed with the suggestion to use "level of experience" as the descriptor element. J. Dessinger (personal communication, Nov. 17, 1997), however, argued for keeping the sub-elements of "novice, mid-level," and "expert" as part of the component. Dessinger stated, ". . . some parameter is necessary." She argued that these details were important enough to display in the conceptual model.

It was concluded to revise the Designer Expertise component of the conceptual model to reflect "level of expertise" to more aptly describe this component as a variable, and it was further concluded to eliminate the sub-elements of "novice, mid-level," and "expert" to reduce the complexity of the model. Although Dessinger's argument for inclusion of these factors was sound, it was concluded that the use of "level of expertise" also reflected the same meaning as the more detailed sub-elements.

Dick's comment on the Strategy component led to a closer look at the descriptors used and intent of the component. Dessinger (personal communication, Nov. 17, 1997) suggested changing the component title of Strategy in the conceptual model to Strategy Selection as it more aptly fit the intent of the model's component.

The review of the Strategy component pointed out that the element of "functional characteristics" was confusing (as pointed out by Dick). It was concluded to replace it with the element of "purpose." The term "functional characteristics" works well in the procedural model but, upon further examination, appeared confusing in the conceptual model. Consequently, the element of "functional characteristics" was replaced with the element of "purpose." Additionally, it was decided not to add the term "selection" to the Strategy component's label as it was felt that the term of strategy alone sufficed; plus, it reduced the potential for additional visual clutter.

Dick's comment regarding the context and environment elements of the Analysis component of the conceptual model was reviewed and it was concluded that there was sufficient differences between the two terms to merit the inclusion of each within the component, but that each should be displayed as an individual element (see Figure 8). This distinction was explained to Dick by E-mail (A. Adamski, E-mail, Nov. 7, 1997):

> . . . The difference: context refers to possible operating situations regardless of environment (normal or emergency);whereas, the environmental factor refers to "physical" (work space, noise, heat, lighting, etc.) and "social" which includes individual or team or combination of performance. . .

Dick replied the following day and concurred with the explanations (W. Dick, E-mail, Nov. 8, 1997). Additionally, Dick concurred with explanations of his other critique items. The explanations included the following (A. Adamski, E-mail, Nov. 7, 1997):

> Yes, the Procedural Model took the shape of the ISD model. The difference, I hope, is reflected in the elements of each component which are focused on JPA design for high risk environments. And yes, I will discuss similarities and differences in conclusion of this phase of study. . .
>
> Try out of model: Yes, the next phase of study involves the designing of a JPA using the procedural model. The proposed JPA is a device to assist cabin flight attendants in completing the preparation of passengers and cabin for an emergency landing. Hopefully, the JPA will graphically provide the desired performance procedures and decision points where past research and experience have identified problems and led to injuries. The JPA will be field tested in an aircraft/cabin simulator on the West Coast. . . .
>
> The conceptual model is the only part that is generic. . . . It is the procedural model that is the focus of study. The conceptual just provides a framework. . . .

J. Dessinger (E-mail, Nov. 17, 1997) also suggested adding an element of "maintenance" to the Evaluation component of the procedural model. Dessinger stated, "Maintenance is one of the most overlooked ingredients to the success of JPAs. Maintenance is the process of keeping the JPA current and up-to-date for the user and addressing ergonomic factors." Consequently, the factor of maintenance was added as a sub-element of the element of "confirmative evaluation." It was concluded that Dessinger's comment and Rowland's comment focused on the same aspect of confirmative evaluation; that is, to maintain the effectiveness of the JPA throughout its service life.

Lastly, Dessinger (J. Dessinger, E-mail, Nov. 17, 1997) stated that she "liked the changes to the models," especially the change in the title of the conceptual model which was revised to reflect its generic role.

G. Rowland (personal communication, Nov. 24, 1997) made three comments based upon his second-round evaluation of the JPA SME package. He maintained, "One needs to consider the projected life of the JPA; that will determine the time guidelines for the confirmative evaluation." It was concluded that this suggestion fittingly completed the element of "confirmative evaluation" of the Evaluation component in the procedural model. It provided a more complete picture to the future users of the procedural model as to the time and place for confirmative evaluation.

Rowland also noted the use of formative evaluation in the procedural model need not be displayed twice. Upon a closer examination of the procedural model it was determined that the element of "final formative evaluation" of the Development component was extraneous as the formative evaluation process is aptly reflected by the large sweeping formative evaluation arrow. Consequently, this element was removed from the Development component to eliminate clutter and to make for a cleaner display of the model.

Rowland's last comment suggested that not only is "level of expertise" needed in the Designer Expertise" component of the conceptual model, but an "area of expertise" element should be added. Rowland explained that in many of the design projects with which he had been involved that the "area of expertise" the design team member brought to the design team was an important factor to design success. Consequently, the element of "area of expertise" was added to the Designer Expertise component (see Figure 8).

Westrum (personal communication, Nov. 11, 1997) addressed the clarity of the revised models and he suggested two changes. He stated:

> I like the way the diagrams have been cleaned up. I only have one comment. I would suggest to change "target population perceptions" of the Strategy component in the conceptual model to something like "target population expectations. What I believe you are looking for is to make the JPA acceptable to the target population and this can be defined as what the target population expects and is willing to accept. This, I think, makes it more of a variable. I also noted that the descriptors of Designer Expertise could be revised. It makes a lot of sense to change them to the suggestion by the other panel member to "level of expertise."

Altman responded by e-mail (November 16, 1997). He emphasized the need to keep the models and definitions simple as possible. Altman was also probed in regards to the descriptors used to explain the Designer Expertise component of the conceptual model and the descriptors being too brief. His responses focused on the future users of the models as he stated:

> For the dissertation, I concur the use of "level of expertise" is more appropriate than "novice, mid-level, or expert". . . while these terms most likely would be sufficient for most, a more "open" approach is going to be easier, i.e. level of expertise.
>
> Also, as to the descriptors being too brief, I firmly believe in "KISS." Should a reader wish to "read" into a descriptor their own "interpretation" then so be it, you can't please everybody. KISS it. . .or buy another ream of paper!

The professional graphic designer expressed one area of concern. He suggested that component of Perception Factors in the procedural model be placed prior to the component of Design Criteria. G. Miller (personal communication, Nov. 26, 1997) stated:

> After reviewing your definitions and from my perspective as a designer, I would want to deal with the Perceptual Factors before I deal with the Design Criteria. The things that the perceptual factors deal with are things that I need to know, such as the distracters and the action logic. Placing Perceptual Factors before Design Criteria just makes more sense to me.

A review of the element definitions of each of the procedural model's components addressed by Miller indicated that his analysis of the process was more fitting than the displayed sequence. Consequently, it was concluded to rearrange the sequence to reflect Miller's concept of the design process.

Lastly, Mosier had no critique items (K. Mosier, E-mail, Nov. 11, 1997).

Based upon the comments of the SMEs' second round formative evaluation, the JPA conceptual model, the JPA procedural model, and the procedural model's definitions were revised into a final form. Figure 8 presents the final version of the JPA conceptual design model and Figure 9 presents the final version of the JPA procedural design model. Table 8 presents the final revisions to the definitions for the components and elements of the JPA procedural design model. The revised JPA procedural design model and the revised definitions were used to conduct Phase Five of this study which consisted of the design and development of a JPA for an aviation task-specific performance problem.

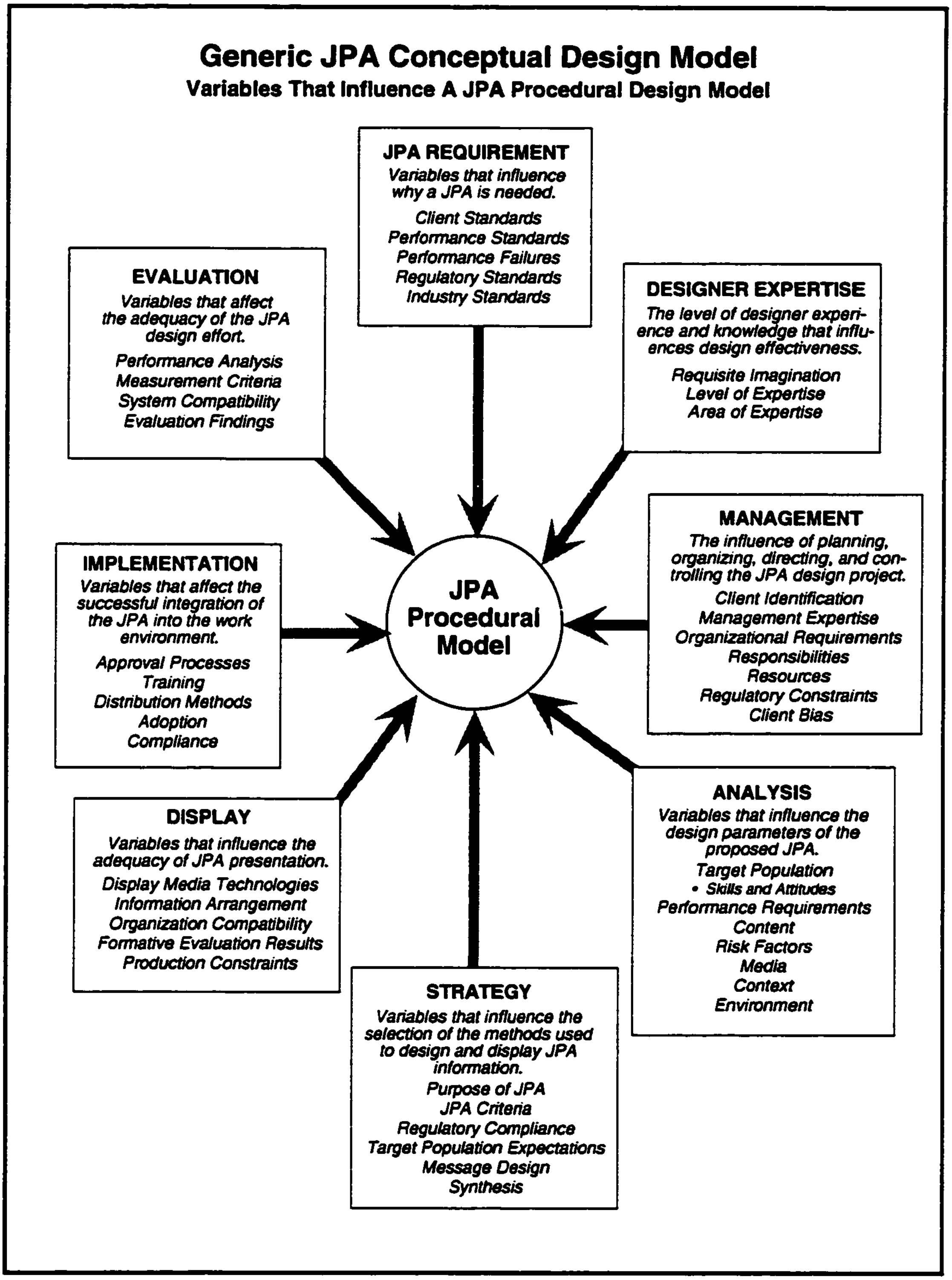


Figure 8. Final job performance aid conceptual design model.

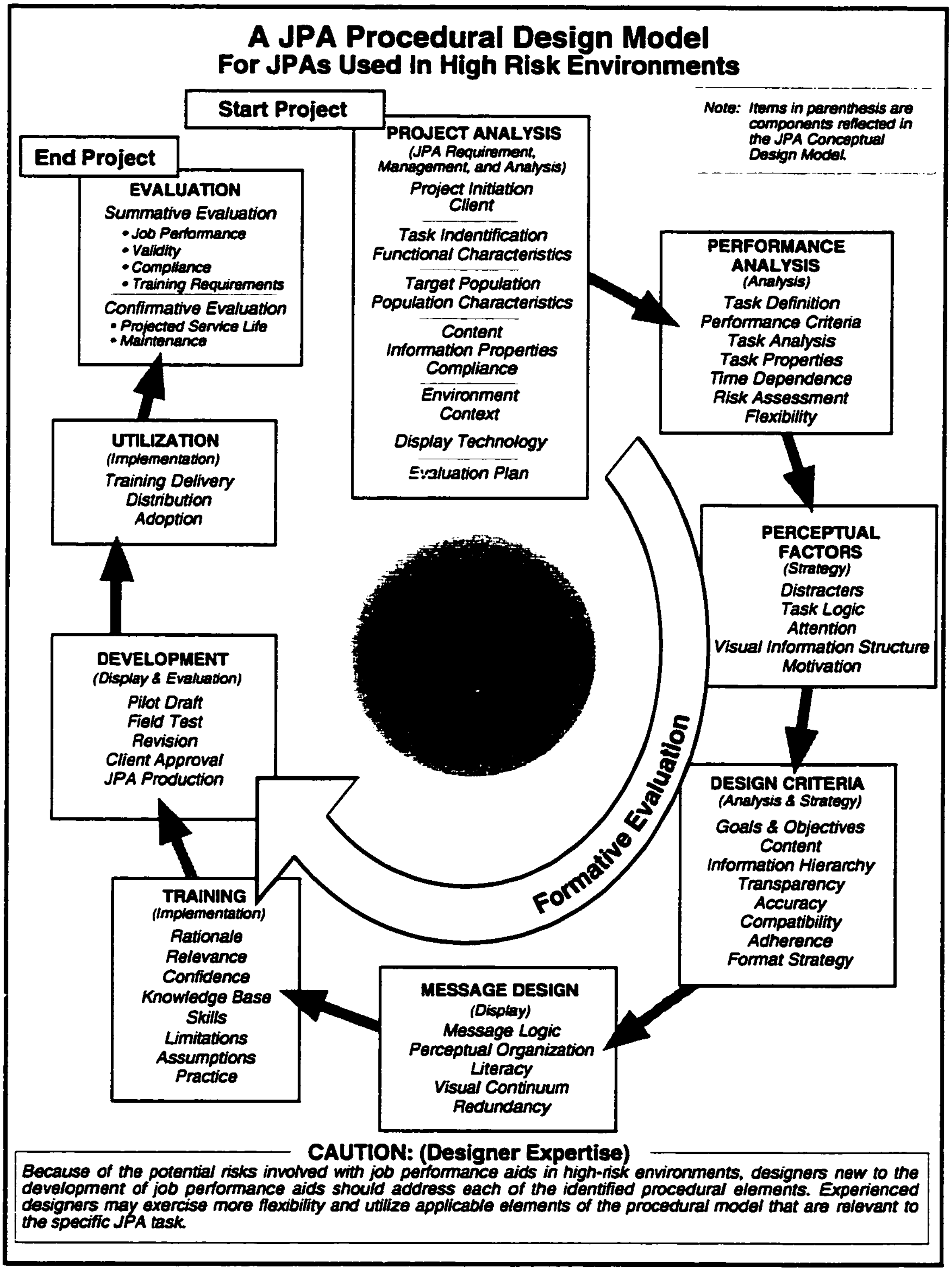


Figure 9. Final job performance aid procedural design model.

Table 8

Final Revisions to the JPA Procedural Model's Definitions

Component/Element	Definition
Project Analysis	This component defines the purpose of the JPA, the type of audience, the job or performance requirement, the environment in which the JPA will be used, and organizational factors that affect JPA design, development, and implementation.
Project Initiation	This element defines who initiates a JPA project and why. For example, the initiator may be an organization such as an aircraft manufacturer that requests the development of an aircraft checklist, a regulatory body such as the Federal Aviation Administration that requires the development of a passenger safety information card, or an individual such as an airline safety director who identifies a gap in performance.
Client	This element defines who holds the ultimate authority for the JPA design project. It specifies who the decision makers are regarding project approval, control of resources, and application of evaluation results. The client may or may not be the project initiator.
Task Identification	This element defines the task(s) that the JPA is to display. This element examines gaps in actual performance or potential gaps in performance. It provides the background information and framework to define the functional characteristic of the JPA.
Functional Characteristics	This element defines the purpose of the JPA. It answers the question, "What is the JPA supposed to do?" For example, is the JPA intended to assist the decision making process? Is the JPA intended to depict the steps of a rarely performed task? Is the JPA intended to serve as a memory device for a simple or complicated task? Or, is the JPA intended to provide alternate courses of action when faced with a specific situation?
Target Population	This element defines the specific segment of the applicable organization's population for which the JPA is intended. It defines the task performer. For example, the target population could consist of only pilots or only of flight attendants, or the target population could consist of a flight crew which is made up of pilots and flight attendants. This element also includes a determination of whether the JPA is intended for use by an individual, by a team, or both.
Population Characteristics	This element gathers data on the characteristics of the intended target population. Characteristics include skills and knowledge, attitudes, and levels of visual and textual literacy. The assessment of visual and textual literacy provides information to reduce the potential for procedural misinterpretation in the JPA's display. Additionally, it assesses the influence of cultural and language differences if applicable.

(table continued)

Table 8

Final Revisions to the JPA Procedural Model's Definitions

Component/Element	Definition
Population Characteristics	This element gathers data on the characteristics of the intended target population. User characteristics include skills and knowledge, attitudes, and levels of visual and textual literacy. The determination of the level of visual and textual literacy of the target population assesses the population's level of comprehension and provides a means to reduce the potential for procedural misinterpretation. Additionally, it assesses the influence of cultural and language differences if applicable.
Content	This element determines what content information is required to complete the task and what content information sources will be used. This element also determines the kind of information that will be displayed (e. g. , quantitative, qualitative, warnings, signals, system status).
Information Properties	This element determines whether the type of information that will be displayed in the JPA is static or dynamic. Static information, such as the information displayed in a printed trouble-shooting guide, does not change. Dynamic information, such as the information displayed in an automated electronic aircraft checklist, is susceptible to change or requires up-dating.
Compliance	This element determines the rules and regulations that the JPA must meet, including equipment manufacturer specifications, government regulations, organizational policies, and others.
Environment	This element determines the physical and social environment in which the JPA will be utilized. It examines the probable and possible physical work conditions to determine both the mean and the range of conditions in which the JPA will be used. Physical conditions include such factors as lighting, noise, vibration, external cues, and physical accessibility of the JPA. It also examines the probable and possible social conditions in which the JPA will be used to determine if the JPA will be used on an individual basis or in a group setting.
Context	This element is an analysis of the range of circumstances under which the JPA will be used. The context element defines whether the JPA will be used in normal operating situations or emergency operating situations or a combination of both.
Display Technology	This element determines the technology that will be used to display the JPA based upon the analysis of the previous elements (e. g., an automated electronic checklist, a printed operations manual, a visual and audio warning device).

(table continued)

Table 8

Final Revisions to the JPA Procedural Model's Definitions

Component/Element	Definition
Evaluation Plan	This element determines the evaluation processes that will be employed during and after the JPA project. It addresses the means to focus on the evaluation processes, reach a state of agreement between the client and the designer, and establish the criteria for project evaluation.
<u>Formative Evaluation</u>	This component is reflected as an ongoing process throughout the JPA procedural design model. It begins with the completion of the project analysis component and ends as an element of the development component. Its purpose is to evaluate each design activity, determine if any corrections are necessary, and determine if any corrections have an influence on previously completed design activities
<u>Performance Analysis</u>	This component defines and determines the desired performance that is to be achieved by use of the JPA.
Task Definition	This element, based upon the initial task identification, defines the specific task(s) to be accomplished with the use of the JPA.
Performance Criteria	This element assesses and defines the level of performance required to complete the task(s) to meet operational and safety requirements.
Task Analysis	This element analyzes the task(s) to determine the steps and behaviors necessary to perform the task(s) to meet the performance criteria. Task analysis also incorporates an examination of task properties.
Task Properties	This element assesses the model-of-expertise that will be used as the basis for the desired performance. It examines the complexity of the task structure and the potential for ambiguity including an analysis of the types of decisions with which the target population will be faced.
Task Properties Continued	It determines if more than one course of action is possible and whether alternate-courses-of-action need be presented in the JPA. Additionally, this element re-examines the previously selected display technology to assure that the technology can display the type and amount of information required.
Time Dependence	This element examines and determines the factor of time on the desired outcome(s) and desired level of performance. It assesses whether the outcome(s) and performance are under any time constraint, and if so, defines that constraint.

(table continued)

Table 8

Final Revisions to the JPA Procedural Model's Definitions

Component/Element	Definition
Risk Assessment	This element examines potential risks while performing the task(s). It explores the types of risks involved including the physical and non-physical. Risk assessment determines the possibility of harm to people or equipment associated with the task(s) and provides the framework to determine if performance flexibility is available or desirable. Risk assessment also examines a personal assessment of value that the JPA may or may not have to the target population.
Flexibility	This element examines if any variance (and if possible, to what degree) is available to the task performer to deviate from the JPA's displayed procedures and to examine the risk associated with the application of individual heuristics by the task performer.
Perceptual Factors	This component addresses design considerations that influence information processing. It determines the detailed design specifications that encompass known perceptual factors which influence decision making associated with the desired task.
Distracters	This element determines potential distracters that could degrade effective use of the JPA and identifies specific areas of the JPA's display which must be adjusted for distracters. Distracters include: (a) environmental factors such as heat, cold, light, noise, vibration, time constraints, and the physical working space; and (b) human factors such as biological, psychological, or sociological stressors, and (c) situational factors such as the operating conditions (normal or emergency) in which the JPA will be used.
Task Logic	This element determines the mental representation (the logic) of the task performance as viewed by an expert or experts who devised the instructions to conduct the task. It provides a means to match the expert's mental representation of the task with that displayed in the JPA.
Attention	This element specifies the physical properties of the JPA that affect the task performer's pre-attentive and attentive perceptions. It also details the specifications for the amount of contrast between levels of information, and provides for sufficient stimulation to compensate for predicted distracters.
Visual Information Structure	This element provides for detailed specifications of the selected display technology. It examines and details display methods which allow the task performer to construct a mental map of the information displayed. Visual information structure organizes information by use of typography, graphics, tables, etc.

(table continued)

Table 8

Final Revisions to the JPA Procedural Model's Definitions

Component/Element	Definition
Motivation	This element examines the factors that increase the probability that the task performer will use the JPA in the desired manner. Motivational factors include: (a) accessibility, (b) ease-of-use, (c) clarity, (d) relevance, (e) risk and potential for personal harm, (f) personal value, and (g) probability of success.
<u>Design Criteria</u>	The design criteria component is the process which sets forth the detailed specifications for the development of the JPA.
Goal(s) and Objectives	This element defines and prioritizes the specific goal(s) and objectives of the JPA design project. The goal(s) is a clearly defined general statement that broadly describes the purpose of the JPA design project. The objectives are clearly defined conditions and specifications of the steps necessary to meet the JPA design project goal(s).
Content	This element is a detailed specification of the information necessary to be displayed to achieve desired performance. This element also determines the information to display in the event alternate courses of action are deemed necessary.
Information Hierarchy	This element provides for a detailed specification of how the content information will be organized. It organizes and prioritizes the information for ease-of-use and comprehension.
Transparency	This element is an analysis of the necessary level of information detail required for systems understanding. It determines whether it is necessary to provide the task performer the rationale behind the recommended courses of action displayed in the JPA.
Accuracy	This element determines that the information to be presented in the JPA: (a) is reliable and accurate, and (b) maintains reliability and accuracy throughout the entire JPA display.
Compatibility	This element determines if any conflict exists between the intended JPA and other JPAs used in the specific work environment. It also determines the potential of multiple fault situations in which more than one JPA may be used. (e. g. , the use of two separate emergency checklists that each address a different system malfunction.)
Adherence	This element is a detailed specification of the level of compliance with the JPA that is required by the task performer. It examines if flexibility in performance is allowable and determines the likelihood that the task performer can or will deviate from the JPA's displayed procedures. Adherence determines when warnings, cautions, and notes should be displayed.

(table continued)

Table 8

Final Revisions to the JPA Procedural Model's Definitions

Component/Element	Definition
Format Strategy	This element determines the specifications for the JPA's physical and content format. It includes a determination of the amount of information to be displayed and a detailed specification of the display technology (e. g. , a printed trouble-shooting guide or an automated electronic checklist). Format strategies include: (a) a directive format that assumes the target population knows little or nothing about the task and the JPA displays all information necessary to complete the task, (b) a deductive format intended for a target population who have knowledge of the tasks and have had training or experience in performing the task and the JPA provides information which serves as a memory device for the task performer, or (c) a hybrid format that incorporates both directive and deductive strategies.
Message Design	The component of message design consists of the application of message design principles to the development of the JPA. Since the field of message design has numerous design principles and techniques, it is not the intent of the procedural JPA design model to provide specific message design methods; rather, the intent is to provide the designer with the primary message design factors applicable to JPAs that need to be addressed.
Message Logic	This element determines the type of message that will be displayed in the JPA. This determination is based on the functional characteristics as determined during the project analysis. Message logic adapts the type of message to the purpose of the JPA. Message types may consist of (a) alert messages that call for action, (b) regulatory messages that present legally binding information or company rules, (c) procedural messages that depict the actions necessary to complete a specific task, (d) instructional messages that provide trouble-shooting information, and (e) integrated messages that have the elements of more than one message type.
Perceptual Organization	This element details the specifications for the visual organization of information by means of a visual information structure. This structure includes the principles of proximity, similarity, continuity, closure, and connectedness. Visual information structure is the application of message design techniques that provide for effective interpretation of the message (JPA). The techniques include the use of fonts and type sizes, typographical cues, the use of headings and advanced organizers, and the use of appropriate white space. Perceptual organization provides for an effective arrangement and visual flow of the message.
Literacy	This element applies the techniques of message design that are appropriate to the target population's visual and textual literacy.

(table continued)

Table 8

Final Revisions to the JPA Procedural Model's Definitions

Component/Element	Definition
Visual Continuum	This element determines the level of realism and detail that is to be displayed in the JPA. It determines and defines any symbols used and assesses the level of detail in any graphics or icons employed in the JPA. This element selects the most appropriate point on the visual continuum for the various segments of the JPA. The visual continuum ranges from the concrete to the abstract.
Redundancy	This element examines the need to provide a means to check that a performance step displayed in the JPA results in the desired outcomes. For example, if a procedural step states to place a throttle to the cut-off position, this element determines the information that should be presented in the JPA for the task performer to assure that the desired results take place.
Training	The training component determines the training content required and delivery methods necessary to implement the JPA effectively into the workplace.
Rationale	This element presents the purpose of the JPA. It describes what the performance task is and how the JPA relates to the requirements of the task.
Relevance	This element presents the factors that make the JPA relevant to the required performance. It addresses the visible and invisible factors that form the rationale behind the development and use of the JPA.
Confidence	This element explores the reliability of the JPA, based on the analysis and design evaluations. Its purpose is to enhance the target population's confidence that the JPA will do what it is intended to do.
Knowledge Base	This element determine the prerequisite knowledge that is required for the target population to interpret and comprehend the information displayed in the JPA. Any knowledge deficiency is presented during training. Examples of knowledge areas may include such areas as equipment systems, environmental factors, teamwork, and situational factors.
Skills	This element determines the prerequisite skills necessary to perform the desired task with the JPA. Any skills that the target population does not possess are identified, described and practiced. Such skills may involve use of a new type of computer key board, scrolling an automated electronic checklist, interpreting digital data, interpreting specific icons or symbols used in the JPA, etc.

(table continued)

Table 8

Final Revisions to the JPA Procedural Model's Definitions

Component/Element	Definition
Limitations	This element presents the capabilities and limitations of the JPA. It describes what the JPA can be expected to do and what the JPA cannot do. System variables and human factors that may affect the capabilities or limitations of JPA interpretation are explained.
Assumptions	This element addresses any misconceptions or misunderstandings of the JPA's capabilities or limitations that are identified during the training program.
Practice	This element determines the need for and amount of practice required to effectively use the JPA.
<u>Development</u>	Development is the process of translating design specifications into the JPA's physical form. It involves the processes by which the JPA is produced and implemented into the workplace.
Pilot Draft	This element consists of the construction of a JPA prototype based upon the data collected from the project and performance analysis components, design criteria component, perceptual factors component, and message design component.
Field Test	This element consists of testing the prototype JPA under actual or simulated field conditions with a representative sample of the target population. An evaluation is made to determine if the prototype JPA meets the needs of the project and performance analysis components, design component, perceptual factors component, and message design component. A pilot training program is also conducted in conjunction with the JPA field test. Findings are documented to validate design or to substantiate revisions.
Revision	This element provides for correcting the JPA's design or training for any discrepancies discovered during the field test.
Client Approval	This element provides for the final approval by the client prior to the JPA going into final production.
JPA Production	This element consists of the actual production of the approved JPA.
<u>Utilization</u>	This component involves the process of introducing the JPA into the workplace and checking on the status of adoption of the JPA by the intended target population.
Training Delivery	This element determines the means to most effectively deliver the required training to the organization's target population.

(table continued)

Table 8

Final Revisions to the JPA Procedural Model's Definitions

Component/Element	Definition
Distribution	This element determines the means by which the JPA will be installed in place and made accessible to all required work stations and members of the target population.
Adoption	This element is a form of confirmative evaluation that evaluates whether the JPA is being properly used and accepted by the target population.
<u>Evaluation</u>	This component addresses summative and confirmative evaluations that are conducted after the JPA project is completed. Formative evaluations (the evaluations conducted after each component as reflected in the graphic model) were ongoing throughout the design process.
Summative	This element is the evaluation process conducted shortly after the JPA project has been completed and implemented. This evaluation reviews all previous formative evaluation findings and determines whether any corrections to the JPA were effective. It also provides for an initial evaluation of how well the JPA has been adopted into the workplace. The summative evaluation includes exploring:
Job Performance	This sub-element explores how well the JPA met performance requirements. It answers such questions as was performance improved? Were performance gaps removed? Did the JPA project meet performance expectations?
Validity	This sub-element confirms that the JPA's information and displayed procedures are current and remain accurate in accordance with technical equipment specifications.
Compliance	This sub-element confirms that the JPA is in accordance with current organizational policies and regulatory requirements.
Training Requirements	This sub-element evaluates whether the training content and delivery methods meet the needs of the target population to effectively use the JPA.
Confirmative Evaluation	This element addresses the process by which JPA effectiveness, accuracy, and regulatory compliance is examined at some time after the JPA has been in place.
Projected Service Life	The time intervals depend on the nature of the JPA, the frequency and impact of regulatory changes, revisions to manufacturing specifications, and revised operating procedures.

(table continued)

Table 8

Final Revisions to the JPA Procedural Model's Definitions

Component/Element	Definition
Confirmative Evaluation Continued *Maintenance*	Additionally, periodic confirmative evaluations determine the durability of the JPA. They assess how well the JPA has maintained its physical properties and withstood damage due to repeated use or long term storage in the work environment.

Note. Final definition revisions are based on SME critique items reflected in Table 7.

Chapter Summary

Phase Two of this study incorporated the development of a JPA conceptual design model, the development of a JPA procedural design model based on factors identified in the conceptual model, and a refinement of definitions that explained the components and elements of the procedural model. The development of the models and associated definitions were based on design factors and design activities identified in a literature review and interviews with a panel of experts. The experts represented the fields of instructional technology, human factors, and graphics design.

A two-round Delphi process was used to conduct a formative evaluation of the models and definitions. Based upon the findings, final models and definitions were developed.

The JPA conceptual design model evolved into a generic JPA conceptual design model that identified specific variables which influence a JPA design project in any work setting; the JPA procedural design model, however, was developed for the design of JPAs to be used in high-risk, high-reliability organizations.

It was found that the JPA procedural model took on a similarity of the Dick and Carey ISD model (see Figure 1). Although the design process appears similar to that used in the Dick and Carey ISD model, there are substantial differences. These differences are found in the explanations of the JPA procedural model's components and elements. An examination of these design factors and activities will point out a number of differences with the Dick and Carey ISD model (see Dick & Carey, 1996). For example:

1. Although the overall purpose of each model is focused on design, the ISD model's purpose is the design of instruction and the JPA model's purpose is the design of JPAs for use in high-risk environments.
2. The JPA model incorporates a number of design factors not addressed in the ISD model including time dependence, risk assessment, performance flexibility, potential distracters, information transparency, regulatory compliance, and confirmative evaluation.
3. The JPA model is based upon variables that influence the JPA design process; whereas, the Dick and Carey model does not visually address such variables.
4. The ISD model displays a sequential linear process and its systemic nature is reflected by feedback arrows. The JPA model, although it too is linear and sequential, reflects a more recursive process.

It was also found that developmental research as used in this study is labor intensive and time consuming due to its qualitative nature. As each step of model development took place, it was found that there were new pathways to explore (e.g., rapid prototyping) which led to new design considerations. Additionally, it was found that it is necessary for a researcher to stop the process at some reasonable point as refinement can easily continue infinitely, and it becomes all too easy to continue the development process without ever reaching a terminal status.

CHAPTER V

PHASE THREE: APPLICATION OF THE JPA PROCEDURAL DESIGN MODEL

Introduction

Phase Three of this study encompassed the application of the JPA procedural design model to an actual JPA design project to determine the strengths and weaknesses of the procedural design model. Additionally, the influence of the conceptual model on the design project was examined. The design project was the development of a JPA that displayed the procedures for a professional corporate cabin crewmember to prepare an aircraft cabin and passengers for an emergency landing. The need for the JPA was identified by the researcher in association with the owner and president of a corporate aviation training company that specialized in crewmember emergency training.

The Influence of the Conceptual Design Model

As explored in Phase Two of this study, there were eight major variables identified that influenced JPA design projects which were presented in a JPA conceptual design model. During the application of the JPA procedural design model to a JPA design project, it was confirmed that the eight variables did have influence on the design project. Furthermore, it was discovered that these influences surfaced more than once and at various times throughout the design process.

Application of the Conceptual Design Model's Components

The following discussion examines the influence of the JPA conceptual design model (see Figure 8, Chapter IV, p. 139) upon the JPA design project.

The JPA Requirement Component

An examination of the elements that comprised the JPA Requirement component confirmed the need for a JPA that addressed an identified performance gap in cabin crewmember performance. A performance gap was identified by the training company's owner between actual performance and desired performance of cabin crewmembers during training simulations. An analysis of performance failures and performance standards indicated that the gap could be closed by the use of an effective job aid which provided guidance to the crewmember in preparing the cabin and passengers for an emergency landing.

The Designer Expertise Component

The Designer Expertise component played a major role in this design project as it was found that the *requisite imagination* of the researcher and the owner of the training company led to a common concept of a JPA that reflected the TEST - PREP procedure. Requisite imagination is the ability of the designer to anticipate what can go wrong. It provides a means to correct for an error in design before the design is actually completed. In fact, during discussions about potential display problems with the JPA, a number of symbols and key terms were simultaneously visualized by the researcher and owner that were eventually incorporated in the JPA. It was found that the expertise of the author and the training company's owner formed a *collective* requisite imagination between the two individuals which greatly enhanced the design project and reduced overall design time. This led to the conclusion that designer expertise depends greatly upon the requisite imagination of the designer or designers.

The Management Component

Although the JPA design project was under control of the researcher, it was still necessary to examine the organizational requirements of the training company that was to provide the simulator for JPA testing. This was necessary so as to not interfere with scheduled training time or provide any basis for student complaints.

Additionally, it was necessary to carefully review the resources available to complete the design project including graphic development and availability of graphics, color laser printing services, lamination services, simulator scheduling, subject availability, travel and lodging expenses, and the overall logistics of meeting the constraints of a scheduled crewmember emergency training session while conducting research simulations. It was found that the various elements of the management component surfaced and resurfaced throughout the entire JPA design project.

The Analysis Component

The *performance requirements* element of the Analysis component was found to be the major factor in this component. Although all the elements were influential, it was found that the performance requirements element had the most influence on the design project as the proposed JPA focused on aiding performance under high-risk and high-stress situations. The analysis of performance requirements indicated that the determination of desired performance becomes the key consideration when designing JPAs for use in high-risk, high-reliability (HRHR) organizational systems.

The Strategy Component

Within the variable of strategy, it was found that requisite imagination resurfaced as a major factor. Without imagination, it is argued that design could not occur or a design strategy develop. The design strategy for this JPA emerged from the imagined JPA as the strategy incorporated perceptual factors and design criteria that led to the concept of a printed JPA which displayed the procedures for an emergency landing.

A review of the elements of the Strategy component, which was done throughout the design process, indicated that the printed card concept was an adequate strategy to meet the purpose of the JPA. Furthermore, it is argued that the expertise of the author and the training company's owner provided the foundations to meet the target population's expectations and provide for a synthesis of the various methods selected to meet the design strategy.

The Display Component

The display technology selected for this JPA project, which was based on the influence of the Strategy component, was a printed paper product. The JPA was proposed to be a four-color printed card that incorporated a combination of realistic graphics, symbols, and text. It was also envisioned that the JPA would be large enough to be easily read in poor visual conditions and sturdy enough in physical construction to withstand the possible physical abuse that could occur during an aircraft emergency.

The Implementation Component

Since the JPA design project was not intended to integrate the JPA into an actual flight organization, the influence of the Implementation component was minimal. It was concluded that for this study's JPA design project that the only element of the Implementation component which was a factor was training. It was theorized that the graphics, symbols, and textual cues used in the JPA would require explanation in a training environment.

The Evaluation Component

The elements that make up the evaluation component were used to determine the testing criteria for Phase Four. Additionally, the elements — performance, measurement criteria, system compatibility, and evaluation findings — were used to determine the success of the JPA procedural design model as applied to the JPA design task. Consequently, the elements of Evaluation component had a major influence on the overall design project which included the determination and application of revisions and final JPA effectiveness.

The Task-Specific JPA Design Project

Based upon the identification of a JPA need as determined in the JPA Requirement component of the conceptual model, it was decided to design and develop a JPA specifically for use in corporate cabin-class aircraft that utilized a cabin-crewmember. The tasks selected for JPA display were the procedures necessary to prepare a corporate airplane cabin and passengers for a planned emergency landing. The JPA was designed and developed following the steps detailed in the JPA procedural design model.

There were a total of four JPA designs required to construct the JPA pilot which included the initial design, two revised designs, and the final design. Although the JPA designs were developed in four-color, only the final design is presented in this study in four-color. The JPA was designed following the applicable elements in the JPA procedural design model. The JPA was designed to present the TEST - PREP procedure which is a series of procedures that are recommended to prepare a corporate airplane and its passengers for an emergency landing. Figure 10 presents side 1 of the initial JPA design and Figure 11 presents side 2 of the initial JPA design.

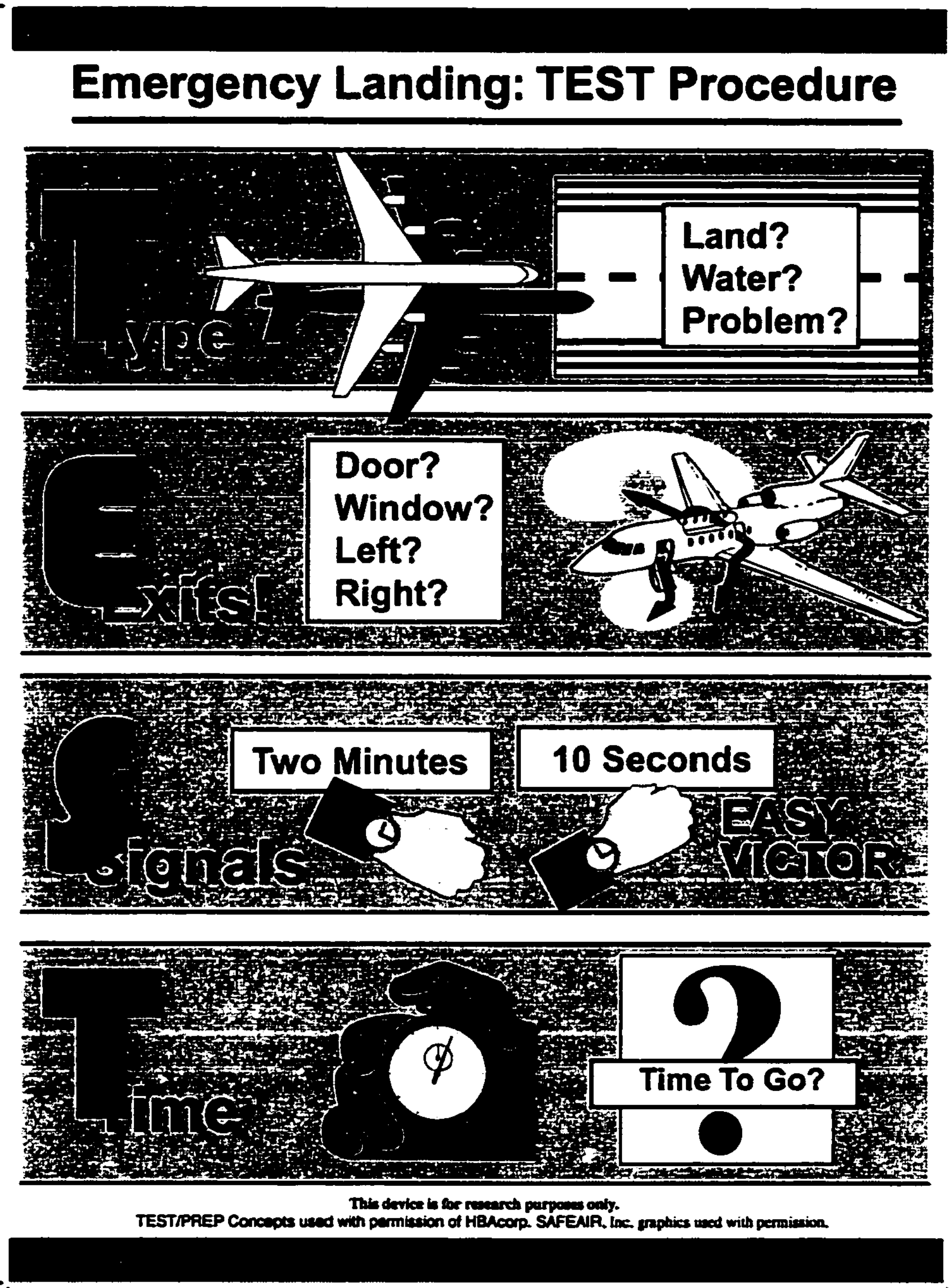


Figure 10. Initial job performance aid design: Side one

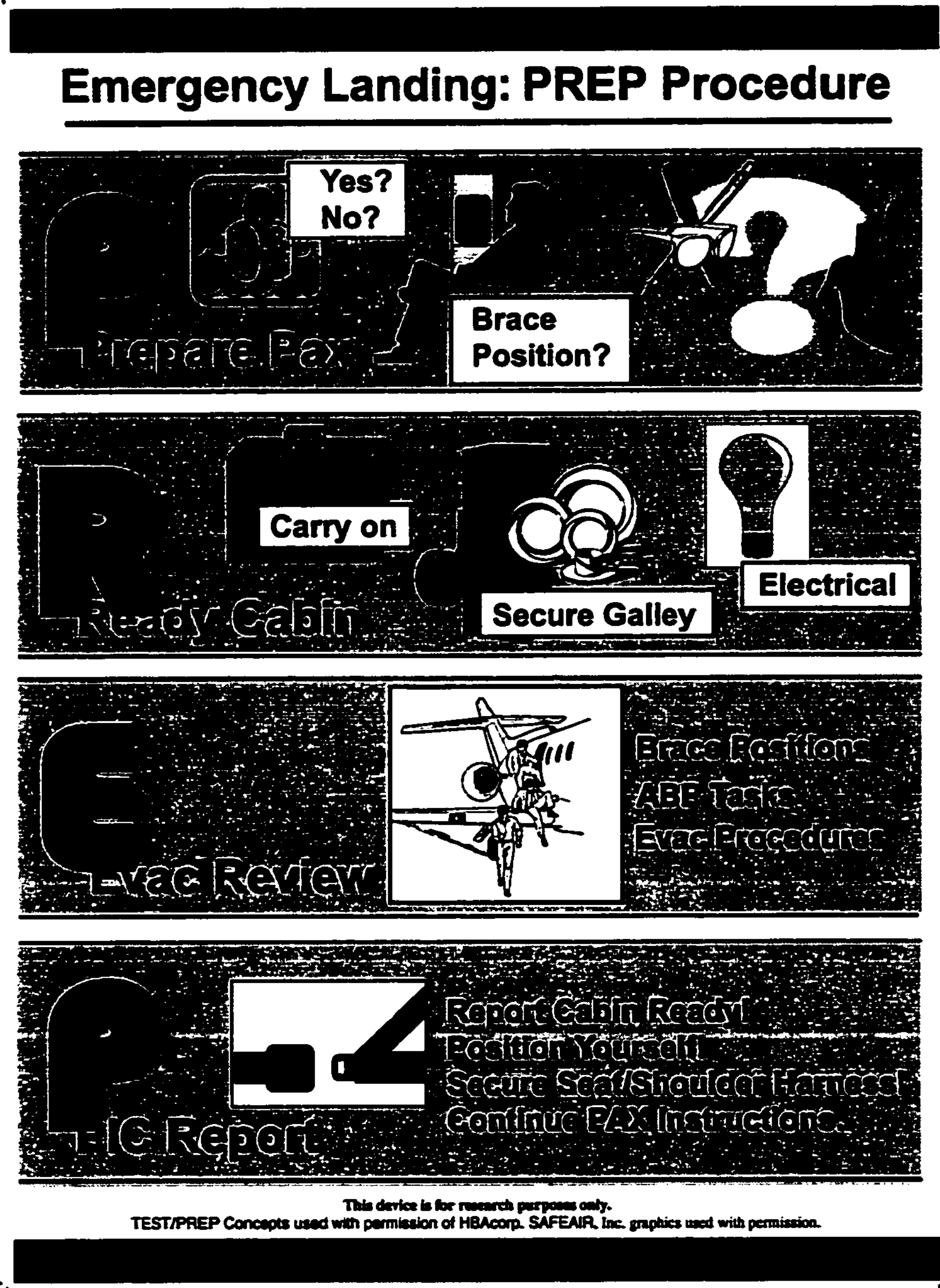


Figure 11. Initial job performance aid: Side two.

The Project Analysis Component

Application of the JPA procedural design model indicated that the most important step in the design process is the first component of Project Analysis. This component provided for the organization and direction of the JPA design project. As suggested by its elements (see Figure 9, Chapter IV), it was necessary to examine the many elements that make up this component by viewing each element as a question. For example, who is the client? Why is the project necessary? What is the task?

The Project Analysis step of the JPA design project provided the following information:

1. The project was initiated by the author of this study and solicited a corporate crewmember training company as a client by identifying a task in which performance could possibly be improved by means of a JPA.
2. The task selected was the TEST - PREP procedure which made up of the tasks, procedures, and considerations for preparing an aircraft cabin and passengers for a planned emergency landing.
3. It was determined that the functional characteristic was for the JPA to serve as a mnemonic device to cue crewmembers to possible courses of action and assist in decision making when performing the TEST - PREP procedure. Additionally, the JPA was also intended to serve as a briefing aid to assist the pilot-in-command in conducting the initial emergency briefing to cabin crewmember in order to establish a shared problem model.
4. The target population for the JPA were professional corporate aviation cabin-crewmembers that consisted of flight attendants who had completed an initial crewmember emergency training program. The characteristics of the intended population were based on the researcher's past training experiences and past experiences of the training company's owner which encompassed over 50 combined years in providing emergency training to aviation crewmembers. The user characteristics included: (a) proficiency in the English language, (b) employment with

major corporations, (c) graduate of an emergency training program, (d) a background in basic aviation knowledge, and (e) skilled in aircraft emergency equipment.

5. The content consisted of the TEST - PREP procedure as taught in a formal crew member emergency training program. The type of information to be displayed consisted of qualitative information, warnings, and signals or cues. Qualitative information included procedures to be followed, questions to be answered, and situations to be addressed. Warning information addressed equipment status such as the cabin electrical system and personal protection by means of securing the safety harness. Signal information consisted of pictorial and textual cues to complete the required procedures. Although the information displayed in the JPA is static as it was to be displayed in printed form, the situations the information refers to are dynamic. Consequently, it was determined that the likelihood of dynamic situations must be addressed in training. Lastly, it was confirmed that no aviation regulatory requirements existed regarding the design or use of the JPA.
6. The environment and context were determined to be the potential physical conditions in which the JPA could be used to include poor lighting, loud noises, toxic smoke conditions, severe aircraft vibrations, turbulence, and other physical factors associated with aircraft emergencies. The social environment was determined to be a crew compliment of three consisting of a pilot-in-command, a co-pilot, and a cabin crewmember. The passenger load would typically consist of a small group (3 — 10) of corporate executive passengers. The context, the range of circumstances, under which the JPA would be used was defined as an emergency situation requiring a planned emergency landing either on land or on water.
7. The display technology envisioned was a four-color printed card that measured 5 x 7 in. The card was to be printed on both sides with one side reflecting the TEST procedure and the second side reflecting the PREP procedure. It was planned to laminate the card to provide for durability. Additionally, a combina-

tion of realistic graphics, symbols, and text was planned to be used for the presentation.

8. As this study called for an evaluation of the JPA's influence on crewmember performance to include the influence of training and the effect of the JPA's physical format on ease-of-use, the elements of summative evaluation and confirmative evaluation were not applicable to this project as the JPA was not intended to be introduced into a flight operation outside of a research environment. This decision was based on the potential liability associated with inappropriate use of the JPA and a corporate aircraft accident involving serious injuries or fatalities.

The Performance Analysis Component

The analysis of the desired performance incorporated a task definition and task analysis of the TEST - PREP procedure. The TEST - PREP procedure is a method used by many major corporate flight operations that employ cabin crewmembers. Two acronyms, used together, represent two complex procedures. The first procedure is referred to as TEST and the second procedure is referred to as PREP. The procedures are employed to prepare an aircraft cabin and passengers for an emergency landing.

The acronym TEST represents the minimum information needed by the cabin crewmember to prepare the passengers and cabin for an emergency landing. The TEST information is typically briefed by the pilot-in-command to the cabin crewmember and co-pilot simultaneously to establish a shared problem model of the situation. The TEST information is then briefed to the passengers by the cabin crewmember in order to set the stage for the PREP procedure. The acronym PREP represents the tasks, procedures, and considerations necessary to prepare the passengers and ready the cabin.

The following provides a detailed explanation of the TEST - PREP acronym and the applicable performance as determined by the task analysis as called for by the Project Analysis component of the JPA procedural design model:

TEST is the minimum information required by the cabin crewmember to prepare the passengers and cabin for an emergency landing. The cabin crewmember's required performance for the TEST portion of the procedure is an accurate and professional briefing of the TEST information to the passengers. The acronym TEST stands for:

T - *Type of emergency.* This element defines the specific nature of the emergency and whether it will involve a landing on land or in the water. It sets the stage for future decisions on part of the cabin crewmember. Additionally, it alerts the cabin crewmember to possible situations that may occur as a result of the type of emergency.

E -*Exits of choice.* This element represents the decision making process regarding the exit or exits to be used once the aircraft has stopped. The decision is normally based on the type of emergency; for example, a water landing would normally require the use of overwing window exits on corporate aircraft. The exit of choice is initially made by the pilot-in-command.

S -*Signals.* This element represents a review of the cockpit to cabin signals which are a 2 minute audio warning before landing, followed by a 10 second audio warning before landing. Additionally, a covert verbal signal is given by the cockpit crew to notify the cabin crew to commence the evacuation. This signal is the verbal term *easy victor.*

T - *Time.* This element represents the estimated time to go before the aircraft lands. It provides the cabin crew with a time framework within which to complete all preparation procedures.

The PREP portion of the procedure is the preparation of the passengers and cabin for the emergency landing. It involves not only standard procedures but it also requires a number of decisions to be made by the cabin crewmember depending on the emergency situation. The performance requirement for each element of the PREP procedure is detailed in the following explanation of the PREP acronym.

P - *Prepare the passengers.* This element represents the various procedures that the cabin crewmember must perform to assure that the passengers are protected and prepared for the emergency landing. The depth and detail of the preparation element is time dependent on the time to go as defined in the TEST phase. The procedures include addressing (a) the use of proper brace positions and repositioning passengers as required for optimum protection, (b) means to protect exposed skin, (c) sharp objects in pockets above the waist, (d) eye glasses, (e) high-heel shoes, (f) jewelry that could be hazardous, and (g) children in arms.

R - *Ready the cabin.* This element represents the procedures necessary to prepare the cabin for the emergency landing. The procedures include (a) storing carry-on baggage, (b) securing galley doors and drawers, (c) securing closet and lavatory doors, and (d) turning off non-essential electrical equipment.

E - *Evacuation review.* This element represents the process by which the cabin crewmember reviews the brace positions and evacuation procedures with the passengers. Additionally, if time permits, the cabin crewmember can assign various tasks to able-bodied passengers to assist the crew if an evacuation is necessary.

P - *Pilot-in-Command report and position.* This element represents the procedures for the cabin crewmember to complete once the passengers and cabin are prepared. The procedures include (a) notifying the pilot-in-command that the cabin is ready, (b) taking the cabin crewmember's assigned seat position and securing the safety harness, and (c) continuing verbal instructions to the passengers.

The task properties of the TEST - PREP procedures were determined by a model-of-expertise that based on past industry testing, Federal Aviation Administration (FAA) recommendations, National Transportation Safety Board (NTSB) studies, and current industry standards. These properties involve the numerous steps and considerations detailed in the previous task analysis of the TEST - PREP procedure.

The analysis of time dependence indicated that time was a major factor in conducting the TEST - PREP procedure. Past aircraft incident and accident reports indicated that preparation time ranged from just a few minutes to hours. Consequently, it was concluded that the JPA needed to be designed to meet a minimum time situation requirement. This minimum time was based on a worst case emergency situation that involved an emergency on takeoff which required an immediate return to the field for landing. This situation led to a specification of a five minute minimum time requirement which is the estimated time for a modern corporate jet aircraft to return to the departure airport after takeoff for an emergency landing.

There were risk factors identified in conducting the TEST - PREP procedure. The risk that was most apparent was when recommended brace and evacuation procedures were not followed which past history has shown results in passenger injuries and increased evacuation times. The risk to the crewmember lies in the increased evacuation time which reduces the probability of survival for the cabin crewmember. The need to stress the use of proper procedures was identified and targeted for emphasis in training.

The flexibility or variance in performance that was examined during the performance analysis included the possibility that the crewmember would not adhere to the sequence of procedures as displayed in the JPA. It was theorized that this variance would most likely occur because of unforeseen circumstances such as inappropriate passenger behavior, severe turbulence, smoke in the cabin, and other unforeseen situations which could distract the crewmember from the PREP sequence. Consequently, it was concluded to provide a prominent cue to each of the procedural steps of TEST - PREP so that the cabin crewmember could easily re-orient himself or herself to the appropriate sequence or review what procedures might have been missed in the event of a distraction.

The Perceptual Factors Component

The potential distracters identified during the flexibility analysis were theorized to be the same distracters that could affect task logic or sequence of procedures, the crew member's attention to the JPA, the effectiveness of the JPA's visual information structure, and the crewmember's motivation to use the JPA. Consequently, the design strategy based upon the identified perceptual factors included (a) using a printed card that was portable so that the crewmember could keep it close by for reference throughout the procedure, (b) the use of pictorials, symbols, and words that were used in the aviation industry, and (c) the use of size and format to enhance readability and usability.

The Design Criteria Component

The design criteria component involved establishing the detailed specifications for the JPA's development. The goals and objectives of this JPA design project had been previously determined and the content had been defined by the TEST - PREP procedure to be displayed; however, the determination of the information hierarchy was an important step in setting forth the JPA's specifications.

Based upon discussions with the training company's owner and the researcher's personal experience, it was concluded to display the TEST - PREP procedure in a split format on each side of a 5 x 7 in. card. The TEST or briefing portion of the procedure was to be displayed on side one of the card and the PREP or the preparation portion of the procedure was to be displayed on side two. Additionally, the level of detail for each procedural step was determined that would provide sufficient cueing to the cabin crewmember for all the procedures that make up the entire TEST - PREP procedure. Figure 10, which is side one, and Figure 12, which is side two, present the initial draft of the JPA.

Transparency, accuracy, and compatibility were determined not to be design factors for this project. Adherence; however, was addressed as critical actions were identified and highlighted so that the crewmember could identify these items. The format strategy was a deductive format in that the JPA was intended for a target population who were familiar with the tasks and who had successfully completed training in the procedures.

The Message Design Component

The message design component involved an examination of the TEST - PREP tasks in order to determine the type of messages to be displayed by the JPA. It was concluded that the JPA for this project was an integrated message that incorporated (a) an alert message that was composed of the TEST information, (b) procedural messages that depicted the preparation tasks, and (c) instructional messages that were comprised of symbolic and textual cues to possible courses of action.

Perceptual organization of the JPA was achieved by presenting each step of the TEST - PREP procedure in a linear horizontal visual frame with TEST on side one of the JPA and

PREP on side two. Each frame was defined by color and border lines on the top and bottom of the frame. The identifying letter for each element of the TEST - PREP acronym was used to began the visual frame for each procedural step. The letter presentation used a Bauhaus 93 font at 84 pt. printed in red. The tasks for each procedural step were presented by means of text and graphics. The text used a sans-serif Arial 12 or 14 pt. bold font printed in red, blue, or black. Additionally, each textual cue or instruction was accompanied by a graphic that related to the required task (see Figure 9 and Figure 9A).

The graphics employed leaned towards the realistic end of the visual continuum. Abstract symbols or graphics were avoided based on the analysis of SME data regarding graphic realism determined during Phase Two. Additionally, it was attempted to use words and graphics that were readily identifiable by the target population to meet literacy considerations.

The Training Component

The following conclusions were made regarding training for this specific JPA design project:

1. The rationale and relevance for the JPA would be fully covered in the formal training course that preceded the field test of the JPA.
2. The prerequisite knowledge and skills required to perform the JPA tasks would be adequately covered during the formal training course. Additionally, the subjects' knowledge base and skills would be confirmed by final examinations and performance demonstrations required by the training facility.
3. The capabilities and the limitations of the JPA would be adequately addressed during the formal training program and the pre-simulation briefing.

It was assumed that the JPA's reliability and users' confidence in the JPA would be explored during the field test of the JPA in Phase Four of this study. Additionally, since practice is a major component of the crewmember emergency training program, it was not considered necessary to determine the amount of practice necessary to use the JPA in this design project.

<u>The Development Component</u>

The translating of the design specifications of the JPA were completed on a computer using available graphics libraries, illustration software for graphic creation, and a page layout program for creating the JPA. A pilot draft was completed (see Figure 10 and Figure 11) and forwarded to the training company's owner for an expert-review, formative evaluation.

There was one suggestion made in the initial evaluation. It was suggested to change the graphics that represented the 2 minute warning and the 10 second warning in the signal element of TEST. The suggestion was to use clock faces instead of the wrist watch graphics. The evaluator felt that the wrist watches were confusing and that they only reflected a male crewmember's wrist. Figure 12 presents the change to side one of the JPA.

The JPA was revised and the second draft was sent to the training company for another expert review. During the second expert review evaluation, two trainers were included in the evaluation by the training company's owner and the following recommendations were made.

1. The graphic symbol for electrical in the *ready cabin* frame needed to more clearly address non-essential electric equipment. It was suggested to revise the text and incorporate the international symbol for *no* over the electric symbol.
2. The graphic used to represent evacuation review procedures in the *evac review* frame was difficult to interpret and made no sense. It was suggested to use a more appropriate graphic.
3. The *PIC report* frame contained too much text and needed to employ more graphics. It was suggested to use two people talking as a symbol for notifying the pilot-in-command that the cabin was ready and to reposition the seatbelt symbol about the textual instructions.

After reviewing the expert review suggestions, it was concluded to revise the JPA using the recommendations of the second expert formative evaluation. Figure 13 presents side two of the revised JPA.

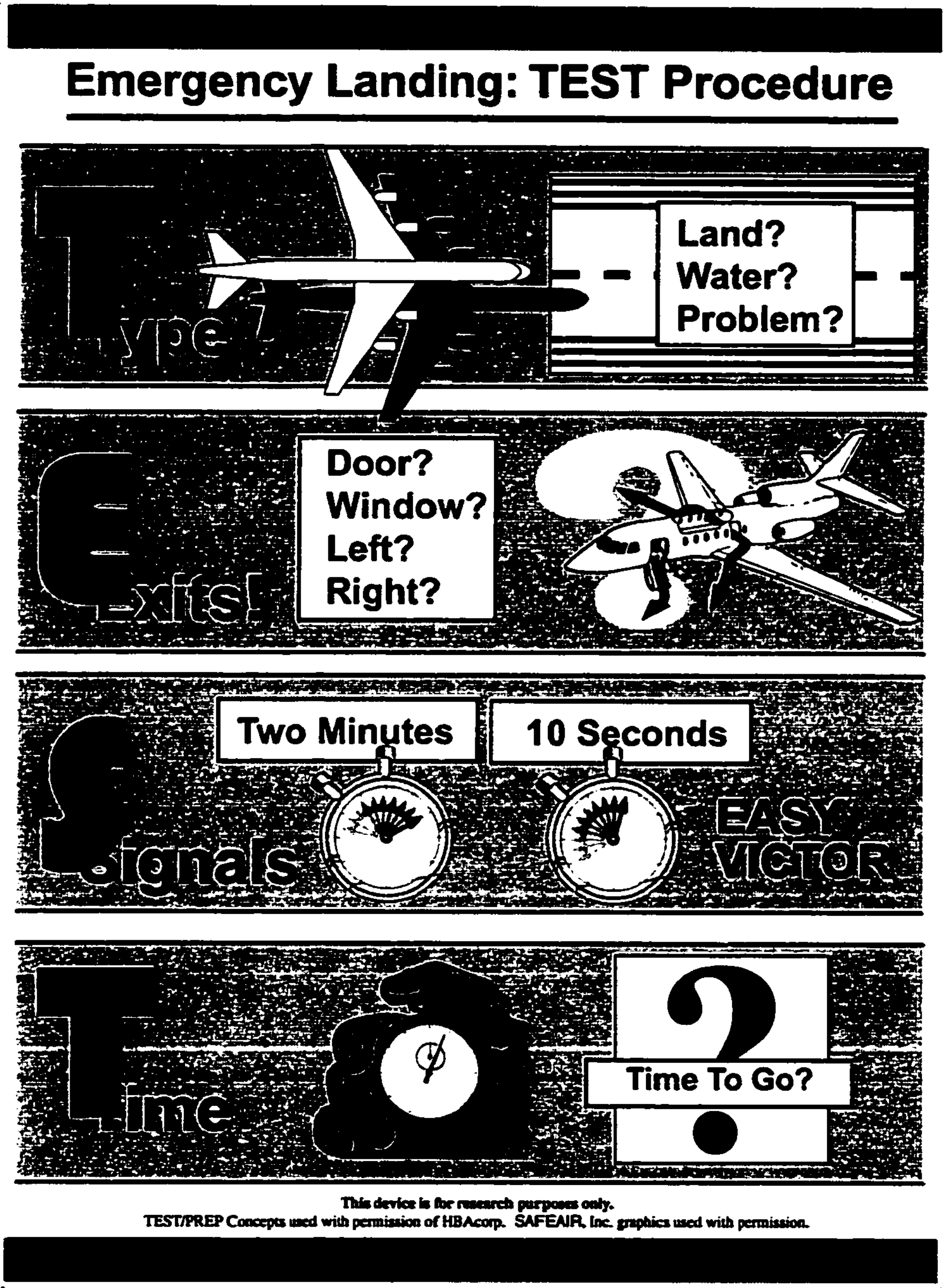


Figure 12. Job performance aid side one: Design revision one.

The electrical symbol was revised as suggested. The international red circle and slash was placed over the electric bulb symbol and the text was revised by adding the word non-essential. It was concluded that this revision more completely described the task which was to turn off all cabin non-essential electrical equipment (see Figure 13).

A graphic of an emergency exit placard was selected to replace the evacuation graphic used as a symbol in the *evac review* frame. The word review was added in blue text to introduce the three evacuation instructions and provide a contrasting heading level to signal an information hierarchy. Additionally, the text size for the review instructions was increased from 12 to 14 pt.

The suggestion to use a graphic of two people talking for a graphic symbol in the *PIC report* frame was rejected by the researcher and a more suitable graphic was selected that appeared more appropriate in the researcher's judgment. A *thumbs-up* graphic, which is a universal sign in aviation that all is well, was selected and the entire frame was revised. Figure 13 presents side two of the JPA's third draft which reflects the revisions made based on the findings of the second expert-review evaluation.

The evaluation of the JPA also involved a small group evaluation that was not part of the original evaluation plan. Circumstances provided for an opportunity for a small group of three professional corporate cabin crewmembers to review the third draft of the JPA during a recurrent emergency procedures training program conducted by the researcher. Although, this evaluation was not required for the study, it proved invaluable as it demonstrated the value of feedback from prospective JPA users. Additionally, it re-affirmed the importance of formative evaluation during the design process.

The small group evaluation was conducted in an informal manner. A copy of the JPA draft was passed to each of the cabin crewmembers and they were asked to make any suggestions or comments that they wished. Critique items were not immediately made. The initial discussion centered on the need for such a device and that the device displayed TEST - PREP in a usable and easy to read manner.

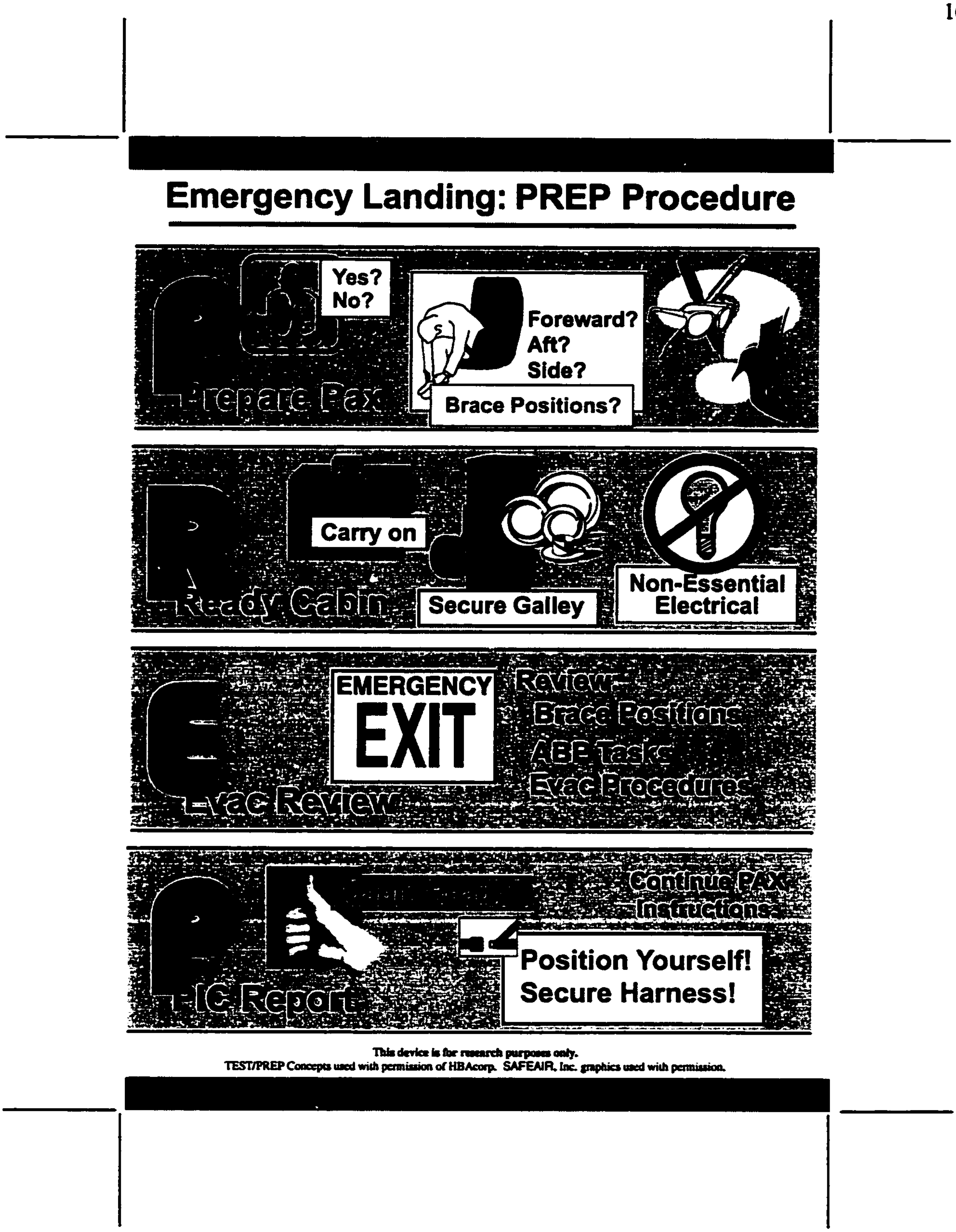


Figure 13. Job performance aid side two: Design revision two.

It was concluded that the initial reluctance on the part of the small group to critique the JPA's design was a result of the researcher, who had conducted the recurrent training, acting as the facilitator for the group evaluation. Once the first critique item was stated, however, the group appeared to open up and discuss and explore items in much more depth. The group's discussion then centered on the *ready cabin* frame and the group made two valuable suggestions that led to revisions for the final JPA (see Figure 14 and Figure 15).

The two areas on which the small group focused their discussion were the visual clutter apparent in the secure galley element of the *ready cabin* frame and the possible misinterpretation of the frame's electrical symbol. The group agreed that the graphic that symbolized a roll of duct tape being used to seal cabinet drawers was a sufficient cue to securing procedures and that the graphic of galley equipment was not necessary and cluttered the frame. It was also found that each member of the small group identified the symbol for duct tape and galley cabinets without assistance or hesitation. This was not true of the electrical symbol.

The group agreed that the graphic symbol for electrical equipment did not meet the intent of the procedures for this element. They felt that a light bulb could very easily be confused with turning off lights and not electrical cabin appliances. A suggestion was made and agreed on by the group that an electrical switch be used as a graphic.

The suggestions were reviewed and incorporated into the final draft of the JPA. Figure 14 and Figure 15 present the final draft of the JPA in a four-color format. The vertical and horizontal lines that mark the corners of the JPA are the trim marks for cutting the JPA to size once it was printed. Additionally, the JPA was laminated with side one and side two back to back. The final pilot draft was then tested in Phase Four of this study.

<u>The Utilization and Evaluation Components</u>

Since the JPA was not to be introduced into an actual field operation, the last two components of the JPA procedural design model were not applicable with the exception of the training delivery element of the Utilization component.

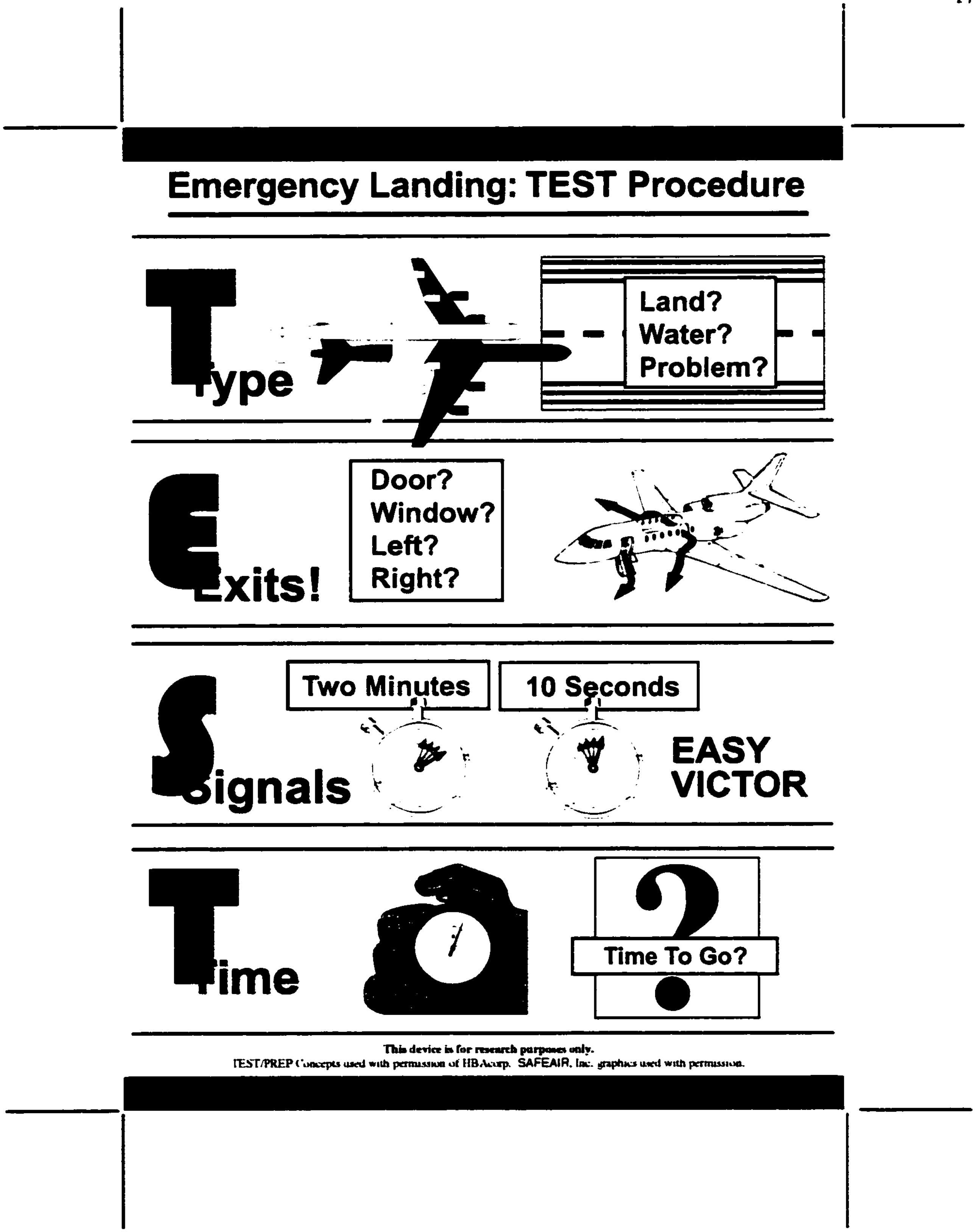


Figure 14. Job performance aid final design: Side one.

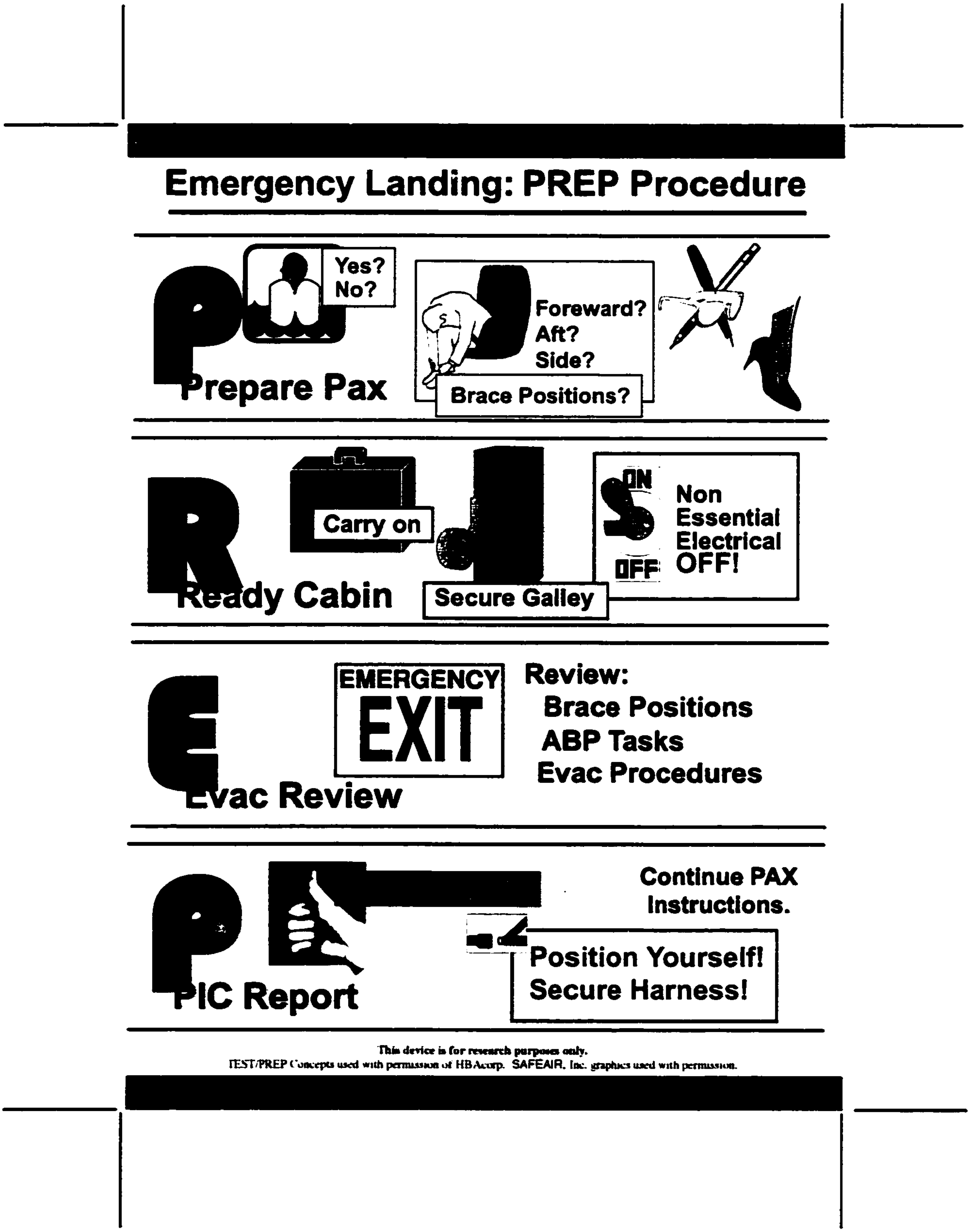


Figure 15. Job performance aid final design: Side two.

It was found that during the design and development processes for this JPA project that training was a key ingredient to JPA effectiveness. The target audience consisted of trained crewmembers and the purpose of the JPA was to serve as a mnemonic and not a trouble-shooting guide or procedural manual for the many procedures involved in the TEST - PREP procedure. Furthermore, it is argued that it is very important for the designer to document training topics and specifics when identified in the design process and assure that these specifics are integrated into the JPA training program..

Chapter Summary

Phase Three of the study involved the design and development of a JPA for use in a high-risk, high-reliability (HRHR) aviation environment. The task selected was the TEST - PREP procedure used in many corporate flight operations by the cabin crewmember to prepare an aircraft cabin and passengers for a planned emergency landing.

The variables of the JPA conceptual design model were examined to determine if and how the model's components influenced the design project. It was found that the identified variables did influence the design project and that the influences occurred throughout the design project and in many cases more than once.

It was found that the two most influential of the variables that make up the JPA conceptual design model were Designer Expertise and Analysis. It was found that within the component of Designer Expertise that the requisite imagination of the designer(s) was very influential during the design process. Additionally, it was found that a collective requisite imagination developed when a design team had common goals and objectives.

Due to the nature of JPAs used in HRHR organizational systems it was found that the element of performance requirements was a major factor in the Analysis component of the conceptual model. It was found that the determination and specification of desired performance was a critical factor in designing JPAs for use in high-risk and high-stress situations.

It is argued that requisite imagination sets the stage for each of the JPA procedural model's components because without imagination, design could not occur. Furthermore, because of the nature of performance requirements in HRHR systems, it is argued that analysis is a critical factor in the effective application of the JPA procedural design model to a specific JPA design task such as the task selected for this study.

The JPA procedural design model was used to design and develop a JPA for a corporate aviation task in which task performers had demonstrated repeated performance gaps. The task selected was the TEST - PREP procedure which consisted of the many procedures necessary for a cabin crewmember to prepare a corporate aircraft cabin and passengers for an emergency landing.

Each of the JPA procedural design model's applicable components and associated elements were applied to the design project. It was found that the component of project analysis was perhaps the most important component

There were three JPA drafts developed. The first JPA draft was designed and developed using the elements of the JPA procedural design model. Two subsequent JPA drafts were developed that were based on revisions determined by formative evaluations. A final JPA was then developed based on the findings of the formative evaluations and printed in four-color in preparation for Phase Four.

It was found that the JPA conceptual design model and the JPA procedural design model did provide for a means to create a task specific JPA for use in an aviation cabin environment under emergency conditions. It was also found that adherence to the procedural model was labor and time intensive due to the many elements that made up the model's components. The design time for the completed pilot JPA was in excess of 20 hours. The hours specified do not include the time required to complete the analyses components of the procedural which was in excess of 20 hours. It is argued, however, that this intensity is a major strength of the procedural model as JPAs designed for HRHR organizations must attempt to eliminate as much potential for error as possible during the design process.

Elimination of error during design involved exploring as many variables as possible and addressing the elements that made up JPA design. Without some map to follow, it is argued that the designer can easily miss critical factors that affect design. Furthermore, it is argued that the JPA procedural design model provided a map that reduced design error, assisted in achieving content accuracy, and enhanced meeting the intent of the JPA.

CHAPTER VI

PHASE FOUR: FIELD TEST AND JPA EVALUATION

Phase four encompassed the evaluation of the pilot JPA that was designed and developed using the JPA procedural design model. The purpose of the evaluation was to determine JPA effectiveness and, in turn, the effectiveness of the JPA procedural design model. The evaluation of the JPA incorporated formative evaluation methods including: (a) an expert review of the JPA made by each member of the experimental group, (b) one-on-one interviews with the subjects who made up the experimental group, and (c) a field test of the JPA in a corporate aircraft cockpit-cabin simulator.

The field test consisted of performance comparisons between the experimental group, whose subjects used the JPA, and the control group, whose subjects did not use the JPA. Each group consisted of professional corporate aviation cabin crewmembers and the comparison was made of the employment of procedures required to prepare an aircraft cabin and passengers for an emergency landing. The procedures consisted of the TEST - PREP procedure which was detailed in Chapter V of this study.

Data Collection and Analysis

The data was collected and analyzed in four stages. Stage one consisted of an expert review which collected and analyzed data complied from JPA Subject Evaluation Forms (see Appendix B for a sample form). Stage two consisted of one-on-one interviews with each member of the experimental group using a prompt-recall technique. Stage three consisted of scoring and evaluating the control and experimental groups' performances. Performance effectiveness was determined by observation of each simulation's videotape and the scoring of performance by use of a Subject Performance Score Sheet (see Appendix C).

The fourth stage of the evaluation incorporated a reflective analysis of the data collected and the evaluation findings. Its purpose was to determine the strengths and weaknesses of the JPA and of the JPA procedural design model.

Stage One: The Subject Evaluation Form

Shortly after the subjects of the experimental group completed their individual simulations, they were asked to complete a JPA Subject Evaluation Form. The form asked the subjects to respond to five statements using a Likert-type scale (see Appendix B). Table 9 presents the raw data collected from the evaluation forms and the calculations of the mean scores and standard deviations. A score of 5 indicated that the subject strongly agreed with the survey statement. A score of 1 indicated that the subject strongly disagreed.

Table 9

Experimental Group: Raw Data and Summary of Mean Scores and Standard Deviations of Responses From JPA Subject Evaluation Forms

(N=6)

Item	Subject 1	Subject 2	Subject 3	Subject 4	Subject 5	Subject 6	*M*	*SD*
1	5.00	5.00	5.00	5.00	4.00	5.00	4.83	.41
2	4.00	5.00	5.00	4.00	4.00	5.00	4.50	.55
3	5.00	5.00	5.00	4.00	5.00	5.00	4.83	.41
4	4.00	5.00	5.00	5.00	5.00	5.00	4.83	.41
5	2.00	5.00	5.00	4.00	5.00	5.00	4.33	1.21

The data reflects that the subjects' scores leaned towards the "strongly agree response" with the exception of statement five which asked if the user liked the JPA's physical format and size. One subject (subject 1) responded that the JPA was too small and that it was "different" than what the subject had been used to in airline operations. This response was reflected in the standard deviation (SD = 1.21) for item 5 which was substantially larger than the other items.

The experimental group's means scores for the first four items indicated the group agreed that (a) a JPA was valuable in order to perform the TEST - PREP procedure, (b) the use of the JPA improved performance, (c) training was an important ingredient to the proper use of the JPA, and (d) the graphics and text employed in the JPA were easy to understand. The "somewhat disagree" response for the fifth statement by subject 1 indicated that the subject's past airline experiences influenced the subject's perceptions of the JPA.

The open-ended questions resulted in all subjects responding to the query of what was liked best about the JPA (see Table 10). Only 1 of the 6 subjects responded to what was liked least. It is argued that the lack of responses to the "like least" section of the Subject Evaluation Forms skewed the overall results of the open-ended questions in favor of liking the JPA over not liking the JPA.

Table 10

Experimental Group: Summary of Responses
to Open-Ended Questions of JPA Subject Evaluation Forms

(N=6)

Subject	Like Best Response	Like Least Response
1	Big pictures, something to hold on to, good colors.	Felt too small. It is different to what I was used to.
2	Short, simple, to the point, much more efficient than one written out. Gave me exactly the right brief and most important information.	None
3	The size, the format via pictures, ease of use. Visually ideal through use of pictures and other prompts.	None
4	The pictures help because with the stressful situation you do not have time to read sentences.	None
5	It quickly gave me the visual cues I needed.	None
6	It was easier to use than written checklist.	None

Stage One: Conclusions

The response by subject 1 for statement five of the evaluation form suggested that the JPA designer must pay careful attention to the Project Analysis elements of target population and population characteristics as presented in the JPA procedural design model. Although the subject critiqued physical size, the JPA format did not appear to influence the subject's performance. The comments of subject 1, however, did suggest a potential for "negative transfer."

Negative transfer is the employment of a procedure by a person that was learned in past training and is not applicable to (or possibly even safe for) the current situation or equipment. Consequently, it is argued that the designer of JPAs used in HRHR systems must examine past training practices and previously employed procedures unique to the target population in order to identify potential sources of negative transfer. The designer must also adjust the JPA's display for these potential conflicts by means of more effective message design and the designer should assure that any identified conflicts are addressed in training.

The lack of responses to what was liked least about the JPA was attributed to the limited time provided for the subjects to complete the JPA Subject Evaluation Forms and the prompt-recall interviews. The time limitation was a result of classroom scheduling and the subjects' travel requirements. Interpretive analysis of the responses that were given led to the conclusion that the JPA design served its purpose and met its design intent. Overall, the experimental group indicated that the device was easy to use and easy to read.

Stage Two: The Prompt-Recall Interviews

Each subject was asked to watch the videotape of his or her performance and to comment on the influence of the JPA as the tape was paused at 30 second intervals (see Appendix H for the complete subject prompt-recall interview transcriptions). It was found that this analysis technique was not as fruitful as was expected.

The subjects did respond, but overall, the responses did not fully address the areas of interest including decision making, JPA display, and information hierarchy. Each of the subjects' responses, however, did point to factors that supported the conclusion that the JPA served its purpose in a more than adequate manner.

Subject 1, who had a great deal of airline experience, indicated that he was heavily influenced by past airline training and experience. Although he indicated that the JPA cued him to the proper sequence and procedure, he felt that his performance was based more on airline experience and training than on the use of the JPA.

The subject, however, appeared to be surprised when he observed himself referring to the card at various times during the simulation. He remarked that he was using the card as a pointer when giving instructions to the passenger and that he was using it as a "security blanket." Also, the subject stated that the JPA did provide a decision cue for the TEST - PREP procedure when he saw the pictorial symbols for time signals.

Subject 2, who had previous airline experience, indicated that the JPA helped her to keep her "thoughts aligned." She stated that her previous training "kicked in" and overrode the sequence of procedures as displayed on the JPA. She remarked, however, that the JPA cued her to the fact that she was "out of synch" with the sequence of procedures and assisted her in realigning her thoughts and actions with the TEST - PREP procedure.

The video taped performance of subject 2 reflected that she was very focused on the infant distracter. Her attention became focused on demonstrating how to brace for landing to the "lady with the baby" during the last few seconds of the first 30 second period and the mid-point of the 90 second period. She indicated that her past airline training was the reason she kept coming back to checking the brace position for the passenger with the infant.

Subject 2 stated that the JPA served as a memory device in that she used the JPA to double check that she had not missed any procedural items. The subject also stated that the JPA cued her to take the proper brace position for the seat she was to occupy for the landing. This cue, she stated, reminded her to inform the passengers to review their passenger safety information card. This item is not displayed on the JPA and it was concluded to include this item in any future revision to the JPA.

Subject 3, who also had previous airline experience, stated that she used the card to prepare herself for the TEST briefing she gave to the passengers. At the 60 second pause, she stated that she got out of sequence when she completed the TEST briefing and commenced the PREP portion of the procedure. She stated that it was the passenger with the infant that distracted her from staying in sequence and she remarked that she had felt that she was failing the PREP portion of the procedure.

Subject 3 indicated that the visual cues used on the JPA were a great help and that she wished she would have referred to the JPA when the infant distraction occurred.

Subject 4, who did not have previous airline or corporate flight experience, was not able to remember any thoughts or attribute any behavior to the JPA at the 30 second pause. The subject did respond to a probe question that the JPA did help her to keep her stress level under control but observation of the subject's performance indicated that she appeared highly stressed and was not able to adequately perform the TEST - PREP procedure. At the completion of her interview, the subject commented that the JPA provided information in a logical manner although she could not remember using the JPA.

Subject 5, who did not have previous airline or corporate flight experience, remarked at the 30 second pause that she remembered referring to the JPA to cue her what to do after she had completed the TEST procedure. The subject was not able to remember any specific thoughts or actions, other than that mentioned at the 30 second pause. When probed, however, the subject stated that the JPA helped her to stay on track. She indicated that the JPA served as a reminder to what steps to perform.

It was noted that the subject's observed performance was the weakest at the passenger briefing point of the TEST procedure. It was observed that the subject she failed to refer to the JPA during this portion of the procedure.

Subject 6, who also did not have previous airline or corporate experience, demonstrated the poorest performance of the experimental group; however, the subject still maintained a mean score of 3.00 which was commensurate with average performance according to the criteria set forth on the Subject Simulation Score Sheet.

The subject admitted being distracted by the passenger with infant at the 30 second pause point. She stated that she believed that the JPA helped her to get back on track. The videotape showed that the subject had referred to the JPA prior to the 60 second pause, but the subject did not recall looking at the JPA. The subject's performance was typical of a novice cabin crewmember who was performing a real time simulation during initial training.

Stage Two Conclusions

As stated previously, the findings of the prompt-recall interviews did not produce the data as had been anticipated. The information obtained, however, did point to some factors that substantiated the conclusion that the JPA did meet its design purpose.

Each of the subjects of the experimental group indicated that the JPA did provide assistance in the performance of the TEST - PREP procedure; five of the six subjects stated that the JPA was easy to read and easy to use; and, all subjects indicated that the JPA helped them to stay in sequence.

Lastly, the prompt-recall interviews did identify one important consideration for future revisions to the JPA. This consideration was the suggestion to add a cue for passengers to review the passenger safety information card during the E (Evacuation Review) of the PREP procedure.

Stage Three: A Comparison of Performances

Stage three involved the comparison of performances between the six subjects who made up the experimental group (those who used the JPA) and six cabin crewmembers who made up the control group (those who did not use the JPA). Subject performances were assessed by the scoring of performance as reflected by the criteria reflected on the Subject Simulation Score Sheet (see Appendix C). The summary of scores and raw data are reflected in Table 11 and Table 12.

A comparison of mean scores between two groups indicates that the experimental group performed overall better than the control group. The cumulative mean score (with standard deviation in parentheses) for the experimental group was 3.98 (.59) and the cumulative mean score for the control group was 2.00 (.47). A two independent sample t-test (two-tailed with an alpha level of .05) reflected t (14) = 6.19, p = 2.35E-05 which indicated a significant difference between the two groups.

Table 11

Summary of Simulation Performance Scores
for the Experimental Group

(N = 6)

Item	Subject 1	Subject 2	Subject 3	Subject 4	Subject 5	Subject 6	Total	*M*	*SD*
TEST 1	5.00	5.00	5.00	5.00	5.00	5.00	30.00	5.00	0.00
TEST 2	1.00	5.00	4.00	4.00	2.00	3.00	19.00	3.17	1.47
TEST 3	5.00	4.00	5.00	3.00	3.00	3.00	23.00	3.83	.98
PREP 1	4.00	5.00	5.00	5.00	5.00	4.00	28.00	4.67	.55
PREP 2	3.00	3.00	5.00	2.00	5.00	2.00	20.00	3.33	1.37
PREP 3	5.00	5.00	3.00	2.00	4.00	2.00	21.00	3.50	1.38
PREP 4	3.00	5.00	5.00	4.00	5.00	1.00	23.00	3.83	1.60
PREP 5	5.00	5.00	4.00	5.00	4.00	4.00	27.00	4.50	.55
Total	31.00	37.00	36.00	30.00	33.00	24.00	191.00		
M	3.88	4.63	4.50	3.75	4.13	3.00		**3.98**	**(.59)**

Note. The cumulative mean score for the experimental group is displayed in bold (with the standard deviation in parentheses).

Although the experimental group's performance level was not as high as was expected with the use of the JPA, it was sufficiently greater on each of the procedural items of the TEST - PREP procedure which reflected an improvement in performance with use of the JPA (see Figure 16). The experimental group's total and individual performance scores are shown in Table 11.

Table 11 reflects that the first item, TEST 1, resulted in a perfect score for the experimental group (M=5.00). It is argued that the perfect for item 1 of the TEST portion of the simulation score sheet was a result of each subject being given an identical briefing by the pilot-in-command (PIC). This provided for more standardization in the cockpit and less chance of confusion. Furthermore, it is argued that the JPA provided a form of script for the PIC to present the emergency information and, consequently, the information was presented in a similar manner to each subject of the experimental group. This feature was not available to the control group as the PIC had no "script" to follow. Table 12 shows the control group's total and individual performance scores.

Although the perfect score for item 1 provided for a higher cumulative mean score for the experimental group (see Table 11), it was not deleted, as the performance for this item was also observable in the control groups' videotaped performances (see Table 12). The cumulative mean (with the standard deviation in parentheses) with TEST 1 omitted was 3.83 (.67) versus the mean of 3.98 (.59) as reflected in Table 11. It was reasoned that the difference between the two did not substantiate the omission of TEST 1.

Observations of the control groups' performances for TEST 1 (based on time in the cockpit and gestures of the cabin crewmember) showed that there was notable confusion on the part of the cabin crewmembers in all but one of the control group simulations. This is reflected in the scoring as presented in Table 12.

Additionally, a reliability analysis of the Simulation Performance Score Sheet reflected that the properties of the eight items that made up the score sheet reflected an acceptable internal consistency that made for a usable instrument (Alpha = .9072).

The differences between the experimental group and the control groups' performances for each item are graphically shown in Figure 16. The differences for each score item point to performance improvement when the JPA is used.

An independent sample t-test (two-tailed, with an alpha level of .05) was completed in order to compare the experimental group's means and control group's means for each item scored on the Simulation Performance Score Sheets (see Table 13). The analysis revealed that two of the eight items, PREP 2 and PREP 4, reflected no significant difference.

This lack of significance is attributed to the fact that the procedures involved in PREP

2 (the removal or storage of hazardous items from the passengers' persons) and PREP 4 (the review of evacuation procedures) are greatly stressed and practiced in the classroom during training. Consequently, the experimental group and control group were amply prepared to conduct these elements of the TEST - PREP procedure which resulted in a difference of no statistical significance.

Table 12

Summary of Simulation Performance Scores
for the Control Group

(N = 6)

Item	Subject 1	Subject 2	Subject 3	Subject 4	Subject 5	Subject 6	Total	*M*	*SD*
TEST 1	2.00	1.00	3.00	3.00	4.00	3.00	16.00	2.67	1.03
TEST 2	1.00	1.00	2.00	1.00	2.00	2.00	9.00	1.50	.55
TEST 3	3.00	1.00	1.00	1.00	1.00	2.00	9.00	1.50	.84
PREP 1	3.00	1.00	2.00	3.00	3.00	4.00	16.00	2.67	1.03
PREP 2	4.00	3.00	2.00	2.00	4.00	1.00	16.00	2.67	1.21
PREP 3	1.00	1.00	1.00	1.00	1.00	3.00	8.00	1.33	.82
PREP 4	2.00	1.00	3.00	1.00	4.00	2.00	13.00	2.17	1.17
PREP 5	1.00	1.00	4.00	1.00	1.00	1.00	9.00	1.50	1.22
Total	17.00	10.00	18.00	13.00	20.00	18.00	96.00		
M	2.13	1.25	2.25	1.63	2.50	2.25		**2.00**	**(.47)**

Note. The cumulative mean score for the control group is displayed in bold (with the standard deviation in parentheses).

The greatest difference between performance items was found in PREP 5 (the report to the cockpit that the cabin is ready). Historically, this has been found to be an often bypassed procedure and the use of the JPA definitely reflected improvement for this procedure. Additionally, the difference between the two groups' cumulative means was 1.98 and it was concluded that this difference was attributable to the use of the JPA by the experimental group.

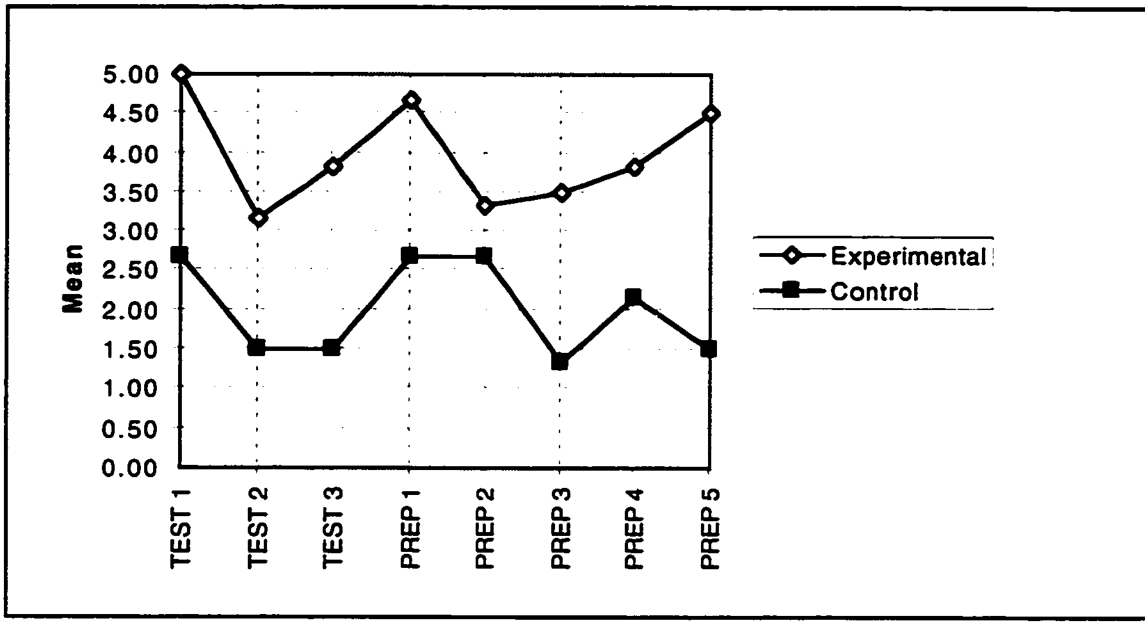


Figure 16. A comparison of performance means between the experimental group and the control group.

Stage Three Conclusions

The comparison of means between the experimental group and the control group indicated that there was an improvement in performance when the JPA was employed. Although the improvement was not as great as anticipated by the researcher, it was of such a nature that it was concluded that the JPA did have a positive effect upon the subjects who used it.

It was also discovered that the phenomenon of negative transfer can play an detrimental role towards effective performance and it is important for the JPA designer to identify potential procedures that may be susceptible to negative transfer. Consequently, it was concluded that the JPA procedural design model met design expectations in that it addressed target population characteristics including potential areas for procedural misinterpretation.

Lastly, it was concluded that when a JPA of this type is introduced into a HRHR work environment, it is important to incorporate the JPA into training so that the users are familiar with it and can optimize the JPA's intent.

Table 13

Results of Two-Tailed Independent Sample T-test
for Comparison of Means Between Items Scored
on Simulation Score Sheets

(N = 12)

Simulation Item	t	df	Sig. (2-tailed)
TEST 1	5.534	10	.000*
TEST 2	2.599	10	.027*
TEST 3	4.427	10	.001*
PREP 1	4.243	10	.002*
PREP 2	.894	10	.392
PREP 3	3.313	10	.008*
PREP 4	2.058	10	.067
PREP 5	5.477	10	.000*

*$p <= .05$

Stage Four: A Reflective Analysis

A reflective analysis of the data complied during the JPA evaluation part of this study pointed to the conclusion that a well designed JPA can improve performance, especially for users under high stress situations. Although the t-test showed that two items were not statistically significant, it is argued that improvement in performance did occur; however, it must also be recognized that the improvements can only be attributable to the subjects that made up the experimental group and are not inferential to a larger population because of the small sample size.

Performance patterns, however, did emerge during the JPA evaluation process that pointed to JPA design and implementation considerations for JPAs to be used in HRHR organizational systems.

These patterns included the influence of past training on performance as well as the influence of current training on performance. Training has traditionally been a major practice within HRHR organizations and this study substantiated the need to include training in the implementation of a new JPA into a HRHR system.

As the experimental group was made up of three people who had previous airline flight experience and three people who had none, the influence of negative transfer was easily recognized during the performance observations. It became evident that the previously airline trained subjects had trouble following the sequence of procedures as displayed on the JPA and taught in the classroom.

It is theorized that past training monopolized the experienced subjects' thinking, and consequently influenced their actions when they were highly stressed. Their past training, however, appeared to provide them the means to complete the necessary procedures although they had a tendency to revert to the procedures they had first been taught.

It is suggested that this reversion to the use of previously taught procedures can be observed in many HRHR organizations that employ personnel who have had initial training provided by a different organization or initial training on different equipment.

Observations of the videotaped performances revealed that the subjects of the experimental group glanced at the JPA throughout their respective simulation. The question that arises is how much influence did the JPA provide as a result of the glances? Unfortunately, the data did not provide the information necessary to make a judgment. What the data did provide was that a need exists to more fully explore the role of JPAs within HRHR systems.

Lastly, the reflective analysis allowed for the identification of a subtle but distinct pattern that was prevalent within the experimental group which was in contrast to the control group. This pattern involved the behavioral separation of the TEST - PREP procedure. This behavior was a subtle physical transition from the briefing of the passengers (TEST) to the preparation of the passengers (PREP). Each subject, within the control group, appeared to combine the elements of the TEST - PREP procedure in that they overlapped and mixed their sequence. There was no apparent distinction observed in the videotaped performances between the TEST and PREP portions of the procedure.

The lack of distinction does not infer that the subjects of the control group did not complete the TEST - PREP procedure; rather, it is suggested that this lack of distinction contributed to a below average mean score. Consequently, it is argued that the performance analysis component of the JPA procedural design model is a critical design activity and that the examination of task properties and flexibility become paramount to successful JPA design.

CHAPTER VII

SUMMARY: DISCUSSION AND RECOMMENDATIONS

Overview of the Study

This study involved the development and validation of a conceptual design model and a procedural design model for designing job performance aids (JPAs) for use in high-risk, high-reliability (HRHR) organizations. All industries are exposed to some types of risks, however, a number of industries involve operations in very high-risk environments and consequently they must maintain demanding standards of high-reliability in order to avert catastrophic loss of human life or equipment.

JPAs designed for use in HRHR organizations are intended to improve human performance and reduce human error by means of providing critical information to the task performer when needed. With today's more complex technologies and more complex operating systems, the need for job performance aids (JPAs), which are designed to improve human performance, is becoming more important.

This study was developmental in nature and used qualitative methods that involved four separate research phases. The results and in-depth discussions for each phase are found in each phase's corresponding chapter. Additionally, the aviation industry was used as a representative HRHR industry. The study's phases consisted of the following:

1. Phase One consisted of a review of literature taken from the fields of instructional technology and human factors that addressed JPA design. Additionally, JPA design data were gathered from a series of interviews with a panel of subject-matter-experts (SMEs).
2. Phase Two involved a synthesis of the data gathered in Phase One that was used to construct two JPA design models. The first model was a JPA conceptual design model that was generic in nature and reflected the variables that influence JPA design. The second model was a JPA procedural design model that was designed to reflect the steps necessary to design a JPA for use in HRHR organizations.

3. Phase Three consisted of the design of a JPA for a HRHR task using the JPA procedural design model.
4. Phase Four consisted of evaluating the effectiveness of the actual JPA and the effectiveness of the JPA procedural design model.

Discussion of Findings

Major trends in technological development have created new demands on instructional technology especially when practiced within HRHR organizations. These demands are a result of the potential of large scale losses that include not only the loss of life of the task performer, but the loss of lives of those for whom the task performer is responsible. Consequently, the field of instructional technology must continue in its search for ways to improve instruction and better human performance. The findings of this study point to three areas in which the field of instructional technology can expand its knowledge-base and improve human performance. The three areas pertain to (a) the use of modeling, (b) the role of imagination in design, and (c) the role of training in JPA implementation.

Modeling

This study shows the necessity of identifying, exploring and modeling the variables that influence the components of a procedural model. Dietrich Dörner, a highly respected German scientist and professor of psychology, explained that a "reality model" may take the form of an explicit model or it may take the form of an implicit model (Dörner, 1996, p. 41). The explicit form represents realities that are always available to the user in a conscious form such as the representation of steps depicted in the JPA procedural model. The implicit model is one in which the individual may be unaware that he or she is operating on a certain set of assumptions which Dörner called "intuition." It is argued that the intuition of a JPA designer is actually made up of the simple and complex links between the variables that influence design. It is these variables that create assumptions.

The findings of this study indicate that it was not necessary for a designer to refer to the JPA conceptual design model in order to successfully use the JPA procedural design model. However, it was found that in order to develop an accurate representation of an explicit model, it was first necessary to develop and examine an implicit model. It is for this reason that two distinct JPA design models were developed.

The JPA conceptual design model was designed to be a generic, recursive, design model that reflects those variables that influence JPA design in an implicit, intuitive manner. The JPA conceptual design model is generic in that the variables it depicts are found in any JPA design project. It is recursive in that there is no starting and ending point. The model's components may be re-visited as needed and there is no specific flow that must be followed.

The JPA procedural design model was designed to be a task-specific, systematic, procedural model that meets the needs of the expert designer, the experienced designer, and the novice designer as well. It is argued, regardless of the designer's experience, that the JPA designer should address each of the components of the JPA procedural design model to the extent possible. It is recognized that experienced designers have a tendency to "leap frog" about a design model in order to meet time and resource constraints, but it is argued that the design of JPAs for use in HRHR organizations requires an extreme diligence to the components and associated elements which are depicted in the JPA procedural design model. Omission by convenience of any of the procedural model's components or elements can result in dire consequences.

Omission by convenience refers to the intentional bypassing of some of the JPA design model's components or elements without a sufficient justification based on the designer's knowledge-base and experience. Consequently, a caution note is presented at the bottom of the JPA procedural design model. The caution reminds the designer of the potential risks associated with JPAs used in high-risk environments and it warns the inexperienced JPA designer to address each of the procedural elements reflected in the model

The conceptual model is applicable to a wide range of JPA design projects as it represents the variables that influence design. The JPA procedural model, however, was developed to address the design of JPAs within HRHR organizational systems and is not intended to meet JPA design needs outside of this environment. While this may be considered by some a limitation of the model, it is argued that such specificity may actually facilitate its precise use and ultimate effectiveness.

The development of the conceptual model to build the foundations of the procedural model is rooted in the concept of grounded design as defined by Hannafin, Hannafin, Land, and Oliver (1997). They described grounded design as a process that linked the practices of learning systems design with related theory and research. Hannafin et al. (1997) stated "Grounded-learning systems design is theory-based in that designers recognize the utility of various approaches and perspectives. It assists designers in synthesizing across, as well as recognizing important distinctions among, various theoretical perspectives" (p. 102). This study employs grounded design in its synthesis of the knowledge bases and research findings taken from the fields of instructional technology and human factors. Furthermore, representatives from each field provided for a strong argument toward linking practice with theory by means of conceptual models.

Richey (1995) argued that the field of instructional technology must expand the scope of its knowledge base. She argued that although procedural models are viewed by many as authoritative theory, they should not be considered the exclusive theoretical format in the field. Richey maintained that the field of instructional technology needed to expand its models to include conceptual models as well. Seels and Richey (1994) described conceptual models used in the field of instructional technology as models that visualize relationships. Richey (1986) defined conceptual models as follows:

> Conceptual models are analytic in nature. They typically describe the relevant events based upon deductive processes of logic and analysis, as well as inferences from observations. Conceptual models, like theories, are generalized in regard to context. One of their most important functions is to provide the foundation for research which can create support for an inductive theory. (p. 19)

Storrs (1997), a human factor specialist, maintained that in order to build an appropriate model of a system image, which he defined as the users' image of a computer system formed from using it, it was first necessary to build a model of the users' view of the domain which Storrs called a "conceptual model" (p. 111).

Although the definition and application of a conceptual model differ between Richey and Storrs, it is apparent that both argued for a need to examine the links between concept and practice. Consequently, it is argued that the application of grounded design provides a means for more accurately developing the JPA procedural design model. The link between theory and practice is often presented in the form of a model and it is argued that a definitive link was made by means of the JPA conceptual design model.

Design and the Role of Imagination

Rowland (1993) suggested that design "... required a balance of reason and intuition ... and an ability to reflect on actions taken" (p. 80). Intuition, reason, and reflection depend on the designer's imagination.

Imagination provides a means for a designer to form a mental model of the outcome. It allows the designer to begin with a cognitive starting point and provide for the construction of a mental map that that sets forth an initial course of design action. The map then may be altered as the designer progresses through the design process.

Imagination, however, holds an additional connotation when applied to designing JPAs for HRHR organizations. In the context of JPA design for HRHR organizations, imagination also refers to the designer's ability to anticipate possible consequences and to forecast what can go wrong, how and when it can go wrong, and where it can go wrong. Anticipation involves the use of a "requisite imagination." Westrum (1993), one of this study's SMEs, described requisite imagination as a key skill required of a designer that is necessary to anticipate for and test for what might go wrong in a developed system.

It is argued, however, that successful design cannot take place in a vacuum. Feedback, which provides energy to the design process, lessens the tendency for a design vacuum and assists the design process to proceed. Because of the inherent risks associated with the outcomes of JPA design for HRHR organizations, it is recommended that the designer tap into the requisite imagination of others who are associated with or affected by the design project. It is argued that such feedback will fuel the design process, aid in identifying potential fail points in the JPA's display, and provide for determining corrective actions for errors in the JPA's presentation prior to its implementation into the field.

It is argued that the role of imagination, and more specifically requisite imagination, is an essential tool for effective JPA design. From the simplicity of a printed paper JPA to the complexity of a fully automated electronic performance support system, it is critical for the designer to attempt to forecast what can go wrong, how and when it can go wrong, and where it can go wrong in order to correct the design. Recognized and implemented, requisite imagination can be a very powerful design tool.

Implementation

Traditionally, the field of instructional technology has viewed JPAs as substitutes for training, but this study has indicated that a strong relationship exists between JPAs designed for HRHR organizations and training. It was found that training, which included practice in using the JPA, was a necessary ingredient to successful implementation of some types of JPAs into the workplace. The types of JPAs that required training for implementation were not specifically explored in this study, but a number of factors were identified that pointed to a training need. This need was reflected in a proposed model of a training continuum. Figure 17 presents the suggested training continuum model.

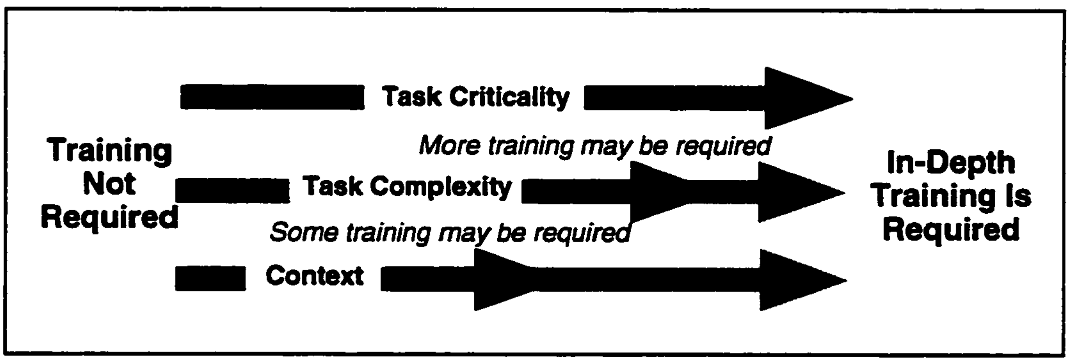


Figure 17. The suggested training continuum that reflects the factors which determine the need for training for JPA implementation into HRHR systems.

The model represents that a *need-for-training point* exists somewhere on the continuum. This point is a theoretical point on the continuum that indicates that a degree of training is necessary in order to successfully implement a JPA into a HRHR organization.

It must be noted that this discussion does not attempt to determine what degree of training is required or how to calculate an exact point on the continuum; rather, this discussion argues that a training continuum does exist and it is an area that requires further research.

The findings of this study identified three factors that appeared to influence the *need-for-training point* and move it towards the *in-depth training is required* end of the continuum. The factors were: (a) the criticality of the task, (b) the complexity of the task, and (c) the context of use.

Criticality of the Task

It was determined that the more critical the task, which is based on the possibility of poor performance resulting in catastrophic outcomes, the more likely the *need-for-training point* on the continuum moves toward the *in-depth training is required* end of the continuum. Whether a JPA displays a simple task or a complex task, it is argued that a slip or lapse in using or interpreting the JPA which could have been eliminated by training during the implementation process is not an acceptable error in HRHR organizations.

Complexity of the Task

This study found that a number of JPAs used in HRHR organizations addressed procedures involving very complex systems. Such JPAs include the computer displays used in air traffic control centers and the electronic checklists and flight management systems used in the cockpits of modern jet aircraft. This study's findings indicate that as the complexity of the task increases, the *need-for-training point* moves toward the *in-depth training is required* end of the training continuum model.

Context of Use

Many JPAs used in HRHR organizations are designed to be used in emergency situations. This study's findings indicate that the stress level of the task performer is an important factor in achieving effective performance. It was found that, although the subjects of the experimental group were prepared to conduct their simulations, some of the subjects indicated in the post-simulation, prompt-recall interviews that their individual stress levels were too high to perform effectively.

Consequently, it was concluded that training was definitely required for tasks which addressed emergency situations, and that such training incorporate the use of the actual JPA in practice sessions that matched actual operating conditions as closely as possible.

Recommendations for Practitioners

This study revealed a number of practical guidelines for the design of JPAs for use in HRHR organizations. The following is a list of recommendations that are based on the design experiences encountered during the course of this study. It is hoped that they will provide practical and useful information to the practitioner in the field.

1. *Identify the client.* It is important that the designer carefully identify who in the organization holds the ultimate approval authority over the JPA design project. As brought out in the SME interview with the professional designer, it is to the designer's advantage to know who can and who cannot exercise authority over the design project. Additionally, it is important that agreement be reached between the designer and the client regarding responsibilities, time lines, resources, and analysis and evaluation processes.
2. *Precision and accuracy are necessary when dealing with procedures.* The JPA designer must keep in mind the necessity of precision and accuracy in the analysis and display of procedures. They are labor intensive and time consuming but they are critical factors towards successful JPA design in HRHR organizations. This study repeatedly revealed the potential for catastrophic consequences that could result from inadequate JPA design. It is argued that such inadequacies are many times the result of imprecision and inaccurate analysis and display of procedures.
3. *Use caution when bypassing any element of the JPA procedural design model.* Past aviation human factors research has identified the dangers of hazardous attitudes. One such attitude was referred to as "macho;" a sense of overconfidence which can be expressed as "I can do it" (see Berlin et al., 1982). This attitude can be averted by the use of one's requisite imagination.

4. *Take advantage of evaluation opportunities.* Unplanned or unscheduled evaluations of the design can be very fruitful. This study reveals that it is most beneficial to accept evaluation feedback when it is offered. The designer, however, must be aware of when feedback becomes repetitive and it no longer provides new information.
5. *Include the real-world JPA user in the design and evaluation processes.* Do not rely only on those in supervisory or expert positions. The "soldier in the trench" can provide some of the most usable data.
6. *Designing by conjecture is dangerous.* Base the JPA design on solid knowledge-based and research-based foundations. Just because it looks good, it does not necessarily mean it will work as intended. Test it.
7. *Requisite imagination is a powerful design tool.* Use it.
8. *Evaluate the JPA's language.* Do not assume that all the symbols, icons, acronyms, abbreviations, text, and graphics used in the JPA design are understood by all members of the target population.
9. *Self evaluation can be very effective.* As a particular design task is completed, put it aside and come back to reflect on it at a later time. This was found to be a very beneficial and effective technique.
10. *Training is a component of JPA design.* Recognize training requirements during the design process. It is during the design process that the limitations of the JPA will be discovered. It is essential if limitations do exist, that they be addressed in the training used to implement the JPA into the organization.

JPA design for HRHR organizations is becoming an important facet of instructional technology. As technology becomes more complex and the human-machine interface becomes more sophisticated, the need for quality JPAs will become more critical to the enhancement of human performance. Hopefully, this study will help designers create effective JPAs, assist organizations in successful implementation, and provide designers and HRHR organizations the incentives to continually and consistently evaluate their JPA designs in the field.

Recommendations for Further Research

The findings of this study point to four major areas that warrant future research. These areas are (a) future research on methods to determine the *need-for-training point* on the training continuum, (b) continuing research into the various factors that influence the effective design and use of automated job performance aids utilized in high-risk environments, (c) future research on the design, development, and delivery of training for the use of JPAS used in high-risk environments, and (d) continued research in the application of conceptual models used to produce other models.

APPENDIX A

Project Checklist

Project Checklist

Documentation of Events

Phase I

1. Conduct literature review. — Completed April 15,1997
2. Send initial SME packages. — Completed Jan 14, 1997
3. Conduct initial SME interviews.
   - SME #1 (Dick) — Completed Jan 28, 1997
   - SME #2. (Dessinger) — Completed Feb 6, 1997
   - SME #3. (Rowland) — Completed Jan 31, 1997
   - SME #4. (Mosier) — Completed Feb 14, 1997
   - SME #5. (Altman) — Completed Jan 31, 1997
   - SME #6. (Westrum) — Completed May 5, 1997
   - SME #7. (Miller) — Completed May 5, 1997
4. Transcribe interview data — Completed May 30, 1997

Phase II

1. Literature and SME interview data analysis — Completed June 15, 1997
2. Develop initial draft of JPA design models. — Completed July 30, 1997
3. Send first-round SME evaluation package — Completed Aug 13, 1997
4. Conduct first-round SME evaluation interviews
   - SME #1. (Dick) — Completed Aug 18, 1997
   - SME #2. (Dessinger) — Completed Sept 17, 1997
   - SME #3. (Rowland) — Completed Sept 18, 1997
   - SME #4. (Mosier) — Completed Sept 19, 1997
   - SME #5. (Altman) — Completed Sept 2, 1997
   - SME #6. (Westrum) — Completed Sept 11, 1997
   - SME #7. (Miller) — Completed Sept 12, 1997
5. Transcribe interview data. — Completed Oct 7, 1997
6. Analyze evaluation data. — Completed Oct 10, 1997
7. Revise Model. — Completed Oct 25, 1997
8. Send second-round SME evaluation package — Completed Oct 30, 1997
9. Collect second-round SME evaluation responses
   - SME #1. (Dick) — Completed Nov 8, 1997
   - SME #2. (Dessinger) — Completed Nov 17, 1997
   - SME #3. (Rowland) — Completed Nov 24, 1997
   - SME #4. (Mosier) — Completed Nov 11, 1997

Item #9 continued. . .

- SME #5. (Altman) Completed Nov 16, 1997
- SME #6. (Westrum) Completed Nov 11, 1997
- SME #7. (Miller) Completed Nov 26, 1997

10. Analyze comments. Completed Nov 7, 1997
11. Revise models into final form. Completed Nov 10, 1997

Phase III

1. Construct initial draft of JPA (Draft #1). Completed Nov 16, 1997
2. Conduct expert review evaluation. Completed Nov 20, 1997
3. Revise JPA (Draft #2). Completed Nov 21, 1997
4. Conduct expert review evaluation Completed Nov 23, 1997
5. Revise JPA (Draft #3). Completed Nov 24, 1997
6. Conduct small group evaluation Completed Nov 25, 1997
7. Revise JPA (Final Draft). Completed Nov 26, 1997
8. Color laser print and lamination of JPA. Completed Nov 29, 1997

Phase IV

1. Check simulation schedule Completed Oct 5, 1997
2. Arrange travel requirements. Completed Nov 17, 1997
3. Simulations completed. Completed Dec 6, 1997
4. Subject Evaluation Forms completed. Completed Dec 6, 1997
5. Subject prompt recall interviews completed. Completed Dec 6, 1997
6. Transcribe interview data. Completed Dec 17, 1997
7. Analysis of interview data. Completed Jan 7, 1997
7. Review and analyze JPA Subject Evaluation Forms. Completed Dec 29, 1997
8. Subject Performance Score Sheets completed. Completed Jan 4, 1998
9. Analysis of subject performance data. Completed Jan 15, 1998

Complete study's conclusions Completed Feb 14, 1998

APPENDIX B

Job Performance Aid

Subject Evaluation Form

JPA Subject Evaluation Form

Please indicate your response to the following statements by checking the appropriate box. After you complete this evaluation form, you will be asked to review your performance in the simulator. Your simulation videotape will be played and stopped approximately every 30 seconds. The facilitator will guide you through this process. Thank you for your assistance.

1. The use of some type of Job Performance Aid is necessary in order to perform the TEST/PREP procedures effectively.

Strongly Disagree	Somewhat Disagree	No Opinion	Somewhat Agree	Strongly Agree
☐	☐	☐	☐	☐

2. I believe that the use of the "pilot" Job Performance Aid improved my performance during the simulation.

Strongly Disagree	Somewhat Disagree	No Opinion	Somewhat Agree	Strongly Agree
☐	☐	☐	☐	☐

3. Training on how to use the "pilot" Job Performance Aid is very important in order use it properly.

Strongly Disagree	Somewhat Disagree	No Opinion	Somewhat Agree	Strongly Agree
☐	☐	☐	☐	☐

4. The visual information structure (the pictures, symbols, and text) used in the Job Performance Aid were clear and easy to understand.

Strongly Disagree	Somewhat Disagree	No Opinion	Somewhat Agree	Strongly Agree
☐	☐	☐	☐	☐

5. I liked the size and physical format of the "pilot" Job Performance Aid.

Strongly Disagree	Somewhat Disagree	No Opinion	Somewhat Agree	Strongly Agree
☐	☐	☐	☐	☐

Please write a short comment:

What I liked best about the "pilot" Job Performance Aid was:

____

____

____

____

What I liked least about the "pilot" Job Performance Aid was:

____

____

____

____

APPENDIX C

Subject Simulation Score Sheet

Subject Simulation Score Sheet

Subject # ______ Date: ________
Start time: _________ End time: _________ Total elapsed time: ____________

TEST Procedure

1. Crew briefing performance:
   __ [5] Excellent (Appeared very attentive, no hesitation, read back accurate).
   __ [4] Good (Appeared attentive, some hesitation, needed to clarify one element in read back).
   __ [3] Average (Appeared attentive, hesitant, required clarification of more than one element in read back).
   __ [2] Fair (Appeared apprehensive and uncertain, required a third clarification of one element}.
   __ [1] Poor (Appeared very apprehensive, required a third briefing of all elements).

2. TEST briefing performance:
   __ [5] Excellent (No hesitation, explained each element professionally, easy to hear and understand, did not use confusing language).
   __ [4] Good (Appeared slightly apprehensive but did not miss any elements or present mis-information).
   __ [3] Average (Appeared apprehensive, was hesitant during presentation).
   __ [2] Fair (Appeared very apprehensive or presented mis-information regarding one element).
   __ [1] Poor (Missed one element regardless of presentation style or presented mis-information in more than one element).

3. Transition performance from the TEST procedure to the PREP procedure.
   __ [5] Excellent (No hesitation, transition smoothly).
   __ [4] Good (Slight hesitation, or slight pause in transition).
   __ [3] Average (Demonstrated a major hesitation between procedures)
   __ [2] Fair (Appeared unsure of transition phase).
   __ [1] Poor (Improper transition performed).

PREP Procedure

1. Preparing passengers for brace positions (Forward, side, aft facing):
   __ [5] Excellent (Appeared professionally assertive, all procedures followed with no hesitation).
   __ [4] Good (All procedures followed but appeared hesitant at times).
   __ [3] Average (All procedures followed, but demonstrated some confusion).
   __ [2] Fair (Failed to correct one improper brace position).
   __ [1] Poor (Failed to correct more than one improper brace position).

2. Preparing passengers, "cleaning up" performance (Pens & pencils, eye glasses, high-heel shoes, jewelry):
   __ [5] Excellent (All passenger items addressed, handled questions professionally).
   __ [4] Good (All passenger items addressed, but did not handle questions professionally).
   __ [3] Average (Failed to address one passenger item but gave proper instructions to those addressed).
   __ [2] Fair (Failed to address two passenger items).
   __ [1] Poor (Failed to address over two passenger items or gave improper passenger instructions regarding items).

3. Ready cabin performance (secure carry-on, food/beverage service, non-essential electric):

__ [5] Excellent (Announcement clearly made, all items properly stored, galley secured, non-essential electric off).

__ [4] Good (Announcement not clearly made, all items properly stored, galley secured, non-essential electric off).

__ [3] Average (Failed to make announcement, all items properly stored, galley secured, non-essential electric off).

__ [2] Fair (One item missed regardless of announcement style).

__ [1] Poor (More than one item missed regardless of announcement style).

4. Evac review (Brace positions, assign tasks, procedures review):

__ [5] Excellent (All procedures followed correctly, properly addressed passenger concerns).

__ [4] Good (All procedures followed correctly, appeared hesitant at times when assigning tasks).

__ [3] Average (All procedures followed correctly but appeared very hesitant or confused during tasks assignment).

__ [2] Fair (Missed one item during cabin ready element or gave one incorrect task assignment).

__ [1] Poor (Missed more than one item or failed to give task assignments or gave over one incorrect task assignment).

5. PIC report performance:

__ [5] Excellent (All procedures followed correctly, continued passenger instructions in a professional manner).

__ [4] Good (All procedures followed correctly, appeared somewhat hesitant in giving continued passenger instructions).

__ [3] Average (All procedures followed correctly, appeared hesitant or confused in giving continued passenger instructions).

__ [2] Fair (Failed to perform one element of procedure).

__ [1] Poor (Failed to perform more than one element of procedure).

Total score TEST _________ Total score PREP _________ Total cumulative score __________
Mean score TEST _________ Mean score PREP _________ Total mean score __________

Possible Passenger Items Missed:

Proper PAX brace ___
PAX seatbelt ___
Pens & pencils ___
Eyeglasses ___
Shoes ___
Sharp objects ___
Bare skin ___
PAX carry-on ___
ABP willingness ___
ABP ability ___

APPENDIX D

Subject-Matter-Expert:

Initial Telephone Interview Data

Subject-Matter-Expert: Initial Telephone Interview Data

The subject-matter-expert (SME) interviews are presented in the following format: (a) entries titled QUESTION or PROBE are questions or comments made by the researcher during the interviews, and (b) responses by the SMEs are noted by the SME's name. Each SME interview is identified by the name of the SME and the date of the interview at the beginning of each interview.

The words or phrases identified as contributing factors to JPA design and coded in the information-management-database indicated by underlined text. The underlined text is preceded by an abbreviation set in brackets that corresponds to one of the following factors:

- Model Outcomes: [MDO]
- Decision Making: [DMK]
- Model Components: [COMP]
- Information Processing: [INFO]
- Visual/Text Display: [VTD]
- Evaluation: [EVL]
- Model Linearity [MDL]
- JPA Effectiveness: [EFF]
- Model Characteristics: [CHAR]
- Performance Time [PFT]
- Training: [TNG]

Jan 28, 1997
Dr. Walter Dick

QUESTION:

What expected outcomes can a design model provide for the user (a user being defined as a person who is assigned the responsibility to construct a job aid for some specific industry such as aviation)? Let me clarify. . . do you see the outcome as only a performance task? Where only performance is an outcome? Or do you see the job aid as being able to provide more than just a task outcome?

W. DICK:

Okay. . . [MDO] I think we're making a distinction between a traditional job aid an electronic performance support tool. If we are. . . the support tool has a broader range of characteristics including kind of a media tool or along with information on the tool to training on the tool to an information base that people can draw on. That's. . . that's one sort of grand job aid. I was responding in terms of a traditional job aid which is more none computer based; so let's make the distinction whether you're interested in having your model result in a computer based EPSS or is it a non-computer based more traditional paper device. . .

PROBE:

Let me respond. . .with a question. Do you envision or do you think possible that a conceptual design model could encompass both media?

W. DICK:

Well if you are . . . if you have an [MDO] extensive front end on the model which results in a clear indication of what the need is, what the gap is. . . and [MDO] describes the environment in which the solution is going to have to operate. . . and some of the characteristics of what the tool is... what are the characteristics going to have to be in order for it to work effectively; then conceivably you could then based on this information. . . it would appear that a paper based aid would be suitable . . . another might be a sticker right on the piece of equipment versus we need to use a system, embed a system in the computer which already exists in the equipment that's being worked on and so forth. Yeah, if its a pretty elaborate model. I can jump ahead a little bit and say that the Dick and Carey Model is really a design and development model based on the assumption that you know what it is you want to design and develop. And that the major problem or task that I see facing you is: One, modifying that model to accommodate your needs with regard to the aid, but also to [MDO] determine what kind of a front end is required from that model in order to come up with a specification that will then allow a person to move in to the design and development phase.

QUESTION:

Do you envision such a model to be linear, systematic in nature or do you think linearity is not a requirement? In other words. . . a step by step process.

W. DICK:

Oh man. . . I would prefer to think that . . . well when I think of models I think of linear models and I don't know what these non-linear, puffy-cloud, sorts of things. . . models are, so you know I would. . . if it were my project, my model, and my task, [MDL] I would think of steps. I think people ultimately are linear serial processors, we do one thing at a time. We aren't multi processors. . . even though computers are. Ultimately, we may go back and do some things over again, and we may jump ahead in a model, but our actions are essentially linear and you can reflect the jump ahead and moving back in any model if you want to.

QUESTION:

Do you think that a job aid, whether it be electronic, paper, whatever, that it can influence decision making on part of the user?

W. DICK:

Oh I hope so. . .

PROBE:

Please elaborate. . .

W. DICK:

Well, I think [EFF] one of the most important features of a job aid is in fact to help the person make the right decision. . . that the job aid is a quick reference, for example if the fuel valve is above 500, you had better turn it off. . . that sort of thing. And, in terms of listing critical values from various pressure valves, etc. . . so, I think that it can be used as a decision making tool or it can be used as a procedural tool. . . do step one, step two. . . step three. . . step four. . . these aren't worth memorizing, just make sure you do them in this sequence.

QUESTION:

What would you consider to be the most critical activities or components of such a model? You already mentioned the front end but would you expand on that. . .

W. DICK:

The characteristics of the model itself?

PROBE:

Of the model. . . to allow the person to design an effective aid.

W. DICK:

Okay. . . one, [CHAR] I think that the more specific that you can be about what a step is. . . or what you want the designer to do. . . what they should be doing, rather than just very general kinds of non specific. . . In other words, more specific. . . you say like put screw A in hole B sort of thing, then the more likely the person is going to do it and be successful. That's assuming that you can bring you model down to that level. . . specificity.

It quickly becomes an issue of use of the model. . . that it is usable. . . that whether it requires training to use it or. . . an experienced designer. . . [CHAR] the question is, what are the entry behaviors required of a person in order to use this model? And that should be perfectly clear. . . so that you don't have a novice trying to use a model that calls for skills that they don't have. And the ever present problem in a model is "what's the level of detail? How many boxes do you have to have? And, I know you have seen situations where somebody has had 120 different steps to do something which no person is going to do. . . by step number 23 they have about had it. So I think that the chunking, the size of the chunks and the steps is really important in terms of a reasonable size effort that then produces some kind of a product which is then the input to the next step. And then, I guess in any model [CHAR] the question is whether other people are involved. . . how do you bring in other people into the use of the model?

I had a conversation the other day with someone who is teaching the Dick and Carey Model and they said that clearly you are teaching the designer to work in isolation and completely ignoring their client. And I said, we never said that in the book. and they said, well you never mention the client. I said well in the learning situation, we felt that it was best for the designer to serve as their own client in the sense of being their own subject-matter-expert as they were learning to use the model, but obviously no designer works in isolation when they . . . are out in the real world. . . [CHAR] its critically important to interact with the client. Well that came as a surprise. . . and [CHAR] I think that the same thing would be true for your model in terms of what is the role of the client in the client's context in the design of the aid. How do you specify that in the model? Is it, again, do-able? The last comment would be that I think that it's absolutely critical that the designer of any model to have tried it out themselves, done the formative evaluation, and then maybe have somebody else use the model. . . and revise that model so that its usable and produces the results you are interested in.

QUESTION:

What role do you see the components of information processing play in the model (for example: perception, motivation, relevance, accessibility)? Do you see these components integrated into the model?

W. DICK:

Well. . . my honest answer is no it never would have occurred to me because don't come from a communications background. I think more of the task and what is to be performed but I also recognize that the things your mentioning are things that enhance the communicability of the model, and certainly I wouldn't deny that having. . . taken those factors into consideration could be important. Their just not in my realm.

QUESTION:

Do you feel that job aids can influence decision making strategies?

W. DICK:

Yes. . . in [DMK] the sense that the strategy used in the job aid can either be visible or invisible to the user. I'm thinking again of an electronic one but conceivably even in a print based one. You can simple use a decision table which the user has no idea why that decision is in a particular box, he just has to find his way to that box. That's the decision and on it goes. Same thing with the computer. But. . .if. . . [EFF] if the expectation is that you will wean the person away from the aid as they use it more and more, then certainly you can use the aid to shape the way you want the person to go about making that strategy decision. . . so that in the aid you could lead them through a series of steps that you want them to use later on. And I guess the question is: Is the goal of the aid to eventually disappear and have the user internalize or automatize. . . not need the aid anymore? If so, maybe you want to shape those decision strategies. If they are always going to use the aid when they get to a certain situation, then I don't know whether its necessary to make a great effort to have them understand the strategy.

QUESTION:

How can the design of a job aid address the critical factor of time?

W. DICK:

I'll have to think of my answer a little bit. . . Well the only thing that really comes to mind is . . . fundamentally the task takes as long as it takes. . .

QUESTION:

Let me rephrase that slightly. . . when I refer to the critical factor of time, I'm not so much referring to a relation to completion of the task, but time to make the proper response to the cues that are available. .

that's where I'm coming from. . .

W. DICK:

Now are you talking about the ultimate user. . .

PROBE:

Yes, that's where we're getting confused. Not the designer, but when one is designing a job aid, what features should one incorporate so that the end product will address the factor of time. . .

W. DICK:

Okay. . . I understand the question. If I had the answer to that question what I would probably do is go to Allison Rossett's book on job performance aids and look at it and see what she had to say about time factors. I really don't know.

QUESTION:

Okay, do you feel the job aid should incorporate more visuals than text, or more text than visuals?

W. DICK:

I think it [VTD] depends on what the task is. Some tasks are highly visible and again in terms of speed of use, they can show you things very quickly and other tasks like five steps to follow in counseling someone who is applying for unemployment compensation. . . I don't think that visuals would make any difference at all. . . that's basically a verbal task. You might have little icons or that sort of thing. But I think that the task in the context in which the aid is being used can . . . is the best guide in answering that question.

QUESTION:

I don't have this written down. . . do see that an icon, a symbol could cue the user to recall a chunk of information? Let's say we have a 10 procedural step to accomplish some task that's critical and you use a pictorial to break the 10 steps into two five step chunks and a pictorial would cue the person on the first five steps and another pictorial would cue the person on the nest five steps.

W. DICK:

Absolutely! [VTD & TNG] If there is appropriate and sufficient training that precedes the use of the icons that assures that you have that linkage so when they see that icon it fires five steps. . . and the only problem I would see with that is kind of what you might want to call memory drift. That's not a technical term but its the fact that you train me and I learn these five things. . . I see that icon, those five things fire but over time my memory tends to decay and I see that icon and now I do one, two, four, five and forget to do three. That reminds me of the Mager diagram in his Analyzing Performance Problems. . . [TNG] when people can't perform certain tasks: is it because they never knew how to do them or they forgot how to do them? And so I think that you have to be quite confident that the user can associate the task with the icon. . . continually over time. . . that they're going to be using a lot because if there are gaps in time between the uses of the aid, then I think you can almost be certain that they are going to lose that and they are going to see that icon and they're going to say: "Oh yeah, I know that's the opening set of things I'm suppose to do and I think that involves. . ." Then you could have some problems if this is a critical task.

QUESTION:

Well you just answered my last question. . . but I am going to read it to you anyway: What is the role of training in regards to the use of a job aid? Should training be a component of the design model?

W. DICK:

Yes. . . [TNG] well, I think that there ought to be a diagram that . . . a diamond not a diagram. . . that says "Will training be required in order to use this aid?" I can imagine certain job aids which with a little cover letter. . . I mean you could . . . it would be self explanatory enough that the person could use it successfully. And depending on the level of the user and the nature of the aid where a cover letter would do it.

[TNG] There are other aids that are so critical to their effective use. . . correct use. . . that training is absolutely mandatory and that training not only on the use of the tool but there will be an attitudinal component that addresses why they should choose to use that tool in that situation. And. . . those are kind of the two extremes and I think in between are the kinds of tools you design which are used over a period if time and they kind of disappear because the person has in fact learned or internalized or memorized all those past . . . but [TNG] I think there ought to be a diamond that says to what extent of training is required and in there some kind of algorithms or heuristics that the person can use to decide to what extent training is going to be critical.

Feb. 6, 1997
Dr. Joan Dessinger

QUESTION:

What expected outcomes can a design model provide for the user (a user being defined as a person who is assigned the responsibility to construct a job aid for some specific industry such as aviation)?

J. DESSINGER:

Well, they should be able to provide the user. . . [MDO] I would think verification that the job aid is required which may be outside the focus of this question, but away to verify that the job aid is the best way to proceed for this particular task or procedure or situation. A job aid should also provide . . . a job aid on how to do job aids would provide the designer with a process. . . for actually doing the design from the development of the goals and objectives for the design through the actual piloting of the design so it would pretty much be following the ISD model . . . it would provide them with guidelines for. . . Boy, I would love to see it present for style, format, and verbage which is certainly an important part of the design focus. . . Speaking of focus, it should help them focus on . . . keep their goals and objectives in mind as they go through designing it. . . to help them to [MDO] focus on exactly why they are doing the job aid and what outcomes they expect. Actually, what it should do is take them by the hand and guide them through. . . without having to go to something else.

QUESTION:

Do you envision such a model to be linear, systematic in nature.

J. DESSINGER:

I see it being that way but it also has to have some flexibility. . . [MDL] I kind of like the models that are linear and yet allow the user to move in and out of the various components. Maybe not at the beginning when they are first beginning to use it but . . . because this is a situation where the outcomes can be dire, I think linear models are probably the best but even in that case a well trained expert user would need to be able to move in and out of the model. . . have some flexibility where a novice user would definitely need a very linear model.

PROBE:

You gave me an idea for a probe question. . . do you think a conceptual model should have a two path direction: one for a novice and one for an expert?

J. DESSINGER:

There are two thoughts on that: one is you take [MDL] novice, intermediate, and expert and try to build one model that works for all three. . . or you build it sort of like programmed learning where you have branching. . . or you build just the one model and make the assumption that. . . or make the statement up front that the novice should follow it exactly, the intermediate may begin to explore flexible ways of using the model and the expert, based on their past experience, can use some flexibility. [MDO] The problem is your outcome which is tasks or procedures that have dire consequences. . . if the job aid is not produced correctly. . . that limits you a little bit.

QUESTION:

Let's talk about a job aid itself. . . not the model. Do you think a job aid can influence decision making?

J. DESSINGER:

Yes.

PROBE:

Could you expand on that?

J. DESSINGER:

I've seen job aids that have been developed for example for tasks or for jobs that when decisions makers look at them. . . now I don't know where your coming from. . . whether your coming from that or a trouble shooting perspective. . . but when they look at them, they realize that the job or the task was not what they thought it was and that there needed to be some kind of a change. . . either in employee selection or training or incentives or whatever. At the same time in trouble shooting and determining what the problem is and what to do about it , [DMK] I find that job aids are extremely effective because they force you to search out options that have been proven in the past to be potential causes of the problem. The problem there is they don't always allow you to use your heuristics. . . your gut feeling.

QUESTION:

What would you consider effective characteristics of an effective job aid? We are speaking of the aid itself, not the design model.

J. DESSINGER:

[EFF] Simple. . . direct, accurate, complete and unambiguous.

PROBE:

That really sums it up. Sound like you wrote a dissertation on that?

J. DESSINGER:

It sure does. . . I was just thinking about that today. . . Boy, you'd better pull that out! But really that kind of does it.

QUESTION:

Getting back to a conceptual model, what would you consider the most critical activities or components of a model for designing a job aid?

J. DESSINGER:

I guess I would [CHAR] parallel pretty much with the ISD model because up front you have to have. . . [COMP] you have to establish your goals and objectives. . . that kind of implies that you have done an assessment of the situation up front. You certainly have to have a good design. You have to have formative evaluation that's kind of ongoing. [EVL] You need to have a summative evaluation at the end of it and make sure that it really. . . it has done what you said it was going to do. So pretty much that same. . . maybe blown up a little bit. . . and adding a few other steps just to blow up each one. . . but otherwise that's pretty much how it would go. Because under each piece, like under development, you would get into format and style types of things. There would be some systems within it.

QUESTION:

What role do you see the components of information processing play in the model (for example: perception, motivation, relevance, accessibility)? Do you see these components integrated into the model?

J. DESSINGER:

I think there's a [INFO] strong tie between developing and designing a job aid and using some of the research and methodologies that's come out of information systems.

PROBE:

How would you envision these components being integrated into a design model?

J. DESSINGER:

. . . [INFO] The motivation aspect in particular, one of the problems is that in your particular case . . . with the outcomes. . . if you want a person to consistently use a job aid is that he become more familiar with the job. . . motivation becomes even stronger. . . that leads to accessibility for example. . . you are not motivated to use a job aid that is not accessible on the job when you need it. . . and if you are. . . I've seen so many situations where the job aid is decent, good, but it's positioned so that nobody can read it or that nobody can access it. . . you know. . . so people aren't motivated to use it because it's just not around.

PROBE:

So. . . environmental conditions are. . .

J. DESSINGER:

[EFF] Environmental conditions are extremely important. They have to be taken into account when you're designing.

QUESTION:

This may be redundant, but do you feel a job aid can influence decision making strategies?

J. DESSINGER:

Sure. . . [DMK] it can guide them for one thing. . . there are many job aids out on how to make decisions. It can . . . on the negative side and I think we did talk a little about this, it can stifle creativity so that maybe your decision making proceeds too linearly that it doesn't allow for that Ah AHH moment. . . or that very creative person who can make a decision or resolve a problem very creatively so you have to be careful for that, but especially for the novice. . . the manager who's new to management. . . if a good aid in helping them to focus on what it takes to make a decision even if it's as simple as a checklist of factors or a simple if/that . . . you know. . . type of job aid.

QUESTION:

How can the design of a job aid address the critical factor of time?

J. DESSINGER:

Really. . . [PFT] most of the time it can speed up a process, especially if it's a process that you're unfamiliar with or you just don't do very often and timing is a factor. In a crucial situation, for example a how to shut down a machine or how to do a lock out or something like that, it's crucial l that you do it quickly because somebody's arm is caught somewhere or . . . the nuclear power plant is going to explore or whatever and you need to do something quickly and if you have the job aid and it is [PFT] accessible. . .if it's right there and you don't have to think about making a mistake, you just follow it and do it. . . it could impact timing a lot. It takes a long time to develop and design in order to make a job much faster.

PROBE:

Making the assumption that the aid is accessible, what characteristics in the aid itself do you see that would speed up the process. . . the task process?

J. DESSINGER:

The [PFT] formatting. . . making it very easy to read and easy to follow. . . knowing where to start and where to stop. . . and probably in this situation what to do first, what to do second, third, etc. It's just got to be very clear. . . it has to take its audience into account . . . [EFF] if it's an older person that might be using it, then the type has to be larger. . . then there is all those communication types of skills that the designer has to use. . . font, type sizes kinds of things. . . just making sure that it is accurate.

QUESTION:

Do you feel the job aid should incorporate more visuals than text, or more text than visuals?

J. DESSINGER:

With today's generation coming on I guess I would go for the visuals. You know I wish I were more up on the research cause I know there is some research on this out there on this and I don't know what they're saying. It may need a combination. I know in the past that we've kind of hedge on that and said it's best to have a combination because while most people are very visual... you know if you do a survey of a group you're probably going to come out with 80% people who say they're visual... but that may mean that different things... I had somebody in class the other day who said they were really a very visual person and normally you'd transcribe that as liking pictures, liking charts... what they meant was that they had to see the text. They didn't want a visual in terms of a graphic. They wanted to see written text and they considered themselves a visual person. So, I think maybe [VTD] a combination is necessary. Also, regarding language, if you're talking about situation where there is a language barrier, then graphics become extremely important. So maybe you need... I think if you can do a combination.

QUESTION:

What role do you think training plays in regards the use of the job aid?

J. DESSINGER:

[TNG] If it's a good job aid, training in how to use job aids should have to be minimal... a minimal factor... a minimal time.

PROBE:

Let's say we have a ten step procedure... an emergency situation...

J. DESSINGER:

Still... if the job aid is well constructed... you almost should be able to hand it to somebody and they should be able to do it. If any training at all is necessary it should be minimal and it might be for example following a flow chart and just a refresher on what the various shapes mean so that you can quickly point out to yourself what's a decision point, what's a stopping point. [TNG] But it really thwarts the use of a job aid... if you have to have a lot of training involved.

QUESTION:

This leads to a follow up question: should training be a component of the model?

J. DESSINGER:

You're talking about a very more complex model then say a ten step procedure... I think. Talking about a conceptual model for job aids... especially for your outcome, I see a little more complicated... [TNG] There's another way of looking at training in job aids and that is if you are training someone to do a task for example that either they don't perform very often or that they must perform exactly right every time or something dire will happen, in those cases you then sometimes need the training up front and then they use the job aid to help them transfer it to the job and to help keep them consistent. I guess when you're looking for consistency and when you're looking for exactitude... training becomes more important.

Jan 31, 1997
Dr. Gordon Rowland

QUESTION:

What expected outcomes can a design model provide for the user (a user being defined as a person who is assigned the responsibility to construct a job aid for some specific industry such as aviation)?

G. ROWLAND:

Yeah... I'm going to have to shoot from the hip on all this.. .first thing that came to mind when you said high risk was kind of a [MDO] mirroring... you want something that is unbelievable reliable and clear and the user is well trained in the use of the job aid... so you just can't have them look at it and learn it on the spot. It's got to be able to do X Y Z right off the bat. It's kind of . . . I don't know, kind of factorial in a sense. . . kind of a mirror in a sense. [MDO] You wouldn't want a model of your own creation here to give the designer overconfidence in any sense. . . if you know what I mean. You don't want to dump a bunch of the knowledge on job aid development in this high risk environment on to an aid that somebody really doesn't know what they're doing and does zero testing and stuff that somebody is going to rely on. So [MDO] maybe it's going to be a heuristic device to get them thinking about various elements. . . things like that. But it's also got to be itself a reminder that "do not trust this model." Do not trust the user's ability to do this. You just can't overplay the criticality here.

QUESTION:

Do you envision such a model to be linear, systematic in nature.

G. ROWLAND:

I'm not sure. . . I go back and forth. . . you know Walt's model that you gave me here. You know we have criticized it over the years for its arrows and boxes and that kind of stuff and it surely does suggest a linear process but Walt doesn't use it that way and he knows better and he doesn't think anybody else does either. So maybe that's {MDL] a case where the linearity . . . if it helps somebody just to remind them of what's happening. For example: I think Walt's model is easier to use when you think about as what are you going to fire off on when. . . not necessarily you engage in those steps in sequence but you are going to fix your objectives before you fix your strategy. . . that kind of thing. So its like if you look at a Gnat chart and you see all the bars going across, the one that ends with objectives is going to be before the one that ends with strategy. But it doesn't mean you start work on one after you finished the other. You know Walt doesn't do that in his own practice I'm sure.

QUESTION:

Do you think that a job aid can influence decision making?

G. ROWLAND:

Well sure. . . you are talking about [DMK] a situation of human performance and any stimulus in the environment is going to be of influence, particularly one that is designed in such a way to influence that performance. So like Jack Carroll talks about anytime you develop a new technology, you're not just assisting the processes, structures, organizations that are current, you are creating a new environment. So for example when you place a job aid on a machine you got a new situation of job performance. It may affect the motivation of the worker, it may affect their ego, who knows. . .

QUESTION:

What would you consider effective characteristics of an effective job aid? We are speaking of the aid itself, not the design model.

G. ROWLAND:

I'm thinking of industrial context right now. . . It's got to be [EFF] absolutely clear to a wide variety of users. At least a little beyond the range that going to be the user. It's got to be visible and that means you have got to do a very thorough examination of the environment so that you're not sticking it somewhere that the user has to be looking a different direction to actually apply it. Well. . . just decent message design.. . certainly all colors and text and that sort of stuff. It's got to be something that can be referenced easily and by that I mean you got to be able to . . . like if you're using both your hands. . . you got to be able to look up and see where you are at each step and not have to search through it each time to get to the next step. Ideally, it's memorable so that you look at the job aid, you get something in short term and you can use it real quickly, and not have to read word for word, and apply word for word. Probably multi-modal.

PROBE:

Would you define that for me please.

G. ROWLAND:

Yeah. . . [CHAR] it's pictures and words. Can I go back for just one second. . . I said pictures and words but we also ought to think of sound. A job aid doesn't have to be visual.

QUESTION:

Now let's consider the model. What would you consider to be the most critical activities or components of a model required for designing a job aid? What type of activities would you envision such a model incorporate?

G. ROWLAND:

Yeah. . . I think the first one and [COMP] most important that comes to mind to me is working with the user. . . the intended user. . . you know starting formative evaluation from before you even begin designing in a sense. I kind of work that through. . . user design as a concept throughout the whole thing. I imagine there would be a some sort of element of design itself. . . that is the creation, the idea generation. . . and selection. I don't normally use specific performance objectives myself unless clients ask for such things and they are expecting them, but some sense of purpose. . . definition of purposes would be important so that you can actually see if you've accomplished what you want to from it.

PROBE:

I am just adding something now. . . how do you feel about task analysis?

G. ROWLAND:

Essential. . .

PROBE:

As one of the components of the model?

G. ROWLAND:

Sure.. . [COMP] the task analysis, in a very rich sense. . . I mean getting in there and observing for a day, interviewing, if possible trying it yourself. . . getting inside their head. . . having them to think aloud as they do it.. . those sorts of things. Not just sitting down and doing a learning hierarchy or something... that's not going to help you.

QUESTION:

What role do you see the components of information processing play in the model (for example: perception, motivation, relevance, accessibility)? Do you see these components integrated into the model?

G. ROWLAND:

You know I am a visual thinker and I started to see it as we talked. . . some of these elements being up in a big bubble shaped or something at the top of a page. . . as being involved and I do not mean with arrows and boxes or anything but just up there somewhere. The kinds of things you just described I think would kind of be outside of that bubble with a dotted line in or something . . . and what I mean by that is . . . these are [INFO] important bases of knowledge that the designer will have but not necessarily steps. . . that the designer will take or activities. . . you know a lot of design is even unconscious. . . so it's a lot of influence from your theoretical perspectives about learning and perception and all these things, but it's not that you sit there and you call up rule thirty-seven and then . . . you know. . . apply text based on that or something. It's much more dynamic than that and a lot unconscious based on experience. . . case experience. . . that kind of thing.

QUESTION:

Do you feel that job aids can influence decision making strategies?

G. ROWLAND:

Absolutely.

PROBE:

Could you expand on that. . .

G. ROWLAND:

Sure. [DMK] When you've got something in front of you telling you this is the appropriate way to do anything, you are going to either accept that, reject that, or modify it. But you will be reacting to it in some way.

QUESTION:

How can the design of a job aid address the critical factor of time?

G. ROWLAND:

Oh . . . [PFT] simplicity. Simplicity is kind of a layered thing you know. You got to be able to call up sub-routines in your head when you look at a job aid. For example, I've seen some that have huge headings and underneath it it'll have more complete information, but the experienced person or the person who's doing it more often. . . this came up every month rather then every year or something. . . they're going to look at that heading and call up the . . . kind of automatic sub-routine from it.

QUESTION:

Do you feel the job aid should incorporate more visuals than text, or more text than visuals?

G. ROWLAND:

Well. . . I tend to think that more visuals, but I'm not certain on that . . . for a couple of reasons. One is that I know that I am a visual thinker . . . and secondly, I've seen some studies of things that contradict that sort of evidence. For example, [VTD] I remember some studies done about icons and I remember for at least for initial usage and stuff, which of course is a criteria for a job aid, words were at least as effective . . . simple words rather than icons . . . thing like that. So if it's going to be a picture, it's got to be a very well designed picture . . . that the user can really identify with very carefully and very easily; otherwise, it may be just as well be words.

QUESTION:

What is the role of training in regards to the use of a job aid? Should training be a component or activity of the model?

G. ROWLAND:

Oh absolutely. . . [TNG] It should definitely be part of it. We've made the mistake over the years. . . this goes back to Allison Rossett's stuff of thinking that a job aid would stand on its own completely, but it's a message . . . it's an instructional message and if you can't understand how to use it in a flash then you're out of luck. So a job aid in its initial presentation . . . somebody really has to learn how to use it. . . now if that takes a half an hour you've got a problem. So training ought to be part of it, but if its a long training session required for a job aid, you have to go back and re-examine the performance situation in general. Maybe you got the wrong people involved or something.

01/31/97
Dr. H. B. Altman

QUESTION:

What expected outcomes can a design model provide for the user (a user being defined as a person who is assigned the responsibility to construct a job aid for some specific industry such as aviation)?

H. B. ALTMAN:

You're asking me a design model. . . I think that a design model would [MDO] assist the user, like me, in coming up with an aid to provide the crew in an aircraft situation. . . looking at that as being a critical situation. . . so that we could be more effective in the procedures necessary for a particular emergency scenario.

PROBE:

When I'm speaking of outcomes... I'm speaking of the job aid, the device... whatever it may be and... when a designer designs this device what criteria would you envision that would show that this device is worthwhile?

H. B. ALTMAN:

If the objective is met by [EVL] measurable results.

QUESTION:

Do you envision such a model to be linear, systematic in nature or do you think linearity is not a requirement? In other words... a step by step process.

H. B. ALTMAN:

I believe that [MDL] one step needs to be made before the next step is taken ... in other words you need to know that I've accomplished one level successfully before you go to the next level.

PROBE:

How would you determine whether a level has been successful?

H. B. ALTMAN:

[EVL] Measurable objectives.

PROBE:

Would you expand on measurable objectives?

H. B. ALTMAN:

Let's say that if an individual was suppose to pack three spools in a box; than the measurable objective would be whether the individual was able to do that. Does that make sense to you?

PROBE:

Well when we're talking systematic, step-by-step, do you envision where a designer could perhaps do more than a step at the same time or do you feel that the model should lead the user very rigidly?

H. B. ALTMAN:

Well I think it has to do with the particular function of the job involved... for example if you were going to take-off an airplane, you want to be able to one item at a time in order to accomplish your lift-off task.

QUESTION:

Let's go to the job aid, do you think a job aid can influence decision making?

H. B. ALTMAN:

Absolutely. Well, it becomes a [DMK] programmed decision making situation... so that your job aid... you're relying on the job aid to make the decision for you which becomes a programmed decision maker.

QUESTION:

What would you consider the characteristics of an effective aid?

H. B. ALTMAN:

I think I would want to know [CHAR] is it an oral aid... is it a visual aid... do I have to read it... do I have to look at pictures? The aid must abet the cause the situation requires...

PROBE:

You have seen good and effective passenger information cards and you have seen ineffective or poor passenger information cards... think of the characteristics that a good card has over a poor card...

H. B. ALTMAN:

Well, a good passenger information card would follow along with the [EFF] KISS principle. . . keep it simple, keep it short, and keep it informative. And like a well illustrated card would be more effective than a photographic card that would have a lot of visual noise in it. If you have a photographic card and you remove the visual noise than it probably would be no different than an illustrated card, but in regard to what's a good card and what's not, it can tell a story from the photographs or illustrations from the beginning, middle, and end. And can it be measured.

PROBE:

Same question, but think of some of the checklists you've seen. . . which are verbal versus visual. . . what do you think distinguishes a good effective design versus an ineffective design?

H. B. ALTMAN:

[VTD & CHAR] Redundancy. . . you can't have just verbal because in a stressed situation the individual may have. . . inattentive to the verbal and so you are going to have to have a written backup.

PROBE:

I think you misunderstood what I meant by verbal. . . I meant textual.. . thinking of checklist again. . . what would the characteristics be of a good checklist?

H. B. ALTMAN:

The first one would be big letters. . . big writing. . . short phrases. . . to the point and that meet the required performance objective.

PROBE:

How would you determine the required performance objective?

H. B. ALTMAN:

The end product would be. . . or determination. . . in other words, whether the individual can get to the end and getting to the end in the least effort way and that it can be [EVL] measured in some effective way like time or accuracy.

QUESTION:

Thinking of a design model for job aids. . . what would you consider the most critical activities or events in such a model?

H. B. ALTMAN:

I think the very first one is the beginning, the [COMP] assessment of needs. What is the need that the model is going to address. In other words you have got to start with a beginning . . .that's the same thing I've always said, you've got to start a paragraph with a first sentence. And you've got to start any model with the assessment first.

PROBE:

What other components do you see in such a model?

H. B. ALTMAN:

Well. . . once you've determined the necessity for the model and you have your assessment, then you are going to have to come up your design of the component of the. . . or the beginning of the model. . . then you're going to have to deal with . . . make it happen and the you've have to do it. And then you have to evaluate it. . . in other words [COMP & EVL] it's a circular event. . . meaning that it's a closed looped situation. . . and you're never out of the loop. You're constantly in the assessment and evaluation stage.

PROBE:

Any other critical components that you may see as necessary for an effective model?

H. B. ALTMAN:

Nope! Keep it simple.

QUESTION:

What role do you see the components of information processing play in the model (for example: perception, motivation, relevance, accessibility)? What role do they play?

H. B. ALTMAN:

Big time! And that would be in your developmental stage. When you assess the need. . . now you are going to go in the process of developing your. . . I think you've got to do both at the same time. . . you're developing a model and a product at the same time. . . it's almost universal and while you're doing that you have to [INFO] think about everything from learning theory to perception to motivation, stress management. You have to think about all of the human factors that come into play so that you can get to the end product to measure it.

QUESTION:

Do you feel that job aids can influence decision making strategies?

H. B. ALTMAN:

Yes. . . A lot of people don't have strategies. They work off the seat of their butt or they are totally not able to use any kind of [DMK] problem solving techniques. So if there is a job aid that would assist them in being more effective in that decision making I think it would be very effective.

QUESTION:

How can a job aid address the critical factor of time?

H. B. ALTMAN:

[PFT] Limit the number of activities leading to the conclusion of a decision. The fewer activities that one has to go through to the decision making point, the quicker the time and the more effective the decision.

QUESTION:

Now speaking of the job aid itself, some device: do you feel that a job aid should incorporate more visuals than text, or more text than visuals?

H. B. ALTMAN:

That depends again on the [VTD] nature of the subject for which the aid is approaching. . .

PROBE:

Go ahead and give me an example. . .

H. B. ALTMAN:

Okay. . . in a cockpit checklist, for example, most likely the majority of checklist items would be visual-verbal, they would be words. Whereas like in the building of a bicycle from a kit might be more visual than words.

PROBE:

In regards to design. . . the design model. . . can you see some point when we would say one should go more visual or I should go more textual?

H. B. ALTMAN:

That would be in your closed loop when you were in the developmental stage. . . in other words you've got a development. . . [VTD & EVL] you develop an approach that you think is going to work then you have to test it out. And then, that testing it out is evaluation and from that you go back and . . . to the drawing board and correct for your direction.

QUESTION:

What role do you see for training in using the job aid and should training be a component of a design model?

H. B. ALTMAN:

I would reverse that and say [TNG] what role does the aid have in the world of training?

PROBE:

Answer it anyway you like. . .

H. B. ALTMAN:

I think that any aid that would [TNG] promote learning and effective behavior is a benefit. The use of training aids and. . . you know you say that they are being built by some kind of an instructional design model. . . they will enhance human performance and decrease time of accomplishing that performance.

PROBE:

Remember we talked of visual aids, textual aids, verbal aids. . . let's talk of visual aids. . . what role do you see training plays in these types of aids.

H. B. ALTMAN:

I think that [VTD] in the high risk areas visual aids are easier to remember than verbal. . . so that if you're going to say. . . have to deal with a fire extinguisher. . . you are going to remember the picture, the visual image of that fire extinguisher and of pulling the pin, aiming it at the base of the fire, pulling the trigger, sweeping side-to-side a lot more clearer than if you had read it.

PROBE:

So to finish up. . . do you think that in the conceptual model one of the events or activities should incorporate training as a component of the model?

H. B. ALTMAN:

Absolutely. . .

Feb. 14, 1997
Dr. Kathleen Mosier

QUESTION:

What expected outcomes can a design model provide for the user (a user being defined as a person who is assigned the responsibility to construct a job aid for some specific industry such as aviation)?

K. MOSIER:

Well it should include all of the critical areas that will be included in what ever job or decision that you're aiding. . . so it should encompass things like [MDO] information needs, somewhere what the ultimate goal, how to prioritize goals. . . It should include things like who. . . a box or something that includes who the users are going to be . . . are they going to be experts or novices. . . differentiate whether its going to be a training thing or on the job thing. . . it should include information requirements. . . it should include what kind of feedback. . . you know a box that provides feedback to the user. . . those kinds of things.

QUESTION:

Do you envision such a model to be linear and systematic in nature?

K. MOSIER:

No. . . [MDL] more iterative in nature.

PROBE:

Please expand on that. . .

K. MOSIER:

Well. . . okay. . . the model that you gave us as an example is a loop model. . .it loops back. It does have some linear components but there is always feedback.. . that goes back so that you can have a second iteration or you can do a second part. . . and I would think that whatever you come up with would have to not just be linear but would have to have some way of going back and iterating and perfecting or getting more information or re-prioritizing in the face of changing environments or whatever. If I'm being to vague you have to tell me. . .

QUESTION:

Let's talk about an actual aid, what the device may be. . .do you think a job aid can influence decision making?

K. MOSIER:

Oh Yes! Especially if it's a computer. . . I mean if you're talking about something that aids decisions. . . Okay, well first of all. . . [DMK] what information you provide and how you provide it will influence how the information is absorbed for making decisions. We've had some evidence that presenting things in computerized or automated contexts kind of biases people towards processing that information and using it . . . sometimes to the exclusion of other stuff. The format of your information and what you present will also influence the way that priorities are put together and the way that risk is assessed.

PROBE:

You were talking about presenting, prioritizing information . . . would you think that if the aid was improperly constructed you could lead the user to improper decisions?

K. MOSIER:

Yes.

PROBE:

What could be the safeguards to prevent that in design?

K. MOSIER:

One safeguard that is talked about a lot in decision aids is [EFF] making the processes transparent to the user. . . so not only does the user see what the aid is telling them . . . or what information. . . the user can see where it's coming from and so a lot of times what happens in automation is that you can't detect these things because you can't see how the aid got to where it is. You can't trace the reasoning process. . . and you can't understand why it switched to this mode or told you to do such and such. . . or recommended shutting down such and such a system.

PROBE:

How far back is tracing necessary to be effective?

K. MOSIER:

That's a good empirical question. . . I would think that you want it to go back to the point that the user. . . him or herself. . . would have done the diagnosis.

PROBE:

Let's put it in context of a printed aid. . . an aircraft checklist. . . how would you envision tracing being used in such a device?

K. MOSIER:

Okay. . . I wouldn't envision it unless it was an electronic checklist. . . that's doing some of the calculating itself. . . because a checklist, a {DMK] paper checklist is a completely different . . . world of decision aids from. . . some. . . say automated diagnostic system monitor.

PROBE:

Talk a little bit about a paper device. . .if you would. . .

K. MOSIER:

Well, [DMK] paper devices. . . as I understand them. . . would be largely used as a guide. And with respect to traceability. . . what you might include is not only the steps to do on the job but perhaps the reasoning behind it. . . For example, a lot of times when you use a paper checklist a lot of times in airplanes . . . and there are sometimes when you have multiple faults. . . what one checklist tells you to do contradicts what the checklist for the other fault tells you to do. . . and when you can't follow both of them. You know some way of showing you the why behind the procedure so that if you do have to interpolate you've got some information to base it on.

PROBE:

One of the reports you sent me talked about a study . . . I think it was six airline crews with automated aids. . . and everybody shut down the wrong engine except the one crew that used a paper checklist. . .

K. MOSIER:

Yeah. . . the numbers . . . you have the numbers a little bit wrong. . . there were twelve crews in all and five out of eight of them that had an automated checklist shut down the wrong engine and one out of four that had the paper checklist.

PROBE:

Did the automated aid they used in this experiment . . . did it have tracing capability?

K. MOSIER:

Not exactly. . .no. . . it had information . . . which you could double check by looking other places. And one of the things that we're doing right now is using that same checklist but adding a note on the emergency procedures that says verify other indicators. . .to kind of force the pilot to look at other things. . . For example, that message that triggered that checklist said "engine fire." But it didn't tell you what it was basing that diagnosis on. . . if it was an overheat. . . what it was sensing kind of thing. And what could render that thing wrong. . . it didn't give any information about that.

PROBE:

So what you're suggesting is that when an automated aid when it gave for example an engine fire indication, it should also include whether it's an overheat or abnormal fuel flow or something like that?

K. MOSIER:

To allow you to trace why it's telling you. . .

QUESTION:

Okay, now that makes sense. . .Now I am going to shift you back to the model itself. . . whoops sorry, not yet. . . we're still on question four. . . which is still talking about a job aid and you talked about it already but. . .what are the characteristics of an effective job aid? Now we have automated aids of course which you have been talking about and we have printed aids and audio aids, but overall, realistically what do you see as characteristics of an effective aid?

K. MOSIER:

You're talking about a decision aid?

PROBE:

I am going to call it a job aid because it can do . . . it can be a guide like you said earlier like a paper checklist or it can be a task analysis type thing like what decisions have to be considered. . . like a flow chart or something like that. . .

K. MOSIER:

So it's a task aid. . .Okay. . .

PROBE:

So the question is what kind of characteristics would make it effective?

K. MOSIER:

Okay one of things I said was the [CHAR] transparency of the processes. . . a clear view of information requirements. . . some sense of prioritization or risk assessment. . . feedback. . . provision for feedback.

QUESTION:

Now we are shifting back to the model. . . in the conceptual model we are discussing, what are the most critical activities or components of the model that you feel are necessary for designing a task aid, job aid, decision aid?

K. MOSIER:

Okay. . . when you talk about components of the model. . . would you say that the model you sent to us, the Dick and Carey model. . . that each of those boxes is a component?

PROBE:

Yes. . .

K. MOSIER:

So . . . [COMP] goals , needs and priorities is critical. Information requirements. . . is critical. . . users.

PROBE:

Talk about the users a little bit. . .

K. MOSIER:

Well, for one thing you would design an aid differently if you have new people. . . [TNG] novices using it versus having experts that already know what they're doing. . . but you're just kind of streamlining it. . . proceduralizing it. . . that would be a difference I would say. You might have to give more or [INFO] different kinds of information to experts versus novices.

PROBE:

You said more information to experts?

K. MOSIER:

No. . . what I meant is depending whether it's an expert or novice.

PROBE:

I stopped you . . . user? You talked about . . .

K. MOSIER:

Yeah. . . [DMK] types of decisions that are going to be supported. . . you know are they basically yes/no . . . do I take off or not decisions or is it making a choice among several options. . . is it mostly diagnosing what's wrong and then the decision is pretty straight forward. Is that where you need the help or is the help in deciding what to do once the problem is clear? Let's see. . . instruction. . . well I don't know if that fits into what we are talking about.

PROBE:

Anything you feel fits in. . . Throw it in.

K. MOSIER:

Yeah. . . [COMP] Feedback and assessment. . . Also. . . environment.

QUESTION:

The components you've discussed. . . what role do you see the components of information processing play in the model regarding such things as perception, motivation, relevance, accessibility, interpretation, and transfer? What I'm asking you is do you see a conceptual model being able to address information processing?

K. MOSIER:

It would have to. . . partly also where [DMK] expert or novice comes in.

PROBE:

In the studies you have been involved in so far have you run across any significant differences in the design of the screen in how the crewmembers perceive what they are seeing?

K. MOSIER:

The design of the screen and how they perceive it. . . hmmm. . .

PROBE:

Has that been looked at? This is kind of a sideline question. . . I am just interested. . .

K. MOSIER:

Yeah. . . they are doing some work now looking at [INFO] conflict resolution and avoidance based on display type and that kind of is looking at how you present information about the aircraft and what information you give them and how it looks on the screen. They're doing some things like that . . . we are not looking at much at this point. . . I don't know if I'm a good one to answer the question.

Okay. . . one thing you can say is that the [INFO] salience of it as far as where it appears on the display. . . how loud the noise is. . . how bright the light is. . . that is going to affect how that information is processed.

QUESTION:

We've kind of covered this but I have it written down so I am going to ask it. . . do you feel that a job aid can influence decision making strategies?

K. MOSIER:

Yes. . . for example, a job aid. . . [DMK] an automated job aid that does a lot of the work for you can promote heuristic sort of decision making strategy because you've got a really easy to use shortcut and if you've read some of the stuff I sent I've written some stuff about this. . . and which. . . you know, you have to decide whether that's what you want or not because what seems to happen is that what drops out is the more vigilant type of information processing and assessment and looking at all the available information and integrating cues.

QUESTION:

How do you feel that the design of the job aid can address time. . . the critical factor of time?

K. MOSIER:

How can it address time. . . well one thing. . . [PFT] if you design an automated aid that does a lot of things for you . . . you certainly get things done faster. . . the question is, Do you want that? I mean sometimes the question is not how do you speed it up but how do you slow it down so it's done carefully? I don't think it's very hard to make things happen faster, all you do is present some integrated thing that tells the user what to do. I mean you can get things to happen fast as you want. . .

PROBE:

What I think I am hearing you say is that in the design of the conceptual model, the designer has to consider whether they want the user to be able to process it very rapidly or whether they want to slow them down so they think about what's going on.

K. MOSIER:

Right. . . right. And also the designer has to think about whether or not they want their aid to be used as a [CHAR] substitute for other things or as a supplement for other things.

QUESTION:

Do you feel a job aid should incorporate more visuals than text or more text than visuals?

K. MOSIER:

I don't think you can answer that point blank. I think it depends on [VTD] what you are trying to aid. . . I mean you couldn't do a checklist with visuals, it would have to be text. Graphic aids have been shown to speed up processing in some cases but it depends on what you're trying. . . that's why it . . . I have a bit of a problem talking about a generic job aid because a job aid is much more than a task . . . and what you're talking about is aiding a specific task. And when you look at them that way, task by task, what you are going to come up with something different then if you say I want to come up with a job performance aid for the job of a pilot.

PROBE:

I hope you will find as this comes together that the concept is to provide the designer, whether it's a pilot at some commuter airline or whether it's a technical designer at a major airline, the conceptual model will hopefully provide them all the considerations and issues they must reflect on as they proceed through the design. This point that you made is that you have to look at the usage of it is what I hope to put in the conceptual model.

QUESTION:

What is the role of training in regards to the use of a job aid? Should training be a component of the conceptual model?

K. MOSIER:

Mmmm. . . yes. And [TNG] one of the things that I see happens in training often that is not a good thing is that training is after the fact of the design and training tells you how . . . it's kind of like a cookbook. . . I'm going to do this and that. But training does not include a information about how this aid functions and what you can expect to be it's strengths and weaknesses.

PROBE:

Did you arrive at this from some of the studies that you've been doing?

K. MOSIER:

I think I sent you a chapter . . . right. . . about myths of expertise? [TNG] One of the things we've noticed in automated systems in airplanes is that pilots know what buttons to press to get what, but they don't have the really good conceptual idea of what is. How, for example, the flight management system works and what they can expect it to know and do for them. . . [TNG] and really more importantly, what they can't expect it to know. You know. . . they have been around for a long time. . . but pilots for a long time would kind of expect that. . . well the computer is so smart that it should know that I am not suppose to fly faster than 250 knots when I am below 10,000 feet so of course it will tell me or not let me do that.. . and that's not in the computer. . . they get used to it knowing so much and doing so much, they don't get an idea of what it can't do and where it's going to catch them.

05/05/97
Dr. Ron Westrum

QUESTION:

What expected outcomes can a design model provide for the user (a user being defined as a person who is assigned the responsibility to construct a job aid for some specific industry such as aviation)?

R. WESTRUM:

Well I think the key point is if you have a model you are going to do a better job of designing a job aid because we'll have some [MDO] idea of what the key questions are and what the issues are in terms of putting the thing together. Without such a model, often you are using common sense principles instead of realistic, scientific principles.

QUESTION:

Do you envision such a model to be linear, systematic in nature or do you think linearity is not a requirement? In other words. . . a step by step process.

R. WESTRUM:

I think the basic point is that [MDL] the single linear model is probably not going to work because the features that are involved in the model interact in non-linear ways; for instance, you might have step functions and so forth or certain variables are present . . . variables will behave in a very different kind of way. . . so it's hard to throw all this stuff together in an equation. . . I think a phrase you use is systematic and I think that's the key element and that is how all these things interact. . . to shape the way the model is going to work.

PROBE:

Did you not use the term iterative in one of our discussions?

R. WESTRUM:

Yeah. . . I said that a lot of times [CHAR] the design process to be effective has to be iterative rather then simply sitting down and saying okay what is it I want to present and how do I present it, and so forth. [MDL] You often have to go back and forth between the . . . the job aid and user and so forth. . . and try to use feedback from the users to make the job aid better. . . but there may not be a single linear process that you go through and do this, in fact, I don't think that's a very good idea. . . that linear process.

QUESTION:

Let's go to the job aid, how do you think a job aid can influence decision making?

R. WESTRUM:

Well, I think there are a number of different ways that this happens because. . . for instance, the job aid may be [DMK] difficult to read or easy to read. . . therefore it may allow a person to do the operation that the job aid is for rapidly or un-rapidly. It may be more or less conducive to error. . . and it may provide different kinds of thinking processes associated with it. I think thinking processes are important because it may. . . [PFT] if the job aid requires the person to do too much thinking it may unreasonably delay their actions.

QUESTION:

What would you consider the characteristics of an effective aid?

R. WESTRUM:

An effective aid would be one that would be [EFF] unequivocal so that there would be no way of misunderstanding it . . . it could be interpreted rapidly. . . it would be compatible with the other job aids so that you wouldn't have interference effects like I call them Klang. . . between it and other stuff. . . It would really have a very low rate of mis-perceptions. . .

PROBE:

You call it what. . . I didn't hear what the word was. . .

R. WESTRUM:

Klang. . . K-L-A-N-G.

PROBE:

Define that for me, please. . .

R. WESTRUM:

That's when. . . in music when you get two chords that come together and they don't sound right together; well there are [EFF] interference effects with job aids so that if you have some job aids that read one way and some that are to be interpreted differently. . . the person has to change psychological sets . . . this is a disorienting process. So you don't want to have a situation where the things are going to read differently. Now at the same time, you don't want to have job aids that are so similar that it's easy to mistake one for another. . . this of course can happen too.

QUESTION:

Thinking of a design model for job aids. . . what would you consider the most critical activities or events in such a model?

R. WESTRUM:

Well the person obviously should be reasonably acquainted with human factor data in general. But I think the key thing is to [COMP] gather information on the context of use so that the situation in which the job aid is going to be used is understood. . . for instance in terms of lighting, space, time pressures, and so forth. The . . . but I think the data you have to gather has to do with what is it the user really has to know. . . in most cases you don't want the job aid to present more information than the person really needs to know. It will simply cause additional processing time. . . be confusing, and so forth. At the same time, that information should be readable or understandable in an unequivocal way so there is no doubt about what the information is.

PROBE:

What role do you see evaluation play in design?

R. WESTRUM:

Evaluation of the design itself?

PROBE:

Yes. . .

R. WESTRUM:

Well I think good training for designing future systems is to evaluate other people's systems and vice-versa. . . unless you design something yourself, you're really not in a position to evaluate it. Furthermore, [EVL] the best evaluators are people who have had a lot of experience on how job aids are used. . . so they are likely to anticipate the things that are going to go wrong and so forth. In other words that have the requisite imagination as I put it. . . to imagine the ways that the job aid might be misused or misconstrued.

QUESTION:

What role do you see the components of information processing play in the model (for example: perception, motivation, relevance, accessibility)? What role do they play?

R. WESTRUM:

Well I think any good model has to include some of [COMP] how people tend to process information. . . you mentioned perception, thinking, and decision making and so forth. . . but I think the key thing is that the model has to take into account how long for instance is it going to take people to make decisions about things; how good they are doing that, how likely are they to arrive at the right answer and so forth. In general it's probably a useful thing to think that people are better at reading something than in figuring out what it should be. So, if the . . . if you got a situation where some computing needs to be done, it probably needs to be done by the machine and not by the person.

QUESTION:

BY what your saying it seems that you feel that job aids can influence decision making strategies?

R. WESTRUM:

Yes. . . that's right, simply by the questions it asks. [DMK] It suggest places to look for data. . . courses of action that should be considered. . . you can build into a job aid for instance . . . questions such as are there any alternatives? Or how do you know this is the best alternative? Why would you consider this best than other alternatives? Of course it again has to do with the context of use. [PFT] How urgent is the decision making and so forth. It's interesting, people who have been trapped in burning buildings have literally, in some cases, have gotten down on the floor and figured out now what are the alternatives and. . . what's the best way to get out of here alive and have gotten out because they picked the best alternative.

QUESTION:

You mentioned time. Do you feel the design of a job aid should address time, and if so, how?

R. WESTRUM:

Well if it doesn't address the issue of time it is not a very good job aid because people. . . a checklist for instance is going to take a certain amount of time to get through. [PFT] A display or something like that . . . is something that is going to take some time to read, and in some cases take some time to even understand. So I think the critical point about time is that the designer be acutely aware of this and check out his or her hunches and perception and so forth by [EVL] actually giving the interface or whatever it is to the user and see how long they actually take to run through it.

PROBE:

Isn't this where you have talked about analogue and digital readouts. . .

R. WESTRUM:

Yes. . . my personal preference is for analogue readouts because it gives the person a better idea of context. I mentioned the accident where an airplane crashed because people were . . . thought that the 33 on the screen was a descent rate of 3300 hundred feet per minute whereas actually it was 3.3 degrees of descent. There are quite a number of things like this in the literature. . .

QUESTION:

Now speaking of the job aid itself, some device: do you feel that a job aid should incorporate more visuals than text, or more text than visuals?

R. WESTRUM:

[VTD] Text is desirable when you've got the leisure to digest it, for relatively quick decision making you can't beat graphics, but of course the problem with graphics is . . . well in many cases what the graphics say will be easily grasped and so forth, and in other cases, graphics may be subject to cultural convention and may be difficult for people to understand who are not used to seeing things represented in that way. A good example, a friend of mine makes scales and medical instruments and found that the universal symbols for something that essentially represented a new alphabet and that in fact that things like start and stop were found to be more easily understood than graphics.

QUESTION:

What role do you see for training in using the job aid and should training be a component of a design model?

R. WESTRUM:

Well as I said before, you need to make a judgment call about this. . . [TNG] in instances where the job aid is likely to be used without training, it has to be idiot proof and has to be simple and understandable even to people without education or training. Where you have another group like air traffic controllers who can be assumed to want to get the relevant training for the job aid and are probably going to get it simply because of their position. . . the amount of training can be quite impressive because the group will actually go through the training and the job aid will not be used without it. So, I think you have to . . . you have to have a judgment call which is more important: is it to make the thing idiot proof or to actually allow people considerable amount of discretion. . . and therefore give them a lot of training on how to use whatever it is.

PROBE:

My idea is to develop a conceptual model that will address the many variables that will allow for effective job aid design and then to develop a procedural model based upon the conceptual model for a specific job aid. Do you agree with this concept?

R. WESTRUM:

Well yeah up to a point. I mean its useful to have a structured design process because you're less likely to skip steps. . . such as checking with the users after every iteration. And it's nice to have some sort of structure and design process, but [COMP] the critical thing is obviously the mental model that the designer has of the user. . . and I cannot emphasize enough how important it is for direct contact with the user; rather then using common sense understanding or some sort of verbal reports.

PROBE:

Would you make a few comments about the design process as you have written a lot about design. . .

R. WESTRUM:

Well. . . again [COMP] I think the design process has to engage a non-linear thing. You have to go back and iterate through the various steps that you've got and I think the key is to find users who are intelligent enough and experienced enough who are willing to cooperate with you in designing the hardware and software so that what you've got is something robust and will actually operate in the field as it's expected to do. We know in the past often things have been sent to the field and rejected by the users. . . because the stuff was introduced in the wrong way or didn't really respond to the users' needs. . . broke down easily or seemed non-intuitive for whatever reason.

05/05/97
Mr. Greg Miller

QUESTION:

What expected outcomes can a design model provide for the user (a user being defined as a person who is assigned the responsibility to construct a job aid for some specific industry such as aviation)?

G. MILLER:

Well. . . some [MDO] tried and true steps. . . point A, point B, point C to follow in order to continually and consistently repeat an effective model.

PROBE:

You said steps. Do you envision a model to be linear, step by step, or do you see it more systemic. . . it explore relationships? Do you see it step by step?

G. MILLER:

I do in the sense of recreating it. It's not that there's not systemic areas that one model. . . that's not cast in stone. I mean it's a good model as a starting point and for many situations it can be repeated, [MDL] but it should be ever evolving. . . depending upon feedback. We get feedback on what we do and we take a look at it and it's not uncommon for us to incorporate some of the feedback and changing it so from that standpoint, the model should have a systemic character to it.

QUESTION:

Let's talk about a job aid device itself such as a passenger information card or a checklist. Do you think a job aid device can influence decision making?

G. MILLER:

For the end user?

PROBE:

Yes. . .

G. MILLER:

Absolutely. . . we hope so. . . Well in terms of what we do is to try, if at all possible, is to [DMK] make these things as completely pictorial as we can. We try not to use words at any time. We know that is not always possible with everything, but we. . . one of the things we found is that people are not. . . because the cards are not . . . the concepts we show are linear, the people do not readily participate in any kind of visual linear understanding. . . so by showing step A, step B or one, two, three, in a visual sense, the recipient of the information can then say "Okay," and understand what the correlation is . . . what he's suppose to be looking for. . . visually from one step to the next rather than verbally stating grab the handle, pull it in, and set it down and climb out leg-body-leg for instance. The user can actually see the physical actions that take place which work much better than a verbal instruction given by someone.

QUESTION:

You are almost answering the next question. . . what are the characteristics of an effective job aid? You have been describing visuals. . . what other characteristics would make a job aid effective?

G. MILLER:

Well, not just the simplicity of it, although that always helps, we like to make sure the things are [EFF] accurate. So working with photographs and then illustrations from the photographs we tend the illustrations to be realistic; now then there is a realism. . . a certain amount of realism that we try to maintain in order to [EFF] make everything recognizable rather than going all the way to a very simple kind of cartoon aspect of it. Some of the things we deal with are rather technical. I mean you have hatches and doors and how they operate. You have oxygen systems and how they operate. It goes beyond just regular seatbelt type thing. . . you've got a lifejacket and a liferaft that you have to know how to operate. [EFF] Therefore, getting rid of a lot of the detail to make things extremely simple can be detrimental in our situation when it may be a life and death or death threatening or harm threatening situation. . . still being to recognize things for what they really are rather than some form of idealistic, oversimplified image. If you just have a box and a handle on it, it may not relate to the passenger quite as well as being a liferaft as if it was drawn more in perspective and the proper kinds of detail that show that: yes, this is a life raft. [EFF] Simplicity without the abandonment of detail to make the objects recognizable.

QUESTION:

In regards to the design process for your devices, what do you consider to be the most critical activities in your design phases? What critical activities do you think are necessary for successful design?

G. MILLER:

[COMP] Well I think again we move back to simplicity, but also with a character about the information . . . a pictorial character about the information that's pleasing enough to want to read it. Using proper scale, using proper sequencing. . . compartmentalizing activities. That's one thing that we've been doing is compartmentalizing activities. . . framing in specific sequences so that the information does not exceed the boundaries of the frame; therefore, the eye tends to stay inside that frame and annotating that particular frame with. . . say a letter A or a number one corresponding with another illustration in showing where A or number one might be on the aircraft. Color choice, medium. . . tone, color choices. . . not getting to carried away. We figure that the letters or numeral designations should overcome any type of color blindness that might be. You can use boxes and very bright colors but you're not always going to cover all your bases in terms of color blindness. . . continue to reinforce that A goes with A and B goes with B, or one goes with one and two goes with two.

PROBE:

Now speaking of design. . . not so much the passenger information card itself but the design concept. . . when you get the assignment from an airline, what activities do you undertake in the design process. . . to carry out the project?

G. MILLER:

Well, initially we have a checklist of items and this works more with commercial aviation that it does with corporate because there are varying procedures that a particular company may endorse over other procedures. For example, we have to decide if it's got a type three type hatch where we're are going to place that hatch when it's removed from the exit. . . are we going to keep it inside the aircraft, if so where are we going to put it? Are they going to pitch it out? [COMP] So we go through an information gathering process first. What is in their manuals, training procedures that we must reflect because we need to not conflict with what the flight attendants have been taught, what's been written in the manuals, or what the flight attendants impart to the passengers. [COMP] It all must be consistent, so what we do is gather information so that their actual procedures are visually reproduced and are complementary rather than any kind of conflict.

QUESTION:

Let's talk a minute about information processing. What role do you see the components of information processing play in design (for example: perception, motivation, relevance, accessibility)? Do you attempt to integrate these things into your designs?

G. MILLER:

Well, I think all of them to a certain extent. I'd have to take each one of them individually and sort of address it.

PROBE:

How about motivation. . . for the device to be used. . .

G. MILLER:

Well, I think that's one of the things we really strive for in terms of working with color and composition. [INFO] Something that is pleasing. . . something that is not cluttered to the extent that the passenger picks it up, takes one look at it and says I'm not going to read that. You know we have a situation in the airlines with the emergency exit row or exit seat seating criteria which is a Federal Regulation, in other words you cannot sit at an exit seat if you're not physically able and willing to perform all the duties that are required if, indeed, an emergency come about an a flight attendant is not there to help you. So the government has created all of this verbage that the FAA has interpreted as saying pretty much that if you want to make sure you're covered, repeat the ruling on the card. Well, a lot of them opt to do this on the cover of the card. . . it is such a large amount of information that in a five by eleven inch rectangle you have to create relatively small type and, again we're looking at, [EFF] we don't like to produce anything less than a nine-point type size because it's almost unreadable. . . especially when you have a lot of information. And these cards are literally covered with this litany of governmental regulation on the outside. What that does. . . all I'm bringing this to is that people will pull that out of the seat back pocket, they will do either of one of two things: they'll either bypass it completely and go right to the card, or they will take one look at the information and put it right back in the seat back pocket. In other words, if there is too much stuff. . . [INFO] if there's too much information, especially in terms of writing, the motivation ceases to proceed any farther to what we are really trying to get across.

PROBE:

It appears that a lot of it has to do with the passengers initial perception when they pull that card out of the seat back. . .

G. MILLER:

Right. . . if it's something that is pleasing initially, it's like when you open up. . . why do they choose certain images for magazine covers. They're hooks to bring you in so that you'll go to that article or other articles that are inside the magazine. So we don't often get to give a lot of input on a commercial airline cover. It's either corporate identity or it's slapped with all of this government regulation. We don't have a lot of input. When we do ours for corporate aviation, we do have some. . . we pick very pleasing photographs. . . some of that is really nice. . . nice gorgeous photograph, so they open it up and want to see what's on the inside. [INFO] <u>You try to create that motivation on the cover for the passenger to proceed further in to the most important information</u>.

QUESTION:

Do you feel that the job aid device can also influence decision making strategies?

G. MILLER:

Well. . . yes dealing with what we deal with. . . [DMK] <u>there is a hierarchy to what information is placed</u> first and hopefully that has an influence. I mean if children. . . and placed in certain areas because it's the information they need most often in an emergency.

PROBE:

So placement would help?

G. MILLER:

[DMK] <u>Placement is important; it's not random</u>. It's thought out. It sort of follows you . . . you know there is an initial part of information that you start with the minute you get on the aircraft. You've sat down, you've picked up the card, well then from that point on before you take off you've got a litany of linear information that takes you up to the point of safe flying. . . and then you start with the emergency situations and the illustrations you show are the most common . . . information that you would need in an emergency landing where an evacuation would take place. So we deal with the door first because that's the place the passenger came in. . . that's what he's familiar with because he goes in and out the door. . . so we show the door first and chances are that the door would be accessible, so that's the first of the information. [DMK] <u>The decision making. . . you give the information first that's the most important because hopefully they get that even if they don't continue on reading the rest of the information. They've got at least the basic part of the information</u>. So you take the odds factor, what are the odds this is going to happen? This is going to happen? And you start using that as the lineage for the first sequence of illustrations down to the last sequence of illustrations for the various types of equipment. This is the thing that would be the most normal that they would run in to . . .

QUESTION:

How do you address the factor ol time on part of the user?

G. MILLER:

We don't normally consider it. There are two ways of looking at it. First of all, our aid is usually only looked at in the beginning of the flight process. But on the second, the flip side of that, is that it is available all the time. So if they want to re-reference . . . or the person wants to go into further depth, it's there. It's not like an announcement that's only given at one time and then there is no way to re-reference it. That's probably the beauty of this particular emergency aid over any of the other types, formats, or media that is utilized in trying to impart this same information to the passenger. The pre-flight briefing is always given and gone; whether it's done verbally by a flight attendant or whether it's done by video or by audio, it's only done one time. The safety card is the only thing that sits there, this particular aid is the only thing that sits there and can be re-referenced at the leisure of the passenger.

PROBE:

So that would be an accessibility factor?

G. MILLER:

Yes, so it's always accessible. You can re-reference it. They do it when they initially get on the aircraft but also it's there if they want to refresh their memory.

PROBE:

Your cards used to have by the oxygen sequence a little clock that would show seconds going by, do you still do that?

G. MILLER:

We do that mainly in commercial airlines. . .

QUESTION:

You have really already answered this, but I'm going to ask it anyway. Do you feel a job aid should incorporate more text than visuals or more visuals than text?

G. MILLER:

More visuals than text.

PROBE:

Please expand on this. I know what you're feelings are but I would like you to say a bit more.

G. MILLER:

Well, we know that [VTD] it's a matter of space and clarity. The illustrations are better perceived and better understood when they are more of a stand alone and isolated by color or white; and when you start wrapping text around objects it becomes hard to read. You have space constraints. Space constraints are a factor in designing the cards. [EFF] The illustrations should be absolutely as large as space allows. Once you start adding text around every single illustration, you start shrinking your illustration down to fit the format that you are allotted. Again, the same situation as I described in the commercial airline card with all the government information in it; you open it up and if it becomes too busy, un-pleasing to the eye and brain, then you're just going to fold it right back up and not pay attention. [VTD] There are very few instances where we found an illustration cannot convey the actual sequence of events or can't be understood by itself.

PROBE:

Could you give me an example of where illustrations wouldn't work?

G. MILLER:

Let's see. . . let me back up a bit and say that [VTD] sometimes we use a phrase to reinforce an illustration. Not so much to explain it but to reinforce it. I think that we do that in the oxygen sequence where the adult passenger or the most capable passenger puts their oxygen mask on first and gets that taken care of before they help someone who's not able or a smaller child who doesn't know how to do it. So we re-state that by saying "place your mask on first, then assist others." When we get into the brace position sequence, even though we've reinforced with symbols, brace positions vary within corporate aircraft because of the seating configurations. . . forward facing seats although standard in commercial aviation . . . aft facing seats are standard in corporate aviation although they are rarely seen in commercial airlines. So the direction of travel then has to be taken into consideration when bracing for an impact, and you're showing these sequences of illustrations forward facing, side facing, and aft facing . . . trying to explain to the passenger which direction the airplane is going based upon the seating configuration of that aircraft. Sometimes that's a little difficult to understand even with symbology because we have a space constraint, so we might reinforce that sequence by saying forward facing, aft facing. . . It reinforces it.

QUESTION:

Your users are novices but considering the conceptual model in regards to designing job aids, do you think that training for the user should be part of the model?

G. MILLER:

In other types of industrial situations or manufacturing situations, [TNG] especially when the people are dealing with items that have possibly some form of harm. They could come into harm by using a piece of equipment or process or procedure incorrectly. So the training reinforces the aid and the aid is always there to refer to. . .

PROBE:

If you were going to give some suggestions to a designer who is going to come to work for you and will be designing brand new information cards or aids, what advice would you give in reference to the concept of design?

G. MILLER:

[EFF] You know it's clarity. Try to get rid of extraneous information or what we refer to as visual noise. Try to keep your concepts clean. . . your steps to a minimum in order to accomplish it. I'm thinking of someone who's starting a project from scratch or we're working with a completely new aircraft. . . or doing something we have never done before. Not necessarily a card, but like say how would you do this, how would you do that. We are going to illustrate a process or procedure that is going to be placed in a visual format in a printed piece that someone is going to utilize in an emergency. Say like if we were asked to do illustrations on how to use a defibrillator. . . something we've never done before. What would you have to do? How many steps would you have to go through? How clear and how clean can you make that? You know you are going to teach someone how to use something that is a life saving device that if drawn wrong could be more detrimental than by not using it at all.

[EFF] To do this you would have to be very thoughtful about clarity and the minimum amount of information to do the job correctly. . . [EVL] and then test it. Something like that you're going to have to test. Get information and feedback from people who don't know anything about it, which we often do. We will design a symbol or series of illustrations and print them out and just hand them to people who are novices and ask what does this mean to you?

APPENDIX E

Subject-Matter-Expert Evaluation Package:

First Round Formative Evaluation

[date]

[recipient]
[address]
[city, state, zip code]

Dear *[recipient]:*

Enclosed you will find a proposed Conceptual Job Performance Aid (JPA) Design Model, a JPA Procedural Design Model, and a list of definitions that are presented in the procedural model. In review, a conceptual model is not a procedural model; it is not intended to depict how to design a JPA; rather, the conceptual model addresses the variables that affect the design process and provides the framework for the procedural model.

I respectively request your permission to conduct one more short telephone interview that will consist of an evaluation of the models and definitions. Based upon the findings of the interviews, the model will be revised as required and a task-specific model will then be developed for a specific aviation related task to evaluate the procedural model.

You will find a list of definitions for the procedural model's components and elements. There is a comment space provided after each definition that allows you to make notes that may be reviewed during the telephone interview.

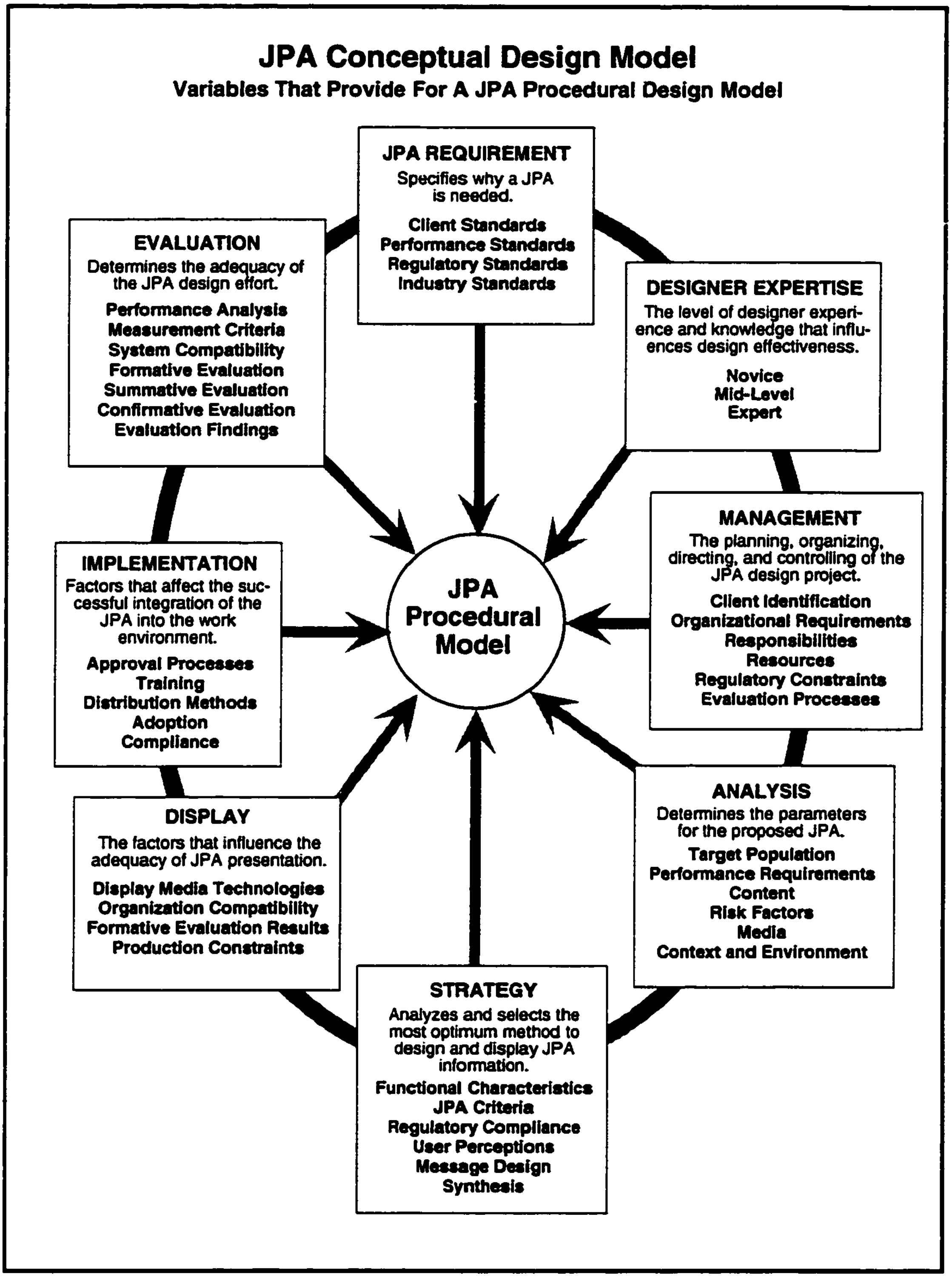
Please review the models and associated definitions. Your input will be greatly appreciated. You will perhaps notice that some of the elements displayed in the procedural model may be familiar! The initial interviews were very fruitful. Thank you again.

Would you be so kind to notify me by E-mail that you have received this package; also, let me know what days of the week or evenings would be most suitable to conduct the telephone evaluation.

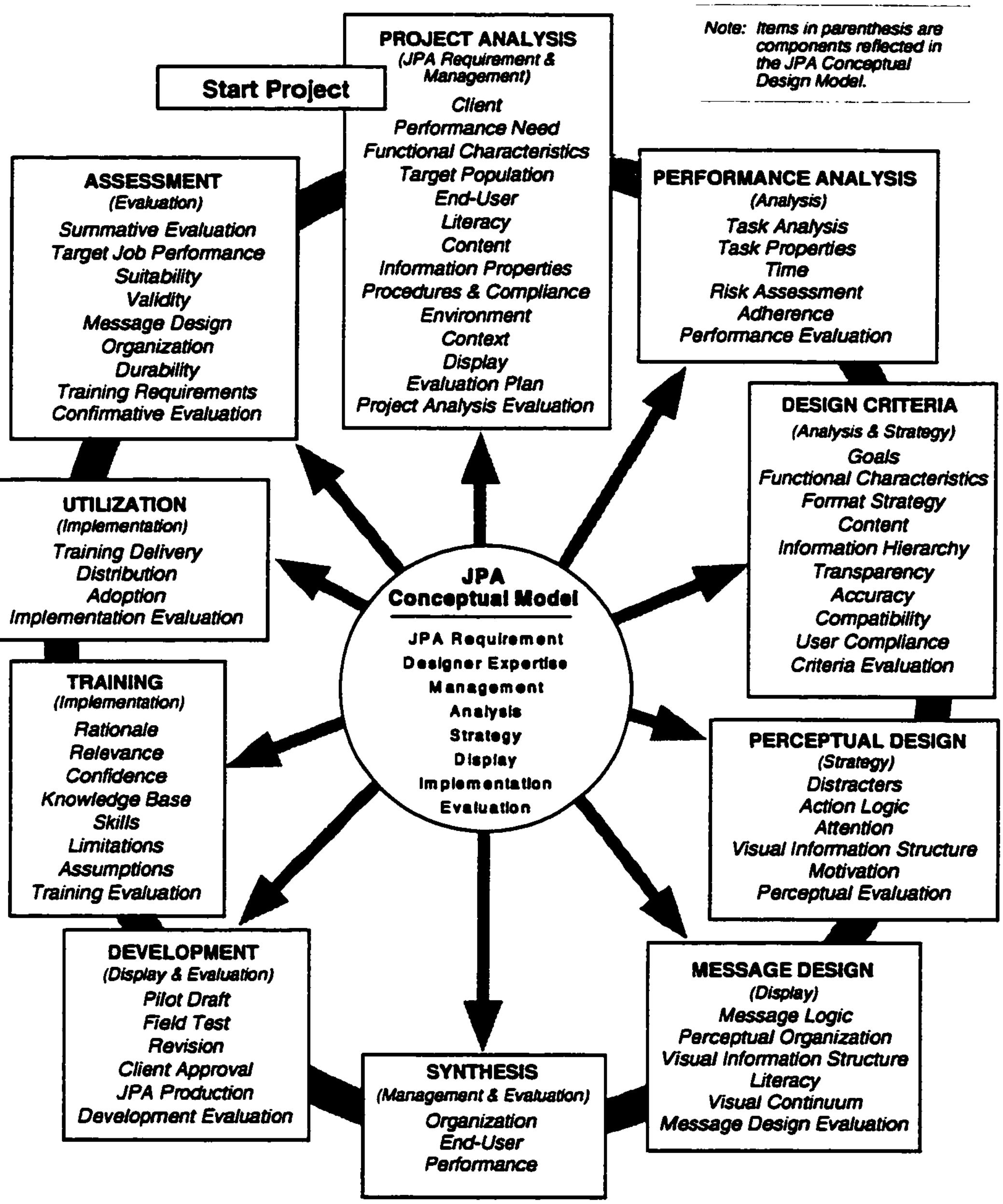
Sincerely,

Anthony J. Adamski

AA/ta
Enclosure: 3 (1) Conceptual JPA Design Model,
(2) JPA Procedural Design Model, and
(3) List of Definitions


JPA Conceptual Design Model
Variables That Provide For A JPA Procedural Design Model
JPA REQUIREMENT
Specifies why a JPA is needed.
Client Standards
Performance Standards
Regulatory Standards
Industry Standards
DESIGNER EXPERTISE
The level of designer experience and knowledge that influences design effectiveness.
Novice
Mid-Level
Expert
MANAGEMENT
The planning, organizing, directing, and controlling of the JPA design project.
Client Identification
Organizational Requirements
Responsibilities
Resources
Regulatory Constraints
Evaluation Processes
ANALYSIS
Determines the parameters for the proposed JPA.
Target Population
Performance Requirements
Content
Risk Factors
Media
Context and Environment
STRATEGY
Analyzes and selects the most optimum method to design and display JPA information.
Functional Characteristics
JPA Criteria
Regulatory Compliance
User Perceptions
Message Design
Synthesis
DISPLAY
The factors that influence the adequacy of JPA presentation.
Display Media Technologies
Organization Compatibility
Formative Evaluation Results
Production Constraints
IMPLEMENTATION
Factors that affect the successful integration of the JPA into the work environment.
Approval Processes
Training
Distribution Methods
Adoption
Compliance
EVALUATION
Determines the adequacy of the JPA design effort.
Performance Analysis
Measurement Criteria
System Compatibility
Formative Evaluation
Summative Evaluation
Confirmative Evaluation
Evaluation Findings
JPA
Procedural
Model

JPA Procedural Design Model



CAUTION: (Designer Expertise)

Because of the potential risks involved with job performance aids in high-risk environments, designers new to the development of job performance aids should address each of the identified procedural elements. Experienced designers may exercise more flexibility and utilize applicable elements of the procedural model that are relevant to the specific JPA task.

Procedural Job Performance Aid (JPA) Design Model: Component and Element Definitions

(Note: The space and lines for SME comments after each definition were removed to conserve space for publication)

Project Analysis

This component defines the purpose of the JPA, the type of audience, the job or performance requirement, the environment in which the JPA will be used, and organizational factors that affect JPA design, development, and implementation.

The analysis component consists of the following elements:

Client: Defines who the decision makers are in regards to JPA design, development, and implementation. It also provides the designer information towards determining the functional characteristics of the JPA.

Performance Need: Determines the requirement for a JPA. This element examines gaps in actual performance or potential gaps in performance. It provides the background information and framework to define the functional characteristic of the JPA.

Functional Characteristic: Defines the purpose(s) of the JPA. It answers the question, "What is the JPA suppose to do?" (e. g., Is the JPA requirement a result of hardware design that calls for an automated electronic checklist, or is the need for a JPA a result of a performance problem?)

Target Population: Defines the end-user. This element gathers data on the characteristics of the end-user to include skills and knowledge, attitudes towards the use of the proposed JPA, attitudes towards the organization, and relevant characteristics of the end-user group.

End-User: Member(s) of the target population who will perform the task. Defines whether the task will be completed by an individual working alone or by a team.

Literacy: Determines the level of visual and textual literacy of the target population to assure for end-user comprehension and reduce the potential for procedural misinterpretation. Examines the impact of cultural and language differences if applicable.

Content: An initial determination of what content information is required to complete the task and what content information sources will be used. This element also determines the kind of information that will be displayed. (e. g. , quantitative, qualitative, warnings, signals, system status, etc.)

Information Properties: A determination if the information to be displayed in the JPA is static in that it does not change; or dynamic, in that it constantly changes or is subject to change.

Procedures and Compliance: Determines all regulatory requirements for the JPA to include equipment manufacturer specifications, government regulations, organizational policies, and any other applicable regulatory bodies.

Environment: A determination of the possible work conditions and work settings in which the JPA will be used to include such factors as: lighting, noise, vibration, physical accessibility of the JPA, etc.

Context: An analysis of the possible situations under which the JPA will be used. The context element defines whether the JPA will be used in normal operating situations or emergency operating situations or a combination of both.

Display: An initial determination of the medium that will be used to present the JPA. (e. g. , an automated electronic checklist, a printed operations manual, a printed trouble-shooting guide, a printed emergency procedures guide)

Evaluation Plan: An initial determination of the evaluation processes that will be employed during the development of the JPA. This element addresses the means to focus on the evaluation processes, reach a state of agreement between the client and the designer, and establish the criteria for the evaluations.

Analysis Evaluation: A formative evaluation that assesses the adequacy of the project analysis component.

Performance Analysis

This component determines the desired performance that the JPA depicts.

The performance analysis component consists of the following elements.

Task Analysis: Defines the behaviors necessary to achieve desired performance and determines requirements to match the physical characteristics of the JPA with the functions required to perform the task. It defines the skills necessary to perform the task and breaks the task down into specific steps as required. Task analysis also incorporates an examination of task properties as defined below.

Task Properties: Determines the model-of -expertise that will be used as the basis for task presentation. This element examines the complexity of the task structure, the potential for ambiguity, and possible forms of JPA presentation. Task properties also includes an analysis of the types of decisions with which the end-user will be faced and determines if more than one course of action is possible.

Time: Determines whether the desired performance is under a time constraint, and if so, defines that constraint.

Risk Assessment: Examines the potential risks involved while performing the task. It assesses the potential for harm to the end-user or equipment associated with the task and defines the level of adherence required.

Adherence: A determination if any flexibility is available to deviate from the JPA's displayed procedures and apply individual heuristics.

Performance Evaluation: This element consists of a formative evaluation that assesses the adequacy of the performance analysis.

Design Criteria

The design criteria component is the process which sets forth the detailed specifications for the JPA to meet the intent of the JPA's functional characteristics, the development of the JPA, implementation of the JPA, and the JPA evaluation process.

The design component consists of the following elements:

Goals: Defines and prioritizes the purposes of the intended JPA design project. The goals are general expressions that specify the general results the JPA design project is intended to achieve.

Functional Characteristic: Defines what the JPA is intended to do. It includes detailed specifications of the conditions under which the JPA will be used, the desired performance outcomes, and evaluation criteria for evaluating the desired performance outcomes.

Format Strategy: A determination of the JPA's format specifications by which the information will be incorporated into the JPA based upon the target audience analysis. The format strategies include: (a) a directive format that assumes the end-user knows little or nothing about the task and provides all information necessary to complete the task, (b) a deductive format intended for end-users who have knowledge of the tasks and have had training or experience in performing the tasks, or (c) a hybrid strategy that incorporates both a directive and deductive format.

Content: A detailed specification of the information that is necessary to provide the end-user in order for the user to perform the desired task. This element also determines the information necessary for the end-user to employ alternate courses of action if applicable.

Information Hierarchy: A detailed specification of the format that will be used to display the information in a hierarchical form that provides for ease of-use, displays alternate courses of action if applicable, and displays sufficient cues for the most critical information.

Transparency: An analysis of the necessary level of information detail that provides a means for the end-user to trace the rationale for the recommended courses of action displayed in the JPA.

Accuracy: A determination that the information presented in the JPA: (a) is reliable and accurate based on the content analysis, and (b) maintains consistency throughout the JPA display.

Compatibility: This element determines if any conflict is present with the JPA and other similar JPAs used in the specific work environment. It also determines the potential of multiple fault situations in which more than one JPA may be used. (e. g. , the use of two separate emergency checklists that each address a different system malfunction.)

User Compliance: The detailed specification of the level of adherence required by the end-user. This element also determines the need for warnings, cautions, or notes that should be displayed on the JPA.

Criteria Evaluation: This element consists of a formative evaluation that assesses and validates the design criteria specifications.

Perceptual Design

This component addresses the information processing of the end-user(s). It provides for detailed design specifications that encompass known design factors that influence the decision-making process and perceptions of the end-user(s). This component also provides much of the framework for training content.

The perceptual design component consists of the following elements:

Distracters: A determination of potential distracters that could degrade effective use of the JPA. Distracters include: (a) environmental factors such as heat, cold, light, noise, vibration, time constraints, and the physical working space; and (b) human factors such as stress, fatigue, fear, etc.

Action Logic: Determines the mental representation of the performance process as viewed by an expert who devised the instructions to conduct the task. It provides a means to match the expert mental representation with that of the end-user.

Attention: The specification of the physical properties of the JPA that affect the end-users' pre-attentive and attentive perceptions. It details the specifications for the amount of contrast between levels of information, and provides for sufficient stimulation to compensate for predicted distracters.

Visual Information Structure: The detailed specifications of the JPA display for the selected presentation medium that provides the end-user a means to construct a mental map of the information displayed. It organizes the information into a logical sequence by use of typography, color, signaling, graphics, tables, etc.

Motivation: Defines the factors that will enhance the probability that the end-user will effectively use the JPA. Motivational factors include: (a) accessibility, (b) ease-of-use, (c) clarity, (d) relevance, , (e) risk and potential for personal harm, and (e) probability of success.

Perceptual Evaluation: This element consists of a formative evaluation that assesses the findings of the perceptual design component.

Message Design

The component of message design consists of the application of message design principles to the development of the JPA. Since the field of message design has numerous design principles and techniques, it is not the intent of the conceptual JPA design model to provide specific message design methods; rather, the intent is to provide the designer with the primary message design factors applicable to JPAs that need to be addressed.

Message Logic: Defines the type of message that will be displayed in the JPA. Message types consist of (a) alert messages that call for action, (b) regulatory messages that present legally binding information or company rules, (c) procedural messages that depict the actions necessary to complete a specific task, (d) instructional messages that provide trouble-shooting information, and (e) integrated messages that have the elements of more than one message type.

Perceptual Organization: The application of the principles of Gestalt applied to message design which address proximity, similarity, continuity, closure, and connectedness. These principles provide for the design of visual information structure.

Visual Information Structure: The application of message design techniques applicable to the selected medium that provide for effective interpretation of the information hierarchy. Such techniques include the selection of fonts and type sizes, typographical cues, the use of headings and advanced organizers, the use of appropriate white space,

Literacy: Applies the techniques of message design that are appropriate to the target population's visual and textual literacy.

Visual Continuum: Determines the level of realism and detail that is to be displayed in the JPA. Determines and defines any symbols used and assesses the level of detail in any graphics or icons employed in the JPA. This element selects the most appropriate point on the visual continuum which ranges from the concrete to the abstract.

Message Design Evaluation: This element consists of a formative evaluation that assesses the effectiveness of the message design principles applied to the JPA.

Synthesis

Although this component may be considered an evaluation, because of the nature of JPAs used in high-risk environments, it is deemed critical for the designer to assure that the JPA meets the needs of the organization, the end-user, and the desired performance.

Organization: Assures that the goals and objectives of the JPA match the philosophy and policy of the organization.

End-User: Assures that the design elements meet the needs and match abilities of the end-user.

Performance: Assures that the procedures presented in the JPA are accurate, reliable, meet regulatory requirements, and match the policies of the organization.

Development

The component of development is the process of translating the design specifications into the JPA's physical form. It involves the production of the JPA into its final form and preparation for implementation into the workplace. Within the context of the procedural JPA design model, development encompasses four phases: (a) the creation of a pilot JPA, (b) the testing of the JPA in a field environment, (c) pre-production formative evaluation, and (d) production of the approved JPA.

The development component consists of the following elements:

Pilot Draft: A JPA is constructed based upon the data collected from the analysis and design phases.

Field Test: The pilot JPA is tested under actual or simulated field conditions by a representative sample of the target population. An assessment is made to determine if the pilot JPA meets the needs of the analysis results and criteria of the design specifications. A pilot training program is also conducted in conjunction with the JPA field test. Findings are documented to validate the design or to substantiate revisions.

Revision: This element allows for revisions to any discrepancies discovered during the field test.

Client Approval: This element provides for the final approval by the client prior to the JPA going into final production.

JPA Production: The actual production of the approved JPA.

Development Evaluation: This evaluation is the final check for JPA accuracy prior to the JPA being implemented into the workplace.

Training

The training component determines the training content required and delivery methods necessary to implement the JPA effectively into the workplace.

The training component consists of the following elements that make up the training content.

Rationale: Presents the purpose and functional characteristics of the JPA. It describes what the performance task is and how the JPA meets the requirements of the task.

Relevance: Presents the factors that make the JPA relevant to the required performance. It addresses the visible and invisible factors that form the rationale behind the development and use of the JPA.

Confidence: The reliability of the JPA, based on the analysis and design evaluations, is explained to enhance the end-users' confidence that the JPA will do what it is intended to do.

Knowledge Base: The required knowledge base to effectively employ the JPA is presented to the end-user group. Any areas of weakness identified are reviewed to assure that the end-user possesses the knowledge base to interpret the information displayed in the JPA.

Skills: Any skills that the end-user does not possess to use the JPA are identified, described and practiced. Such skills may involve use of a new type computer key board, scrolling an automated electronic checklist, interpreting digital data, interpreting specific icons or symbols used in the JPA, etc.

Limitations: The capabilities and limitations of the JPA are presented. This topic describes what the JPA can be expected to do and what the JPA cannot do. System variables that may affect the capabilities or limitations of JPA interpretation are explained. The phenomenon of selective attention is addressed when salience could be a limiting factor to effective JPA interpretation.

Assumptions: Any misconceptions or misunderstandings of the JPA's capabilities or limitations that are identified within the end-user group are addressed and rectified.

Training Evaluation: This element incorporates a post-test that determines the ability of the end-user group to effectively use the JPA.

Utilization

This component involves the process of introducing the JPA into the workplace and assessing the status of the JPA's adoption by the intended end-users.

Training Delivery: Determines the means to most effectively deliver the required training to the organization's end-users.

Distribution: Determines the means by which the JPA will be in-place and accessible to all required work stations and end-users.

Adoption: A form of confirmative evaluation that determines whether the JPA is being properly used.

Implementation Evaluation: A determination of the adequacy of effort of the implementation process.

Evaluation

This component of the model addresses summative and confirmative evaluations as the formative evaluations were conducted during the analysis, design, synthesis, development, training, and implementation phases.

The evaluation component consists of the following elements:

Summative: This is the evaluation process conducted after the JPA has been completed. This evaluation reviews all previous formative evaluation findings and summative evaluation findings which provide information to the client in order to approve or disapprove implementation. The data collected is gathered from the following summative evaluation elements:

Target Job Performance: Determines if the JPA meets the requirements of the functional characteristics.

Suitability: Assesses whether the JPA remains applicable with associated equipment at the time of implementation.

Validity: Confirms that the information displayed is accurate and valid in regards to technical content.

Message Design: Reviews that the message design techniques utilized have not diminished comprehensiveness, perception, accuracy, or consistency. It confirms that the display medium meets the functional requirements of the JPA.

Organization: Confirms that the completed JPA is in accordance with the organization's policies and regulatory requirements.

Durability: Determines if the JPA will withstand any physical impairment due to repeated use or long term storage in the work environment.

Training Requirements: Determines if the training content and delivery meets the requirements to effectively implement the JPA.

Confirmative: The process by which JPA effectiveness, accuracy, and regulatory compliance is validated. This evaluation is conducted at a pre-determined intervals after the JPA has been in-place. The predetermined interval depends on the nature of the JPA. It depends on the impact of regulatory changes, changes to manufacturing specifications, revised operating procedures, etc.

APPENDIX F

First Round Formative Evaluation: SME Interviews

First Round Formative Evaluation: SME Interviews

Data and Record of Hits

This appendix presents the first-round SME formative evaluation interview transcriptions. Additionally, SME responses are coded to indicate the relationships of the responses to the JPA conceptual design model, the JPA procedural design model, or model definitions. The responses are coded into one of three categories and are highlighted (hits) using the following formats:

1. References to the JPA conceptual design model: **Bold Type.**
2. References to the JPA procedural design model: <u>Underline.</u>
3. References to the procedural model's definitions: *Italics.*

Interview: Walter Dick
Aug. 18, 1997

DICK: Lets look at the conceptual design model first. At the top it says **variables** that provide for a JPA procedural design model. What I was looking for was a better word than provide for. I'm not going to nit-pick the whole thing but that hit's you right at the top. Is it variables that determine the model, influence the model? Provide for didn't seem correct.

RESPONSE: Influence sounds like a good one. All right.

DICK: OK, under **JPA requirement,** I was kind of surprised not to see gap and performance as to specify why a JPA is needed. It appears later in the next model, under the performance analysis. But I guess I was curious as why gap and performance wasn't one of the things.

RESPONSE: This is something that Dr. Richey and I talked about when I was formulating this and she tended to lean towards a more generic terminology. I had originally more specific versus just client standards, performance standards. Her meaning was to go with something more generic, if I'm using the right term. So, that's what the performance standards are supposedly supposed to refer to. However, if it's unclear to you then it's unclear to other readers, so it's a good comment

DICK: Well what I was thinking about is if there are certainly situations where you're creating a new curriculum for a particular job and that job has standards that have been established say by federal agency or by, well you've got that regulatory standard.............corporate standards for example. And that's one situation but the other situation is one in which you're already, somebody's performing on the job, a number of people perform on the job and there are **performance failures**. And you need to look at why is this happening?

RESPONSE: You know you said the magic word there. Not to interrupt you but performance failures may be a good variable there. What do you think?

DICK: Performance failures, sure. Moving on to the next box, designer expertise. You're saying that the expertise of the designer can impact. . . is it the model that's used or the ability to implement the model?

RESPONSE: I would use implement the model.

DICK: OK, so does that impact the model itself?

RESPONSE: Oh, I see what you're saying.

DICK: You're saying, that these are variables that influence the procedural design model.

RESPONSE: OK, I see where you're coming from. How would I want to.....how would I do that?

DICK: Well don't decided that. Let me tell you what my next question is. When I look at the management box, would you say, "Well the effectiveness of the model would depend on the **expertise of the manager**."

RESPONSE: You know, it's a very good point. Now how would I.........?

DICK: See I think I know what you're saying, I would say the same thing with an instructional design model. Sure, the person who has more experience, more <u>expertise</u> is probably going to produce a better product but I don't know that the design is going to be that different. The model, the process. Yes, an experienced **manager** will probably do a better job of running a job than a first timer. But I don't know that the things that you tell them to do would be that different. Just something to think about. You don't have to settle these here on the phone, but that was what occurred to me when I looked at that.

RESPONSE: Well during the initial interviews with the SMEs, the designer expertise, I think it was stressed by a number of the, by more than half of the panel, who emphasized over and over again about expertise. And one of the things that I originally had, just a .... I had a designer caution under the conceptual model, which is in the ....

DICK: Yeah, I saw that, it's down there under procedural model.... is the designer expertise caution.

RESPONSE: Right and Dr. Richey said "Oh no, that should go under the conceptual model because that's a variable to design. It is the expertise of the designer.".

DICK: Well what this makes me think about is the layer of necessity model, where essentially it says, based on resources and time available, you might do different parts, include various things. .... What it suggests to me is that there will be either different models or different parts implemented based on the expertise of the designer. **If its a novice, they may only do steps 1, 4 and 8, and you do say something about that in that caution. Experienced designers may exercise more flexibility and utilize applicable elements**. Well you know, lets not settle it here. That was just kind of my reaction as I hit it.

RESPONSE: Well, its a good one. I have to think about it. I am biased. I kind of like the way it sets now but it'll be interesting to see what the others have to say on this.

DICK: OK and if it applied to designer why doesn't it apply to manager? Under manager....

RESPONSE: I'm going to say I should put in expertise.

DICK: Management expertise?

RESPONSE: Yeah, sure. OK.

DICK: Under the management area, the last thing is evaluation processes and I wondered why its there in a separate box? I mean you don't have a separate box for implementation processes display strategy or analysis.

RESPONSE: It sounded right at the time. You're right, you're absolutely correct. And it shouldn't be. I have to agree with you, it probably should not be there. Good.

DICK: Under analysis.......the, well this is kind of minor but the target population further on in the procedural model.......you really break that down very well. And, when I read it, I read this page first and I read everything on it and thought about it before I looked at any of your other stuff. So this is what I'm giving you a reaction to what I thought at the time. It just seemed to be too broad.

RESPONSE: Too broad............

DICK: Yeah, and even just a distinction between *target population, present skills and maybe attitude* or something like that, that its, you know what about its **target population** I guess. It just seemed really, really, really broad.

RESPONSE: OK, how, well, how about a, I'm trying to think of the right word. A descriptor...............I was thinking something along *target population constraints or target population*, uh....I don't want to get it too specific either.

DICK: Well, **skills and attitudes** or ....but I'm thinking all those things that Rita [Dr. Rita Richey] identified in her research that she did over there at Ford. Which kind of really opened up my eyes to the factors that are involved when you look at any part of population. That's frankly what went through my mind when I saw this. And maybe it is, see if anyone else comments on it. It just seemed really broad to me.

RESPONSE: OK.

DICK: Under **strategy**, I differ with you on most optimum. I think if something's optimum, there's nothing more optimum.

RESPONSE: Oh, OK.

DICK: Select the optimum method, that means that's it. Its the very best.

RESPONSE: Alright, so probably just take the optimum out and that would probably ....

DICK: It's the most.

RESPONSE: Select then optimum or select a method.......

DICK: Or select the optimum method to design display it.

RESPONSE: Oh, I see what you're saying. Yeah, that makes since. Boy I tell you, I was talking with Dr. Richey the other day when I was sending drafts back and forth and I was saying this.........I'm starting to lose sight of the trees because the forest is in the way. And she was saying, you can't do something of this nature in a vacuum. She says you have to have interaction.

DICK: Oh yeah.

RESPONSE: Boy if this, these kind of comments really.... really........when I look at it after what you said, I say Wow! How come I didn't see that? I appreciate it, thank you.

DICK: Well that's OK. Under display and implementation, I had nothing. No comments. Under **evaluation**, I.....you already had formed an evaluation listed under display and you suggested under implementation........... I wonder if it's not repetitive.

RESPONSE: I see what you're saying, yep.

DICK: And under **confirmative evaluation**, I wasn't familiar with that word but I learned later on that what you're essentially saying is does the product that's implemented match the specifications for the product? That's what confirmative evaluation.......?

RESPONSE: A, confirmative is the next step beyond summative. So once the product or the design or the instruction is in the field, the idea of the confirmative is to come back on some interval, six months, a year, five years and ask, "Are our original finds still valid?" In the aviation environment, the confirmative evaluation —although they do not call it that — is an ongoing affair. So that's why I threw it in there.

DICK: OK, the **summative evaluation** just made me think, its such a generic term at this point and it made me think about the Kirkpatrick levels, 1,2, 3, and 4. And I don't see that in here, even later on, talking about evaluation in terms of the four levels. I would just say you might want to think about........................

RESPONSE: Adding them in?

DICK: Putting them in there at some point. You know how do the users respond to the tool? Can they use if effectively? Does it make any difference? Do they use it on the job and does it make any difference?

RESPONSE: OK

DICK: Particularly in a term like it's part of the, part of your confirmative definition I guess now. When I think about Russell's article, and we were writing the fourth edition about Dick and Carey and trying to include, level three and four concerns, and both formative and summative evaluations so that any, I'm babbling. But that's something to think about.

RESPONSE: OK, good.

DICK: In the procedural model, I have only one major suggestion and this may be worth spending a little time talking about. This has to do with does your model, should your model include the concept of rapid prototyping? As I looked at the model I looked at the assessment activities coming — you know, I realize this is in a circle and you say they can jump around. But most people think of assessment coming after the product is out there. And you also do, talk about implementation evaluation, training evaluation, the . . . evaluation. So you're imbedding the formative evaluation concepts as well. But the, I wonder, well I throw it out for your consideration — Where that somewhere around between message design and synthesis, which looks like a kind of an end process evaluation, in order to do that evaluation, you need at least a part of the tool available.

RESPONSE: Oh, I see what you're saying.

DICK: Alright now there aren't any, I've gone to conventions and I've heard people say "Instructional designers have really got to get on the rapid prototyping band wagon and that and this and that and the other thing dealing with rapid prototyping and then you go to the literature and there's almost nothing in the literature in our area. I mean, there are in other areas but not in ours about what rapid prototyping really would be like and how people might do it. So its, you know I think if you kind of take your own experience and say what it would be but I think it doesn't mean to me that you have to generate the whole product. It says to me that you might create a screen display. For example they had nothing behind it. None of the intelligence behind it but it may be just 2 or 3 buttons. But they could see what it looked like,. they could see the environment in which the person would have to be using it and see how a couple of the buttons might work. So that they get a sense of what the tools going to be like.

RESPONSE: I see exactly where you're coming from. The thought I had in the back of my head, speaking from an experienced designers perspective now, would the procedural model be, this would almost be like a checklist for an experienced designer. He knows what the project is going to be, he knows what it's going to entail and he goes for the procedural model kind of as a review to say, "Oh yeah, I got to be sure to do this, and do this and do this, I don't have to do this." And he would, I call it drawing a map through the procedural model, selected elements would then be extrapolated and then used for the actual design project. And that's what I'm going to be doing with the next step of this research. I'm going to be designing an actual job performance aid, using only, I'm going to map the required tasks to do this job. Those are the ones I'm going to get everybody, how it's decomposed and see if this works or not.

DICK: OK

RESPONSE: But that was my thought, I see what you're saying and perhaps I should include a prototype block in there for just that purpose. And I think its not just theoretical. You know my limited experience, the people who had done the prototyping have learned so much from it. And it shapes the whole rest of the project and they say "Gee if we'd gone all the way to the end and then now tried this out with some users or had then had to face, how are we going to do this or that, we would have been stymied and we would have had to throw out everything and start over and that really forces you to confront the issues really early on.

RESPONSE: Oh, hey, what a nice idea, that's nice. I like that.

DICK: And I have a few comments on the list of elements and definitions. Some of these are just trivial, for example, on page one under client, second sentence, it also provides the desired information related to functional characteristics. More substantive on that page, down at the bottom, *target population, end-user. I'll be darned if I could tell the difference. I went back and forth between those two definitions. Target population defines the end-user. The end-user is a member of the target population.*

RESPONSE: You know what? You're right. Those trees are getting in my way again. Yep, I should just take one of them right out, that's all. What's your preference, end-user or target population? Let me interrupt you sir and I don't mean to do this but in your original interview, I don't know if you recall but you really stressed the term target population.......target population. And others talked about the end-user. So it was about half and half between the panel. And the literature is the same way. Some say target population, all population, some say end-user. What's your preference?

DICK: My preference would be to use the word *that the eventual users of this model would most easily identify with* so to me its absolutely ....equipment orientation, they may......... end-user. That's my guess.

RESPONSE: Sounds good to me.

DICK: OK, next page. Lets see, a page two under environment. You talk about the physical conditions, I wonder where do the social conditions in which they will be using the tool? Are they serving the client or are they using this tool alone. Will there be groups of people around them? You know for example some tools you cannot use if a client were to see you use it, it would undermine your expertise. Sort of.

RESPONSE: Now somewhere in this thing I talk about, and I don't know where it is. It's designed for a single user or a team user.

DICK: Yes, yes, I saw that.

RESPONSE: But I don't remember where it is on this list. Anyway, from your perspective on the social environment, I think I should add that one in there.

DICK: Yeah, there's a physical environment and a social environment. OK, page three, under performance analysis. The first thing you say is the task analysis.

RESPONSE: Mmhh.

DICK: (Reads the definition) How do they know what the task is? Where in your model is that addressed?

RESPONSE: Ohhhhhh, I see what you're saying. Good point.

DICK: I'm sure its part of the analysis process.

RESPONSE: Yeah, it comes under the functional characteristics and the definition of functional characteristics is what is the job aid supposed to do? Not how is it supposed to do it. So in my mind that's where I came up with you know, what's the purpose of this device? So..........

DICK: Well, I guess somehow relating purpose, function, task is required somewhere. Now maybe somewhere now maybe that's just in an overview statement or something but all of a sudden that just hit me when I read that. Gee, I'm not sure I know what the task is.

RESPONSE: Got it. OK, good one.

DICK: Also on page three you talk about time constraints, *what are the time constraints in which a task must be performed*? It seems to me that that's the ideal place to also list how well it has to be performed. Now you have that under *functional characteristic* under design. (DICK reads definition) I assume that that, the functional characteristics flow from the performance analysis. *So that the performance analysis should indicate how well the task must be performed.*

RESPONSE: OK, so you're suggesting that under the time element that I also include level of performance.

DICK: *Time and level of performance.*

RESPONSE: Time and level, that even sounds better. OK, good.

DICK: Page five. Down at the bottom it says criteria evaluation. (DICK reads definition) This may be nitpicking but, *formative evaluation really doesn't result in validation.*

RESPONSE: OK. Just it assesses the design criteria.

DICK: Yeah, assesses and helps in any revisions or whatever but it doesn't really validate.

RESPONSE: Okay.

DICK: Well the rest of it, well, six and seven was fine, also out of my area of expertise. I guess my next comment is on page eight. Lets see, OK. *Where do you come up with the logic, the flow, the branching..........associated with the job aid*? And I couldn't figure out that you..........

RESPONSE: OK, I think I know what you're getting at. Uh, page seven. I think this is what you're getting at would be the message logic, perceptual organization and visual information structure.

DICK: (continues to read definition)

RESPONSE: Drop down to visual information structure where it talks about information hierarchy.

DICK: Which one?

RESPONSE: Visual information structure.

DICK: Oh, OK. No, see that's selection of fonts, typographical queues, headings, advanced organizers .... I guess I'm looking for once you have all those things, where does it say that the person will use this aid when these things happen. They will push this button to start it. They will have these four major options. If they choose option one, they will branch into a knowledge base that include these things. They will get out of there by coming back. A kind of overall flow. And I guess I don't see that.

RESPONSE: Alright.

DICK: Because these *message logic, these are the kinds of messages but it doesn't say how they are interrelated.*

RESPONSE: What I have for it is under design criteria under transparency. Page five. Now it's called transparency and perhaps it's not fully defined enough. But that's what you were talking about in my mind. (Reads definition)

DICK: Oh, you know what I read that as, I read that as a knowledge engineering laying down the paper trail of if you want to know why I recommended this decision, I can tell you the steps that I went through. But if you're not interested, forget it, I'll just do this. But that's after the fact. I saw that as kind of after the fact telling the person why a decision was made. Why a course of action was made. But I still ....

RESPONSE: Lets just look at the procedural model itself.

DICK: OK.

RESPONSE: I'll ask you where, looking at the elements in the procedural model, where you feel that the factor you're speaking of would fit?

DICK: Well I think it probably comes under *design criteria*, which is the tentative.....let's take another example, may be easier. Let's say you are creating a CAI lesson. You've analyzed the content, you've got your objectives, you know what kinds of learning activities you want to have. But before you actually sit down and start the program, you've got some kind of a flow model that says I'm going to present objective 1 and with this kind of information. *Maybe it's called the instructional strategy. Maybe it's the design.......oh, you've got format strategy.*

RESPONSE: Now that's where I was leading..............

DICK: Use your *strategy* if you like. What does the ......how does this system work when the user's using it? So that if I'm the person who's putting this product together down at the perceptual design stage, how do I know what it's supposed to do?

RESPONSE: OK. Let me see how my format strategy, if that meets the criteria of what you're talking about. That's on page four, toward the bottom.

DICK: (Reads definition)

RESPONSE: Is that closer to it?

DICK: That's a lot, yes. But I don't know that you can do it until . . .you know the last thing that you do before writing an instructional product is to come up with the *strategy* and it's based on all the *analysis* you've done up to that point.

RESPONSE: Oh, you know what we're saying then? Is that *format strategy* should actually be last, just before criteria evaluation. I'm looking at the block. Yep, yep. OK.

DICK: I've only got a couple more here, page ten. I looked at all these things and I said by golly, <u>I don't see where you train the people to use the JPA</u>.

RESPONSE: You know what I did not do? In the model, it just references a training block. Well we should have the definitions there. Why aren't they there?

DICK: The training implementation, rationale, relevance, confidence, etc. (reads definition)

RESPONSE: There it is.

DICK: But I don't see any place above that that says you're going to train them to use it. It says you're going to tell them about the limitations of it and you're going to tell them about the knowledge base. You're going to try to make sure that they're confident to use it. You're going to try and make them understand it's relevant to what they're doing. You're going to try and make sure that they have the skills needed in order to use the too. But there's no place that says and now folks here's how you actually use it.

RESPONSE: Oh, OK. Demonstration is what you're saying.

DICK: Well, yeah.

RESPONSE: OK, I see what you're saying or *practice*. How could I forget that magic part? OK, good. Thank you.

DICK: Then I guess the last thing had to do with the *evaluation* and not with regard to any of your particular headings but the questions of how well did the tool actually work? Was the people's *performance* improved, were gaps removed, were cost savings realized? Kind of back to the performance technology concept and I wasn't sure that that question was in there.

RESPONSE: You're right, those trees were in the way again. Good, thanks Walt, that's nice.

DICK: That ends my critique.

RESPONSE: Very well done sir. And you're not even getting paid or earning any credit hours for this.

DICK: No, not a thing. Just out of the goodness of my heart. I enjoy it, it keeps me intellectually stimulated.

Interview: J. Dessinger
Sept. 17, 1997

DESSINGER: In fact I remember when I was doing my work in job aids, one of the things that we were looking at was whether people liked using job aids or not. And that's the one thing that wasn't here when I went through because I'm real user prone when it comes to analyzing a user before you get started.........

RESPONSE: Well let me just see here. If I'm looking at the conceptual model, the variables, I would see that coming in under the analysis component and including that under the target population, except...but you agree to that?

DESSINGER: Yeah.

RESPONSE: OK, anyway, my question to you is fire away any comments, critique items, go for it.

DESSINGER: Oh God, OK. The only other thing that, well two things. Coming from a user point of view. You talk about designer **expertise** as **novice, mid-level expert** and I didn't see that break down for the **user**. That's kind of an important breakdown as well because one of the issues with job aids and maybe its also and affect issues as well is who is it going to be geared towards, the novice at mid-level or the expert?

RESPONSE: Yes, and one of the other SMEs comment under analysis wants me to add under target population in sub elements of analysis, skills and attitudes.

DESSINGER: OK.

RESPONSE: So that would fit in there and goes right along with what your saying.

DESSINGER: Right, and you also have to think about it in terms of **design** because you have to know whether you may in fact be gearing it for several different levels because actually people at different levels of expertise can use the same job aid they just use it differently. And then the only other thing or the one thing that I had marked was a requirement, I see standards all the way through. The idea very often, there are no standards and that's one of the problems.

RESPONSE: OK.

DESSINGER: There are no **standards** for the job or for the performance. And I know the industry that you're primarily interested in tends to hit standards. But in general I think most industries don't.

RESPONSE: Unfortunately, I did not send each of the panel members the 347 pages of text that goes along with this. But in the definitions of the elements of the conceptual model, what you're talking about, I had intended to fall under performance standards and in the text. It's a term that Rita and I thought fit the best for what we were attempting to do.

DESSINGER: OK, this bothers me and let me flip then to the next thing.

RESPOND: OK.

DESSINGER: It's that, and I know you cover it at one point. But that job aids mainly are used in two areas; one is as a method of overcoming a gap in performance, but the other way is a quick and dirty way of teaching something new, maybe new technology that needs to be trained or a quick and dirty way of teaching or of presenting a task that you're not going to use very frequently but you still need to know how to do and so rather than **train** it, you use the job aid. And in those cases again, the **end-user** doesn't always apply. Especially, particularly with new technology or new processes.

RESPONSE: Could you think of looking at that box under JPA requirement, now we're talking variables.

DESSINGER: Is there a way of putting that? Why do JPA end-users (Tony, can't understand what I'm hearing here)

RESPONSE: No, no, I say thinking of a term that would fit the concept that you're speaking about.

DESSINGER: Well, usually we say, and here is what I talked about. Why do we need training or why do we need performance ___________? That it's either a gap in performance which would mean that implies that they're not meeting the standards of performance. Or, if innovation or new technology......................

RESPONSE: There it is right there, innovation new technology. OK.

DESSINGER: And then lets flip over to, Oh dear, I had it in my head. Shoot! I flipped right over to one other section, oh. On the procedural model when you're talking about training, one of the beauties of job aids is that if they're done properly, you should not need to do training. You may need to do some preliminary training of the population in terms of how to use job aids, but even that may not be necessary. That one of your goals is that they don't need training to use the job aid.

RESPONSE: Well, in the conceptual model, I would agree with your premise because what Dr. Richey is suggesting to me is that she wants to see in the dissertation or explain, is that the conceptual model is applicable to a wide range of job aids and where the procedural model now becomes industry specific.

DESSINGER: Why?

RESPONSE: Why? Well that's just the way my dissertation's going.

DESSINGER: OK, you'll have to do it so your dissertation's right.

RESPONSE: I'm wondering if I should maybe add a sub-element about referring to is training actually required?

DESSINGER: Yeah, somewhere along the line I would because .....

RESPONSE: I know where you're coming from and I remember the original interview we did where you talked about one of the beauties of job aids problem design is it reduces training, when you look at the literature.....

DESSINGER: Job aids can either support training or supplement training or it can be done in lieu of or instead of training.

RESPONSE: From the literature stuff I've gone into and not too surprising from the other panel experts I've talked to, when we're talking about the high risk environment, everybody stressed a need for training.

DESSINGER: Oh yeah.

RESPONSE: And the literature supports.

DESSINGER: This may be, but then I think, I wasn't clear, well OK. You do say that at the very bottom. Then I think I would put it in your title, Job JPA Procedural Design Model, I would put high risk environment at the top also.

RESPONSE: Super, I like that.

DESSINGER: And maybe since your **conceptual** one is more generic I'd indicate at the top that it's a more generic model but your procedural, I would take that off of the top.

RESPONSE: Got it, very good.

DESSINGER: Because I did check it before, you know I looked at this earlier.

RESPONSE: By the way, you have to vote on something. If you will look at the procedural design model.

DESSINGER: Yeah, at the very bottom?

RESPONSE: No, at the very top, very top. Where it says, oh about the third or fourth element down, target population end-user.

DESSINGER: Yeah.

RESPONSE: A very prestigious instructional designer said to me, "Tony, pick one." I said "Well which one?" He said "Take a vote." So I'm asking you to vote which term, because in the definition section, I don't know if you got to read them all over carefully, but they're pretty much the same thing.

Everybody so far has remarked that there was confusion between the two terms, pick one and _______________ define it. So I'm asking you what term would you prefer to see in the model?

DESSINGER: Now, tell me again because I don't think I'm tracking with you right now.

RESPONSE: OK. In the definitions, where I said the list

DESSINGER: all right, we're in the definitions section starting on page

RESPONSE: Yeah , if you look at target population definition, and the bottom end-user definition, a number of people remarked there's confusion.

DESSINGER: As to which is which.

RESPONSE: Which is which. They said pick one, make a very nice definition

DESSINGER: I like end-user.

RESPONSE: You like end-user, OK. That's all I need to know.

DESSINGER: That makes it a real *target population*, you could argue, could be a vast population that you may want to target but in the end, *it's the end-user who you really want to focus on.*

RESPONSE: OK, good, I like dissension, it makes for good analysis.

DESSINGER: Mmhh.

RESPONSE: OK, lets see if there's anything else you've got to vote on. Oh, not a vote, just your comments on. Again, looking at the procedural design model.

DESSINGER: I'm back looking at the procedural design model.

RESPONSE: Looking at the 6:00 o'clock position, the synthesis component.

DESSINGER: Yeah.

RESPONSE: A recommendation has been made to substitute that with rapid prototyping. Remove synthesis and either call it just rapid prototyping and include elements of rapid prototyping or rapid prototyping synthesis.

DESSINGER: Well I don't think you should do both.

RESPONSE: OK

DESSINGER: And um, I was, since this is a procedural model, I was assuming that this really is synthesis which I think of as being different than rapid prototyping and I wouldn't put it as rapid prototyping. Boy that would, maybe __________a definition of that. Maybe rapid prototyping would start way up with analysis. And all of that would become part of rapid prototyping so that by the time you got to development, development would kind of fall out except for pilot and rapid prototyping would be done. That rapid prototyping in my, the way we do it for project, generally job aids is that we immediately with analysis do design and development so I don't see that it, I think it might be an alternative or it could be or you could say that this is what you want to do but it would have to come up front.

RESPONSE: OK

DESSINGER: It couldn't replace synthesis.

RESPONSE: You think if it went up front all the other.....

DESSINGER: All the other pieces would become part of it until you got to pilot.

RESPONSE: Got it.

DESSINGER: And then that would change your whole model.

RESPONSE: Oh well, not really. I could see how it could be.....

DESSINGER: Or, you could impose a, I don't know if that would complicate things. Impose an alternative rapid prototyping that you could go through all these stages, as separate and distinct stages, ending with symptoms that evolve the material before you actually go into development. Or you could indicate that the alternate way is to develop as you go literally. As you analyze and design your developing simultaneously. And then you don't do the synthesis you just do the pilot.

RESPONSE: Right. OK

DESSINGER: You should have a separate procedural model.

RESPONSE: OK, well a couple of three people really liked the concept of including rapid prototyping...

DESSINGER: Oh, sure. And it makes sense, I mean if you're saying, you're dealing with job aids and you're saying that this is you know the way to get things done quickly, I always say quick and dirty but you know that's the military concept. Then why not do it that way when you're designing them?

RESPONSE: You know what can almost be done is that the four blocks there on the right hand side of the model, performance design, perception and message design could all be kind of like components of one large component of a rapid prototype.

DESSINGER: Yeah, you could certainly do something visually that would tie them altogether and indicate that one way is to do them separately and another way....

RESPONSE: I know just how to do it.

DESSINGER: Yeah, and I think you have to include synthesis there first also because otherwise on rapid prototyping, probably what you're doing is synthesis all the way through.

RESPONSE: So you like the idea of keeping a synthesis component there then.

DESSINGER: I think that I like the idea of, unless you're going to go with rapid prototyping and then I think you've got a whole different dissertation if you do.

RESPONSE: Yep, I hear you.

DESSINGER: Yeah, but so if want almost a dotted box or something that indicates that really from project analysis through synthesis can be done using a rapid prototyping model as well. Or it can be done as a separate unit. So that whole, from 6:00 o'clock to the right on could be done as rapid prototyping.

RESPONSE: And that's visualizing a vertical box that has dotted line that just has light grays like the prototype, falling all the way down. That reflecting an alternative method.

DESSINGER: Right.

RESPONSE: OK, I like that, thank you Joan.

DESSINGER: Hey, yeah.

RESPONSE: Anything else you want to kick in there?

DESSINGER: No, that was pretty much, you know as I went through everything that was pretty much what I came up with.

RESPONSE: OK, thank you.

Interview: G Rowland

Sept. 18, 1997

ROWLAND: OK, I hope I can interpret my own comments. OK, I'll start from the top here. As I pulled out the conceptual design model, what I wrote to myself is, it seems reasonable as a more or less a system model for this, from my frame of reference, in systems design. It seems to be kind of like a systems model without the environment. And that's reasonable, you don't have to go crazy. On the other hand it does..................it doesn't really point out what the relationships are among these kinds of things. What the model might do...........

RESPONSE: Yeah, this was kind of brought out and you make an interesting comment because I was waiting to see how the people viewed the graphic representation. What I was attempting to show and perhaps you may have an idea how to more better visually represent it. Is that each of these variables affect the procedural model and it's a systemic approach, meaning that each of the variables are somehow related and influence each other. That's what I was attempting to show.

ROWLAND: That's clear. That's something that is done very frequently in our field anyway. What I have been......I guess maybe I'm coming at this from my own work recently. I've been unsatisfied with that. For example, we have instructional systems that have components and you know you can boil it down to who, what, when where, why and those sort of things. But the only representation, to my knowledge, that have **relationships** shown, tend to be just linear procedural models. And I'm not satisfied that that is what represents a system in the thinking of an experienced **designer**. So what I've been doing and I'm just finishing up a study now is I'm trying to go in and say, OK. Lets just take a look at this and say what's this got to do with that all over the place? And I'm finding that there's some very interesting relationships the experienced designers come up with. They are not clear from arrows. You know sort of like this arrow doesn't mean the same as that other arrow there. That kind of thing.

RESPONSE: Perhaps I am interpreting what you're saying as perhaps put something between the graphical components. Put some think about its to indicate relationships.

ROWLAND: I'm not necessarily telling you to do something different here, I'm just pointing out as with any model you're going to capture and not show other things.

RESPONSE: Right.

GR. What I'm suggesting is behind this, when you say something is systemic, there's a lot more to it. There's a lot more than just some arrows pointing to the middle.

RESPONSE: What would you think about if I put a statement between the components, kind of hanging out there in the air? And I'm not sure what it would even say.

ROWLAND: I would suggest that yeah, you've got another dissertation in front of you.

RESPONSE: Alright, maybe I better just leave better left alone here.

ROWLAND: Yeah, well I've spent six months on very preliminary things on one model of that nature so I'm not sure I would suggest it. It would add on to your task here.

RESPONSE: OK.

ROWLAND: One question I did have noted on here as well as that comment, who would this help and how?

RESPONSE: OK, the idea is........now you don't have all the background information and the lit review and the nature of the problem and all that?

ROWLAND: Right.

RESPONSE: But the original proposal, the original design was to develop a design model for JPAs to use in high risk environments. That was the original concept. As this study started to take its course, it became obvious that we also needed to look at the variables that influence design in this particular boundary of high risk environments. That led to the development of this conceptual design model, which does not provide for JP design, it influences for JPA design which was so notably pointed out to me by one of the other SMEs. And that to look at that first. So the purpose of the conceptual model led to a generic model meaning that it's applicable to JPA design no matter the work setting. That's the concept behind the conceptual model, which leads to the procedural model which leads us into more specifically now high risk environments. And I was asked to re-title the title of the JPA design procedural model for high risk environments to make it more specific. So the idea is and this kind of came from Dr. Richey that the conceptual model is applicable to a wide range. But now the procedural model is becoming more specific. So that's the nature of the study, that's the direction it's taking.

ROWLAND: OK, as I look at the procedural model now, I asked myself the same question right at the outset. Kind of what use is this and to whom? Yeah, is it just a checklist of things not to forget or just something you envision people starting at the top and actually moving through with help of some sort of EPSS or something? What's your thought on that?

RESPONSE: My thought is that it, of course again, I do not have the textual base behind it for actual use. That will come in, I don't even know if that will be in the dissertation. That's more of the book supposedly that follows. Kind of like the Dick and Carey design book with the model and then he spends fourteen chapters explaining each of the components of the model. I envision the procedural design and model intended for designers, novice to experts, in the field who are responsible for designing various checklists, automated aids, this type of thing, in high risk environments. That includes nuclear power, aviation, maritime, things like that. So that's why it's extensive and a lot of stuff in there. So that's my concept and to give you a real quick background. The catalyst for this was NASA. About two years ago when I was talking with some researchers there who were working in automated aids and they brought up the point that one of the problems that we really have is we don't have a design model to follow. I thought, oh, there's a dissertation project, so that's how it kind of got started.

ROWLAND: OK, I'll make a comment here and you can kind of take it or leave it kind of thing.

RESPONSE: Sure

ROWLAND: But when you bring up something like Dick and Carey's model. My experience has been with novices, that they are better off without it if they don't have the whole book explaining it. That is it gives them this sense that all they got to do is X, Y, and Z. They got to come up with some quality instruction from it. And I find that to be not the case at all. That they start appealing in their search for quality to the process rather than to the product. So that's a caution I would just raise when you said that the audience is that wide.

RESPONSE: I don't recall if you remember in our initial interview when you emphasized about cautioning the designer's expertise or the designer? That was a primary purpose I put the caution at the bottom of the model. So I was attempting to elude to that.

ROWLAND: I guess I wasn't looking at the fine print. I should know better.

RESPONSE: So, yes I understand exactly where you're coming from.

ROWLAND: I see, OK. Alright, here are a couple of other comments on the procedural design model that I noted here. I think the first time I saw it I didn't quite capture the difference between perceptual design and message design. After I read the stuff later on, I came back to it and I noted to myself, I wonder if it would be better to call it perceptual factors rather than message design, and that seemed to help me solve that distinction problem at first. But I don't know if that would help.

RESPONSE: Well let me review what you said to see if I understand completely. In other words, instead of message design, calling it perceptual factors.

ROWLAND: No actually I didn't understand the distinction between those two boxes at first.

RESPONSE: OK.

ROWLAND: And when I got to the follow up information, the more detail in there, I realized what that distinction was. Or I wondered whether perceptual design might be better called perceptual factors. Something different, because it wasn't really a design kind of thing.

RESPONSE: Ah, I see, that's right. OK, I like that very much. OK.

ROWLAND: And I noted here I did not have a clue what synthesis was.

RESPONSE: Well, join the rest of the committee. I'm not going to give a defense why that's there, I'm going to give you a suggestion made by a couple of others and then ask for your expertise in model construction. One of the thoughts that came out as similar to what you said is that this synthesis portion, although we kind of understand that it's supposed to be kind of like making sure everything follows and is synthesizes with all the previous steps. It doesn't really fit in the procedural type situation. You should include rapid prototyping. When I talked to a couple of the other SMEs, they all liked the concept of rapid prototyping with either synthesis being kind of like a sub-element of rapid prototyping or eliminating synthesis all together. Replacing that component with rapid prototyping. Then another SME said well you know really rapid prototyping, if you're going to do rapid prototyping you should come right before performance analysis or right after performance analysis and include somehow relate to design criteria, perceptional factors and message design. So I really like the idea of incorporating, perhaps I would use the term, an alternate course of action, instead of procedural step by step by step, of a rapid prototyping phase which is an alternate to the designer. But I'm not sure how to reflect that in a model. You might have an idea on that.

ROWLAND: Yeah, that's very much in since with what I would say, this last comment here. It's not something you can just put a rapid prototyping step in a linear model like this. It's a different conceptual framework, it's a different way of approaching the task. So I wouldn't choose to place it in this. It's almost like you're trying to reflect all design processes with a single procedural model. And I just don't think that's possible or wise even.

RESPONSE: If I'm correct, I get you to say that perhaps we should not even consider adding rapid prototyping into this particular model?

ROWLAND: You know that's something I'd consider. The only alternative I can think of, off the top of my head here is that you just look at the center instead of putting arrows out, put a spiral or something like that. Like spiral prototyping or something that reflects, you got to consider all that stuff but in a rapid prototyping situation, you're looping around there quickly.

RESPONSE: I like ....very good see. It does pay to ask other people. Good one, I like that. OK. In the project analysis block of the procedural design model, oh, about the third element down. It says, target population and end-user.

ROWLAND: Right.

RESPONSE: A number of people expressed a confusion in the definitions I sent between the two they said, Tony, why don't you pick one and use it instead of vacillating between........

ROWLAND: Yeah, I'm glancing ahead to my notes on the definitions now and that's precisely what I indicated there.

RESPONSE: That's your vote. What would you prefer?

ROWLAND: Same is true with *literacy, you're talking about a type of characteristic of that audience*. It might be just included with that.

RESPONSE: Would you rather see the term target population or end-user used in the models?

ROWLAND: In the context of a JPA, I would probably use end-user.

RESPONSE: OK. Good enough, that's what I needed to know.

ROWLAND: Why don't I continue through that definition thing?

RESPONSE: Sure

ROWLAND: Lets see. Oh, I noted in the first one, analysis evaluation, it's at the end of the project analysis.

RESPONSE: OK, yeah.

ROWLAND: My comment was hmmm to myself and hmmm to myself and that normally means I've got a little yellow flag going there. What I was asking myself is if this model was buying into an exhaustive analysis process? I don't believe exhaustive analysis is possible. So I was just kind of curious about these analysis things after each one. It was sort of like trying to say it's an iterative process, but yet buying into a deterministic kind of linear thing.

RESPONSE: Yeah, I elected to do that and again, perhaps it's not reflected properly in the visual model that the formative evaluation is ongoing throughout the design process. Instead of just having a component that says formative evaluation or at the end of the project, you know you make a statement, you have a term, formative evaluation. I wanted to show it as a design activity throughout all the entire model. That was the purpose.

ROWLAND: That makes very good sense to me. I would probably go with a more elegant solution with an inner loop on the model or something like that. Just another circle or something that says formative evaluation on it. Notes that, points out that it's going on all the time or something. Sort of like Walt's model, with the arrows to everything.

RESPONSE: OK.

ROWLAND: Under performance analysis, when you got into test analysis properties and that stuff, I started thinking about Jack Carroll's work with scenario descriptions and changing situations and performance. What I mean by that is, what if the JPA actually creates a new task? That if it's not just making one safer, easier, faster, etc.? That the institution of this aid actually changes the situation of human performance. So I guess I'm again reflecting on this sense of doing everything right all along the way, almost opens you up to an error process. You know a process of error accumulation.

RESPONSE: Yes, and I don't know how to address that.

ROWLAND: Well, it's just something to think about. You know if you're not familiar with Jack's work, take a look. Because I think it's really important to us in these kind of areas.

RESPONSE: Yeah, OK. I was just thinking to myself, here very quickly that with the automated aids I'm familiar with in the cockpit, you're absolutely correct. The aids create additional task.

ROWLAND: Exactly.

RESPONSE: I'm not sure what the designer can do, other than in the development and pilot field testing is identified potential error. That was brought up by someone else, let me see..............

ROWLAND: Well you see, this is what Jack is saying, you can do something up front if you don't buy into a straight requirements analysis process up front. *If you base it on scenarios of use, and you treat it as an imagination, a mental trip into the future here, you can sit down experts and say, "OK, we can imagine this situation. We can imagine this aid being there." Now how is the scenario going to play out differently than it currently does?*

RESPONSE: Are you familiar with Dr. Ron Westrum?

ROWLAND: No.

RESPONSE: OK, his stuff is on what is called requisite imagination, and boy, does that fit right in. It appears that what you're saying fits with some other stuff that has come up. Now I have to figure out how to plug it in and I'm not sure how to do that just yet.

ROWLAND: Well that's the great part of me laying it out there for you to work on. Lets see, moving on here. Under design criteria, OK. I guess again, it was just a comment on a sense of determinism being bought into here, with all the functional characteristics, format, strategy.......................everything like this defined before we had a sense of what the thing might look like. So that's just one to file away. Here, transparency. My comment was I don't believe that that's a term and level of detail are the same thing.

RESPONSE: It's the term coined by NASA for that particular...........

ROWLAND: I would use transparency to mean something very different. That's, you're calling that. The environment, if there going to be using such a thing.

RESPONSE: One of the things that, just a side note, trivia. Some research at NASA, two years ago or so, with automated checklists in the cockpit, they discovered that because the automated checklist just provided actions to take versus sources of information determining the action. There were some serious mistakes being made in the ___________ cockpits.

ROWLAND: Oh, sure/

RESPONSE: So consequently, NASA went back in and started doing research and they determined that a, some means, and they are working on that now. That when the automated aids projected on the CRT, that the level of, that the crew member knows the source of information in determining that course of action. And they refer to that as transparency.

ROWLAND: Well, interesting, you know years ago, well in the same kind of context I would have probably called it *system understanding*. You know when they started early cognitive task analysis kind of stuff, was showing that..........I think it was done in electronics troubleshooting and they were showing that you can't just teach people how to use job aids and stuff like that because they'll do just what you just said. You know, act on things without understanding the source of the information. Not understanding the system below it. Hm, fascinating. Well lets see, where are we? Perceptual design, I think is my next comments.

RESPONSE: Yeah, I like your idea about perceptional factors. I think that will fit very nicely.

ROWLAND: Yeah, it does make sense. Let's see. Action logic.........I guess under action logic and attention, I'm not reading very carefully at the time, but I was kind of thinking that these really pertain only to very well defined tasks.

RESPONSE: Yes, I agree with you. Yes, they do.

ROWLAND: Well that makes sense for the context here.............OK. I'm not seeing anything under message designs. And synthesis again, the same issue.

RESPONSE: Yep, and I think I'm not......I haven't. I'm almost to the point I really liked your analysis, your suggestions on the rapid prototyping. I'm almost convinced to eliminate the synthesis block because its probably an overkill on the analysis stage.

ROWLAND: Well it just kind of says, it almost implies that you can leave that kind of activity to a certain time in the process.

RESPONSE: Exactly.

ROWLAND: It just doesn't play out in practice to do that I don't think. I think that was the last comment I had made.

RESPONSE: Well, I appreciate it very much.

ROWLAND: Sure.

RESPONSE: Tell your students, process really works.

ROWLAND: Alright.

RESPONSE: Let me tell you real quick what's going to happen. I have attempted and I have 50% concurrence from my committee. I'm waiting for two others to respond because of the way this qualitative research goes, as you know, different directions take place. What I'm going to do next, once I get concurrence from 100% of the committee, is I'm going to revise these models and definitions, based on the analysis of everybody's comments. I will send the revisions to you and at the same time, I am going to draw, using the layers of necessity approach, a task specific procedural model for a specific task. It's going to pull elements out of the procedural model to build a JPA for a very specific task, as a demonstration. And what I'm going to ask each of the SMEs to do is: 1. Comments on the revisions, comments on the JPA itself. Because it will be a peer review of the JPA. And it's an interesting JPA because it's something needed in the industry and it's a paper JPA and it has to do with preparing an aircraft cabin for emergency landing. Once I get the JPA completed, then I'm taking it out to the west coast to run it in a simulator and compare it to groups that don't have it.

ROWLAND: Gee Tony, you don't that you're going to have something that doesn't sit on the shelf like everyone else does.

RESPONSE: Oh, it will sit on the shelf. Matter a fact, I'm designing a gutter for the binder so it can gather all the dust. Alright, I appreciate your time. Thanks.

Interview: H.B. Altman
Sept. 2, 1997

ALTMAN: OK, What I did was on the airplane, I went through and I read all this stuff. I should have reread it after I got home. I'm going to look at my notes as we go along.

RESPONSE: Mmhh.

ALTMAN: Where you had given comment lines I had written in comments on every one of them.

RESPONSE: Great. OK

ALTMAN: So I can even send it to you after we're done talking.

RESPONSE: OK, but I'm recording it so that's OK.

ALTMAN: So what I did was, I went over and looked at your JPA procedural design model and I looked each one, you know the, I don't know one of them is a job performance and design model and the other one is conceptual job performance and design model. I tried to be as commentary as possible with constructive more than tear down critique.

RESPONSE: Sure, that the purpose. That's what we're......

ALTMAN: I don't know how you want to start so I'm here to go....

RESPONSE: There is no interview questions, its just an informative evaluation, its just any comments you want to make you fire away.

ALTMAN: I'm on page one.

RESPONSE: Page one

ALTMAN: I put this has to be a Ph.D. dissertation, way too much techno-babble. You need to start kissing this thing.

RESPONSE: I understand

ALTMAN: Alright. Well anyway, number one. The analysis component consists of the following outlets, then you went through each one of the connecting blocks in your model.

RESPONSE: Right

ALTMAN: And so what I did was I went through each one of them and I tried to make heads or tails what you're doing here. I do not have any clue as if this is what you wanted me to do or not.

RESPONSE: Whatever, the way this works and you're doing exactly right. Is the idea is to get how you're interpreting what you have in front of you.

ALTMAN: OK. Well so what I did was I looked at the design model and then I went through there and I followed it around to see what is it that you're trying to do. So I'm saying that out of the whole thing, you're coming up with a functional document. That's what I'm assuming.

RESPONSE: Mmhh.

ALTMAN: So then, the client. *You're defining the client is who the decision makers are. And what I wrote here was the client is the originator of the need,* the client has a problem, a task function requiring a JPA floor worker to follow to accomplish the task. Because what I was not feeling comfortable with is some of the definitions. *You know I felt like some of the definitions were a little bit too academic and not quite enough user oriented.*

RESPONSE: Fine, OK.

ALTMAN: It sounded like some of these guys needed to be more of an instructional technologist and I didn't know what you know, the individual reader was going to be.

RESPONSE: Mmhh.

ALTMAN: *In performance need, I got a big question mark here, gap.....what's required to be performed?* I felt that I was being kind of left out. It's a gap. I felt similar to, I have a problem, I have tools and now I'll put the two together. But I didn't know exactly what that was.

RESPONSE: Mmhh.

ALTMAN: Again, trying to fill in the gaps. *Functional characteristics,* actually that's OK. Uh, however, that's a little bit different from later on when you used functional again. You used functional, a design criteria and that sort of a thing and I'll get back to that one on page four.

RESPONSE: OK

ALTMAN: *Then on target population, I felt like that those should actually be reversed. I think that end-user and target population should be flipped.*

RESPONSE: OK, question here for you, or you get to vote. One of the other SMEs said, Ton, you duplicated. Pick one or the other.

ALTMAN: Yea

RESPONSE: And I said well what's your preference and he said, "Hey, query the panel and take the majority vote." So I'm querying you, what would your preference be?

ALTMAN: *The target population to me, refers to the growth group. The people that are going to be affected. End-user reflects to me the individual who is actually going to complete the task,* you know complete the task or the, no lets see, not the task. The end-user is the one who is going to use the document in order to accomplish the project.

RESPONSE: Mmhh.

ALTMAN: So, the target population is pilot, flight engineer, flight attendant, ABP [able-bodied-passenger]. Alright.

RESPONSE: Mmhh, I'm with you.

ALTMAN: *The JPA needs to address the capabilities of the target population in training,* da, da, da. The end-user, I put down this may be redundant to target population, aren't they both the same? So your other SME and I......right on target. So I'm going to say that you need to call the user, is the doer.

RESPONSE: The designer.

ALTMAN: Yea

RESPONSE: In other words, what you're interpreting is you're seeing the end-user is the person who is going to use the model?

ALTMAN: Yea

RESPONSE: And the target population is the person who's going to perform the JPA task.

ALTMAN: Exactly.

RESPONSE: OK, I like that

ALTMAN: Does that make sense?

RESPONSE: It certainly does.

ALTMAN: Alright, 'cause otherwise, that's why I flip flopped those. OK. Next, page two. *Literacy, again I'm confused as to the target population and the end-user. Target population end-user. Whose the literate one?*

RESPONSE: Yep.

ALTMAN: Is it......you get my point?

RESPONSE: Yep, good point.

ALTMAN: You need to make sure those are clarified.

RESPONSE: Got it.

ALTMAN: Alright, next one. Um, I did a little flip flop on this one too. I went down to procedural, procedures and compliance. I almost felt like that ought to come next in your line up.

RESPONSE: Oh, OK.

ALTMAN: Alright, and then content would go down below information properties.

RESPONSE: Mmhh.

ALTMAN: And so but nevertheless, I said OK on the content. It's the what type of information also will depend on the type of display that you're going to use, so that was another thought I had *is the content is often dictated by the type of display that is going to be used.*

RESPONSE: Mmhh.

ALTMAN: And uh, not just necessarily, you've got the element also determines the kind of information that will be displayed. But your display unit, whether it be electronic or typewriter or whatever, has limitations as to whether it's audio or visual or what.

RESPONSE: Good point, mmhh.

ALTMAN: Now information properties, here I said *I'm unclear as to static and dynamic. Does static mean hard copy, dynamic, motion, sound, so forth. Or does it mean static is fixed and dynamic is living?*

RESPONSE: What static means is that the information that's displayed does not change, like a passenger safety information card.

ALTMAN: OK

RESPONSE: And dynamic means like information is constantly changing, like instrument read outs in the cockpit.

ALTMAN: OK, I was unclear.

RESPONSE: OK, so that has to be more fully defined.

ALTMAN: Yea, I think so. *Dynamic, you know, maybe an example of the dynamic would have helped me.*

RESPONSE: Good, mmhh.

ALTMAN: So, procedures in compliance, this is OK, its part of the content though I feel. What about research evidence and such?

RESPONSE: OK

ALTMAN: Needs to be included, like here you've got JPA, equipment manufacturer specs, government regs, organizational policy, and other applicable regulatory bodies and then I'm saying, well wait a minute, you're not really saying anything in here about research and other areas from which, the industry standard..

RESPONSE: Got it, mmhh.

ALTMAN: So in other words, there's **industry standards** as well as manufacturer specs, government regs and so forth.

RESPONSE: Got it, excellent, you did some work on this.

ALTMAN: Now environment, I didn't have any problem with it.

RESPONSE: I'm going to give you a comment someone made. Uh, *environment should include also a social fact or social environment.*

ALTMAN: Mmhh, I don't have problem with that.

RESPONSE: OK

ALTMAN: So you've got the bio, psycho, social.

RESPONSE: That's what I was leading to, that's what I was thinking.

ALTMAN: And a, 'cause I had put down on my notes here, again, cabin, cockpit, da da da, and it's OK though, as you put it. So if you put down, you know the physical factors, the psychological factors and the sociological factors, something like that. Context, in analysis, they, and I underlined possible situations under which that JPA could be used. Then I stated would not each JPA be designed for specific situations, for example emergencies or normal operations.

RESPONSE: Yep, you're right. OK.

ALTMAN: You know like starting a VCR, or opening an emergency exit. You'd have two different sets of functions. Display, I put "of the medium" and you know I went back in my old school and I said the medium is the message. I said again, this is dependent on situation context and type of content. So you've got to look at that, for example; you're conducting and emergency evacuation prep, you're probably not going to use a video or a VCR. On the other hand, maybe you could.

RESPONSE: Well, OK, I don't want to justify any like definition. I want to get your input on it.

ALTMAN: And so, what I'm saying here is that you've got the examples, automated electronic checklist or printed operations manual or so forth and all I'm pointing out to you is that again, *I'm going back up to the content and context in saying that the display will often be dependent on those two items*.

RESPONSE: Got it

ALTMAN: Next, page three, the *evaluation* plan and then I've got here in initial determination of the evaluation process, how. To me that's a big number, *how is the evaluation conducted, this must reflect the performance need.* Has the JPA done its job? And so, here I underlined *reach a state of agreement between the client and the designer.* I'm assuming you're the designer and Beau is the client.

RESPONSE: Mmhh

ALTMAN: And so you say, well alright. You know it's like [company name deleted] right now. They're not willing to accept our data. It doesn't do what they want it to. So you know, that's a real problem. *So how is that evaluation determined prior to the start of the assessment of the device, I think is so very important.*

RESPONSE: Mmhh, that's what this is supposed to say and you're absolutely correct.

ALTMAN: Now the analysis evaluation, this is a *formative* and I know that you don't like me to say this but I think that's techno-babble again because I'm getting awfully confused from a client's point of view of formative and summative and all this. It would probably have been a little more helpful for me, which I did. *I went back to my definitions that you gave me once, and I put them all together. And again I said, " Kiss it."* Is the job done, how well can it be replicated? Can you repeat that phase that we just went over? The analysis component phase, I think that's really important. Alright, now on page three, continuing performance analysis. I underlined *desired performance, performance of the individual using the JPA*. So my feelings are that's what this device should be doing if you state that this performance should be accomplished. Put the life jacket on in twenty-five seconds, tied and secured, those are the performance requirements. So looking at *task analysis* then, match the physical characteristics of the JPA and here's what I was a little confused over. This probably is the most important component of the JPA, who what, why, where, when. And like getting onto that one, I'm a little bit confused over the physical characteristics of the JPA.

RESPONSE: This comes from the human factor stuff about one of the important criteria parameters of JPA design is to match the physical JPA itself.

ALTMAN: Well, I mean is that a piece of paper?

RESPONSE: Yea, paper or how large the paper is, how large the type is.

ALTMAN: That's what I thought. OK, but again, *it was a little unclear to me in your definition, I felt like that if you were going to stick with that model and you would ever publish that model, that model has to be better defined.*

RESPONSE: Got it

ALTMAN: Task properties, the model of expertise, your designer may know what that means, the user won't.

RESPONSE: OK

ALTMAN: Analysis of the type of decision with which the user, again we've got to go back to what's the end-user in the target population. Controversy that we spoke of earlier, will be a phase that determines more than one course of action possible. Then I, you know, if this, then do this, if that, then do this. A decision tree type of an approach. Alright, so that's all I wrote.

RESPONSE: OK

ALTMAN: Time, I said OK.

RESPONSE: A comment here from someone else. <u>They suggested time and level of proficiency be included in that element. In other words, to what level of proficiency is time a factor with the level of proficiency are they coordinated?</u>

ALTMAN: Well, in fact you might make a side note to this, some of the recent evidence that has been published in the American Psychologist is that intelligence is being more and more graded on time of retrieval. How fast can you make the decision based on, you know your information storage of course. So yea, I could see time and level of proficiency. And I put on here, *JPA should perhaps address several different time constraints or allowances* so that maybe different people have a different, you know like right now. This life jacket study for example. Twenty-five seconds is way too short for old people. They can't meet it. They can't possibly meet it so I think it should be 30 seconds for anybody over the age of 60. So maybe you have to look at that.

RESPONSE: Good

ALTMAN: *Risk assessment*, examines the *potential risk* involved while performing the task. Does this mean making wrong decisions or what risks, physical, social, biological, where is the risk, what's the risk?

RESPONSE: Making a wrong decision, that's what I was pointing to. Lift the lever instead of push the lever down.

ALTMAN: OK, yea, and again I think that needs to be more clarified.

RESPONSE: Good, OK.

ALTMAN: Alright, page four. *Adherence, in this, I underlined if any flexibility... displayed procedure, da da da .... I said what displayed procedures*? What individual heuristics? Decision tree, quote again, like CPR, if not breathing, fix it. Is this a check it, fix it thing? Adherence, adherent to the JPA and if it ain't broke, don't fix it?

RESPONSE: Well, OK, uh, the idea during the design process is that this comes out of NASA. You have to consider how much deviation from whatever the JPA says to do. Do you want to.....

ALTMAN: You give the 5%, 10% deviation.

RESPONSE: Yea, in other words, when it says lift the lever, do you have to lift the lever or can you just monitor the lever or something along that line? It's probably not well defined.

ALTMAN: I also felt that *it's blended with risk assessment. So you may want to look at that in terms of adherence*. You say five degrees, I say I don't think so. I think six degrees is better. I'll take the risk that I'm wrong. Got the point?

RESPONSE: Yep, exactly.

ALTMAN: *Performance evaluation*, this element consists of a formative evaluation that assesses the adequacy of performance analysis. My comment was, *formative versus summative. Which one are you talking about there really.*

RESPONSE: Yea, I hear what you're saying. Well......

ALTMAN: I'm not sure formative is the right one.

RESPONSE: Well, from the IT world, that's when you're in the design process, and your checking your step by steps. Did I do step one correctly, that's referred to as formative.

ALTMAN: I can understand that, but in the, 'cause this says performance evaluation, and I don't know that, does that refer to the designer?

RESPONSE: Yea, well its referring to the under the performance analysis box, square, whatever you want to call it. The last step after you've conducted a performance analysis is to doing an evaluation of what you've done and that's basically what it is. Go back and check everything.

ALTMAN: Yea, I saw that. Alright, so all I said was performance evaluation was the correct decision made, was judgment good or bad, live or die. *Alright design criteria, and again, what I put here was again, who, what, where, why, when and how in the goals.* Seems to be like that's really what your talking about. You know like objectives at the beginning of the chapter, purpose, I thought that they were a little screwed up, by the way. You might want to go back in and find out exactly have you really followed purpose or have you mixed and matched. *Because I saw a couple of times where I thought objectives and purposes were switched.*

RESPONSE: Mmhh.

ALTMAN: I might get back into that here in a minute, Uh, yea, *functional characteristics*, again I said that's probably OK but I thought that was more like objectives. *You should be giving specific information, include detail specification of the conditions under which the JPA will be used.* OK, are not those objectives?

RESPONSE: Well, yea, they are design objectives but the stuff from Smiley who's a JPA guru, referred to them as the *functional characteristic* of the JPA. What is the JPA supposed to do?

ALTMAN: I understand.

RESPONSE: But that's the terminology that.... So I kind of liked it, so that's why I picked it up.

ALTMAN: Well, I don't have any problem with it, it just needs, if you're going to use it just for goofies like me, you need to have a couple more words in there to what it means, you know relating it.

RESPONSE: OK.

ALTMAN: *Format strategy*, and here I put directive format, deductive format, hybrid format, these were ABC's that you had. And I'm saying a, trying to directive is do this, do that, and deductive is, I guess thinking about it. And hybrid is something in between.

RESPONSE: Yea, basically, well I don't want to take time getting into the thing. Basically, in the expanded text of the ________ view and all that stuff, it goes pages into directive and deductive formatting and how it's used.

ALTMAN: OK, my question to keep things short here, *but what does format mean?* That was the big one, checklists, dialogues, what?

RESPONSE: Got it.

ALTMAN: Content, uh, kind of goes back into that format strategy a little bit.

RESPONSE: Mmhh, it sure does.

ALTMAN: And a so, how does the *content* reflect functional characteristics in one or more of the other formats? So what I'm trying to do here is to pull those two guys together so that I know what you're talking about.

RESPONSE: OK.

ALTMAN: Information hierarchy, again, here where I went into , and I talked about branching decision, trees stuff.

RESPONSE: That's it.

ALTMAN: Look at that and see if that fits. *Transparency, again, techno-babble. (Laugh) And I know this isn't to you, but it sounds like it to me.* You know people call me a psycho-babbler, so I can call you a techno-babbler.

RESPONSE: Um, log this one into when you're pilot talking with flight management systems. This is the new problem discovered through NASA research, is that a lot of the flight management systems do not provide a rationale for the computer queues and computer procedures that are flashed. And the NASA researchers are calling it a required level of transparency. In other words, how did the computer reach the decision?

ALTMAN: Its a weird word to me, 'cause like I put down, I ain't' got a clue. Is there a need for the end-user to trace the rationale?

RESPONSE: Tracing is what the computer would display.

ALTMAN: Yea, I know. But is there a need for the end-user to trace the rationale?

RESPONSE: Well that's what you have to decide as a designer.

ALTMAN: Yea, accuracy, compatibility, OK, OK. I didn't have any problem with them. User compliance, level of adherence. That goes back up to above in that other section. *My question was, does this mean procedural bypassing?* In other words, determines the need for warnings, cautions, and notes that could be displayed on the JPA. And so what my point is that if I don't adhere to it, did I bypass a procedure?

RESPONSE: That's correct, that's what you're trying to eliminate.

ALTMAN: So that was OK then. Criteria evaluation, again I'm not familiar with formative evaluation techniques. I think that they're sissy.

RESPONSE: I can't put that in the dissertation!

ALTMAN: OK, you can delete that. Alright, then the next one, *perceptual design. My first question was, is this psychological perception, visual perception or emotional perception?*

RESPONSE: You can take them all.

ALTMAN: OK. Because motivation and perception, that's a biggie in psychology.

RESPONSE: You bet, that's a biggie in designing.

ALTMAN: *OK, perceptual design, page six. Distracters, OK. I'm with that. As many variables as listed, how can one JPA account for any or all? I mean I'm asking the question. Can one JPA account for all?*

RESPONSE: Probably not. But the question is.......

ALTMAN: So I think there's where we talked earlier taking the JPA by the situation that you want to deal with.

RESPONSE: *Should probably crank that in there, the term situation into distracters.*

ALTMAN: Yep, we got a lot of airplanes sitting on top of hills because of that. Which by the way, was procedural bypass and were distracted in their process. *Alright, action logic, expert mental representation with that of the end-user, what's that mean?*

RESPONSE: OK, what this is supposed to mean is when you're going to the, if you take an expert who performs a task, what is the model of that expert performing that task?

ALTMAN: Well, here's one of the thoughts I gave you. *Mental representation*, use this. Describe a spiral staircase without using your hands. That's mental representation. In other words, I'm not sure what that means, I don't know if it can be done.

RESPONSE: OK.

ALTMAN: Anyway, attention, physical properties contrast between levels of information, blah, blah, blah, and I said be careful here, kiss it. Pre-attentive, attentive, these are all very difficult things to deal with. So what gets and keeps your attention on the JPA objectives? That's my question, so try with that one.

RESPONSE: OK.

ALTMAN: Next one, I know I keep going back into decision trees, and so forth but here a chart actually could work very well there. A *visual information structure*, construct a *mental map of the information displayed.* Uh, again there I feel like that I know what you're saying provides the end-user.....

RESPONSE: Lets use the word target population now.

ALTMAN: OK, you've got a better one now, OK use the target population to construct a mental map. In other words, you want them to memorize it, or you want them to have it in the back of their eyeballs.

RESPONSE: Well what we want to be able to have them to do is follow the format the way its intended, the information hierarchy.

ALTMAN: OK, when I read construct a mental map that meant to close your eyes and be able to see it.

RESPONSE: Got it, so alright, good point.

ALTMAN: So you need to refresh that a little.

RESPONSE: Good point.

ALTMAN: Cause you talk about typography, coloring, signals and so forth. OK, motivation, I said "no problem." *Personal assessment of value, you might want to make sure that's in your risk category earlier.*

RESPONSE: Where are you at?

ALTMAN: I'm on still page six, motivation. *Motivational factors include accessibility.* Either use clarity, relevance, risk in potential for personal harm, and probability, and I'm putting in one that says value.

RESPONSE: Oh, OK.

ALTMAN: *I'd suggest to put in value. In other words, what's the value for me in accomplishing this performance task?*

RESPONSE: Got it, I like it.

ALTMAN: Is it a dollar bill or is it going to save my butt? OK, the next one is message design, and here is where I put the medium is the message. I was pretty impressed by that book some thirty years ago.

RESPONSE: I have it here on my shelf somewhere.

ALTMAN: Do you? I'll be darn, well anyway, the conceptual JPA design, I did a circle on that. I thought we were working with procedural design.

RESPONSE: Where did you read conceptual?

ALTMAN: Page seven, first paragraph, third sentence.

RESPONSE: You know what, that's incorrect. It should be procedural.

ALTMAN: That's what I said.

RESPONSE: That's incorrect, it should be procedural, it's a typo.

ALTMAN: I said I thought we were working with the procedural type. Well good.

RESPONSE: Yeah, you read this.

ALTMAN: OK, *message logic*, maybe you were just testing me. Message logic defines the type of message and I don't have a problem with that. *Perceptual organization, principles of a Gestalt, I've got a great big HOW with a question mark. And I know what you're talking about, I'm just saying how are you going to do it?*

RESPONSE: Well, and again not to defend, the point of a model though is not which is brought up by some of the other experts is that the level of expertise of the designer is very important. *A model cannot provide you, unless you have a model just to go through, how you do proximity, how you do similarity.*

ALTMAN: Yeah, that gets so complicated. This could become extremely complex and bog down the JPA design. That was the point I was just wanting to defend. And I know you were working on that and I know you had gotten some data and some research and all that and it sounds really wonderful if basically if it looks good, its probably OK.

RESPONSE: You're right.

ALTMAN: OK, visual information and structure, I didn't have any reason to have a problem with that. Not a problem. *OK, literacy again, I got back to the visual literacy or what? And how about training and experience?* You know what are we defining as literate? The ability to read or the ability to do? I know what literacy means, but sometimes its not all the same. Visual continuum, I've got here, photo versus illustration. Color versus black and white.

RESPONSE: That's it.

ALTMAN: OK, here we are. How, how, how? How is the data going to be determined?

RESPONSE: OK, that's one of the potential problems of the procedural model of this nature, because it doesn't give you. . .

ALTMAN: It doesn't give you too many hows.

RESPONSE: As a matter of fact what you and I are doing right now is a formative peer review.

ALTMAN: My problem with it is it's like chili judging. Get another set of five judges and they'll come up with a different set of chili winners. Next page nine, field test. I don't have any problem with that except for one big old word, how?

RESPONSE: Oh, absolutely. And again this is not a cookbook.

ALTMAN: But wouldn't you want to give a suggestion?

RESPONSE: Probably would be another 100 pages.

ALTMAN: Don't tell them everything you see. I suggest that you do something else.

RESPONSE: Oh yeah. I don't think that should go into definitions. There are a set of definitions, you know and in the discussion of the definitions, I am going to have to talk a little about examples of how some things would be done.

ALTMAN: Yeah, anyway *revision, client approval, JPA production,* I say OK, OK, OK, and then in development, my evaluation, I just got one comment here and it says *retest.* I think what I meant was that you may need to re-evaluate it sometime after it has been put in place.

RESPONSE: Yep and that is the very last paragraph on page ten, on page eleven, which is the *confirmative evaluation.*

ALTMAN: I'm going to put you on hold real quick.

RESPONSE: Yep.

ALTMAN: Training, I've got rational OK. Relevance, OK. Confidence, OK. *Knowledge base unclear as to acquired knowledge base.*

RESPONSE: OK.

ALTMAN: So I don't know. The required knowledge base to effectively, what is it? And so I think a word needs to be put in there as to, they have to have another, to meet that other guy's level or proficiency, they had to start with some basic capability. So that's all, skills, OK. Limitation, I've got here *selective attention* and then I've got *salience* with a little question mark. I wasn't quite sure of what your use of that word meant.

RESPONSE: Well that's. . .

ALTMAN: I know what it means,

RESPONSE: Yeah, but in another words you need to KISS it a little bit.

ALTMAN: Exactly. Assumption's OK. *Training evaluation* and I've got here post test, behavioral, real time, real situation, written, what.

RESPONSE: Yep, sometime.

ALTMAN: So however you want to do it. Eleven, page eleven. Again here determine the means to most effective deliverance, OK I said that's video slides, handouts, whatever. Distribution, well in place and accessible like in a manual or in a closet.

RESPONSE: Exactly

ALTMAN: Where your going to put it? Confirmative evaluation, How? Nice words but, again now we're into, now we've got formative, summative, confirmative and I know this is out of your world, not mine. It just seems like another techno-babble.

RESPONSE: I understand.

ALTMAN: Implementation evaluation, adequacy of effort, I've got hhmm, OK. *Then evaluation, I've got another word there, it says assessment.* Summative, confirmative, informative were conducted during the analysis. That's cool. Summative, now see you're getting in there and you're starting to talk about summative now and telling about that. And I said OK. Target job performance. . . Determine if the JPA needs meets the requirements of the functional characteristics. And I put meets the objectives.

RESPONSE: OK, that's right.

ALTMAN: OK, shouldn't that be what that means?

RESPONSE: Yeah.

ALTMAN: So to me, you know I really love this stuff but again I put, maybe you got to go back to page four on here.

RESPONSE: Got it.

ALTMAN: OK purpose, not objective. Page 12, *suitability, I put applicable with associated equipment at the time of implementation*. If the JPA was designed for an equipment and situation, why wouldn't it be suitable?

RESPONSE: Research has shown that many times a thing has been produced, and put on the line, and it's out of date.

ALTMAN: Oh yeah sure, like a computer. So I just put complex. Validity, haven't we already been there done that? And haven't we already done the organization?

RESPONSE: Yeah but we're in summative. This is the summative evaluation, you've got everything done.

ALTMAN: Uhuh. . .

RESPONSE: You produced it, and you've got it in front of you the client. And Beau said alright, did we do this, this, this? And it may be nothing more than just what you're doing. We did this, let me see the data.

ALTMAN: OK, you're ability, I guess this is OK, this should have been discovered in the type of display I thought. But again your switching horses on me here.

RESPONSE: Yep, that might not be a bad place to put that.

ALTMAN: Check it out. Training requirements again. Have we been here already, is this an ongoing retest? Alright, then confirmative, OK at the very end, change as required.

RESPONSE: Mmhh.

ALTMAN: That's it.

RESPONSE: Thank you sir. How did you like the, did you have any comments about the graphic representations?

ALTMAN: No, I thought they were fine.

RESPONSE: OK.

ALTMAN: Yeah, I didn't see any problem with them. <u>You know probably because I'm assuming this is kind of like a closed loop thing and maybe on your wheel, your shaded wheel, you need a beginning and an ending</u>.

RESPONSE: Well, on the procedural model I have a start.

ALTMAN: Yeah, I see that, but <u>I'm thinking of the - maybe an arrowhead under start project. Or something.</u> It's not a big thing at all. Everything else looks like it, everything goes to the center eventually.

RESPONSE: Good, thank you very much for your excellent comments.

ALTMAN: Well I don't know if it did you any good. I'll stick this in an envelope and send it to you.

RESPONSE: OK, excellent comments.

ALTMAN: Well, hope it works.

Interview: K. Mosier
Sept. 19, 1997

RESPONSE: I have no questions, this is an evaluation of what I've sent you which means that you can fire away. I will bring up a couple of things brought up by some of the other subject matter experts in which you get to vote on.

MOSIER: Oh, I get to vote.

RESPONSE: Yep!

MOSIER: You have obviously been through this thoroughly so I don't have any substantive criticisms or anything like that. I mostly have typographical and organizational kinds of things.

RESPONSE: Sure, anything counts.

MOSIER: OK, well one thing is you never say anywhere *that a JPA is an automated aid, is it always automated?*

RESPONSE: No, it's not always automated and the way this study is going, and it kind of evolved after I sent everything off to everybody, is that **the way that it's going is that the conceptual model applies to a wide range of JPAs. That would include the automated aids, the paper aids.**

MOSIER: Most of the examples that you gave I thought were automated, the electronic checklist was one that you used.

RESPONSE: Then the procedural model is hopefully encompassing enough where it will lead the designer through the design phase regardless of really what the outputs going to be, the media's going to be. The third step is going to be a task specific procedural model which is going to end up being a paper JPA. The third model which will be an IT, instructional design, is called layers of necessity where you pull out the elements that are applicable by an experienced designer and I'm going to develop a task specific model and from it, an actual JPA, which will be tested in the simulator. But it is going to be for cabin safety versus a cockpit.

MOSIER: OK, I guess the reason that I say that is that for someone to use this you might want to make it clear that it could be used either for an automated aid and you probably do that in your paper.

RESPONSE: Mmhh.

MOSIER: OK, because from this I wasn't quite sure that you were conceptualizing it to be used for any kind of aid.

RESPONSE: Yea, OK, good point.

MOSIER: And um, lets see, the procedural design model, it looks..............

(The interviewee is calling back because of a bad connection)

RESPONSE: You were talking, we were on the procedural model.

MOSIER: Oh, ________________ the procedural design model, you seem to start the project, then are the steps meant to sequential or conducted in parallel?

RESPONSE: Well, this doesn't make it very clear does it?

MOSIER: There are arrows, so I wondered.

RESPONSE: You're about the fifteenth or sixteenth person who's said that. I'm thinking I am going to put a flow in there. What I was trying to get across and I'm glad its brought out, is that I was trying to use that iterative concept you were talking about, where everything overlaps and has an impact on everything else. And so instead of doing sequential steps like a waterfall like the Dick and Carey model, I was trying to reflect it with the oval gray circle. But others have said you need to have an arrow to indicate direction, so I think I'm going to go ahead and do that.

MOSIER: Right, and what you might want to do is, when you have the arrows, you can have the arrows that go from the center, perhaps they should go both ways, to and from the center.

RESPONSE: Oh!

MOSIER: Then that would make it, you know more iterative to go back.

RESPONSE: I like that, OK. Alright.

MOSIER: OK, and then um, lets see. I found a typo, do you care about that? Are you supposed to do the functional characteristic on that first page?

RESPONSE: Oh you mean on the............

MOSIER: The definitions. . . . That the JPA is supposed............

RESPONSE: Oh yea, I got that marked too, yep. Thank you.

MOSIER: OK, and then, lets see, I was kind of confused about *the overlap between Target Population and End-User.*

RESPONSE: That's your vote. Uh, this was brought up a couple of times. It has been suggested, Tony, pick one and I said O.K. how do I do that? They said, well have everybody vote. So the question is, what would you prefer to see used with a complete definition to it, Target Population or End-User?

MOSIER: Mmhh............target population, or end-user............*I'd probably go for Target Population.*

RESPONSE: OK, that's good. That's all I need to know there.

MOSIER: And then another thing, unless there is some kind of sequential thing the way that you ordered those.............

RESPONSE: Mmhh

MOSIER: I think because there are so many things under project analysis.......... I might want to like organize that into characteristics of people versus characteristics of the aid versus characteristics of the context.

RESPONSE: Very nice, thank you. O.K.

MOSIER: And that was all until you get to page three.... OK, the performance analysis, the component determines the desired performance of the JPA to pick.

RESPONSE: Oh, wait a minute, wait a minute. You're on page three.

MOSIER: Three

RESPONSE: Oh, got it!

MOSIER: Performance analysis, this component determines the desired performance of the JPA to pick.

RESPONSE: Mmhh....

MOSIER: Is that in combination with the human?

RESPONSE: Oh, lets see. What you're saying is the stem that leads you into the various elements of performance analysis is lacking. And it,........umm........

MOSIER: *Now are you talking about what specifically the JPA is supposed to do.....aid the human or what the end performance is on a human using the JPA?*

RESPONSE: End performance......

MOSIER: The end performance, probably you would want to have something in there in combination with the actual behavior.

RESPONSE: Yea, good, OK. Because, you know I'd have to stop and recollect, because I did this, you know two months ago. But I'm looking at the sub-elements, you know task analysis, task properties and time and risk assessment.

MOSIER: Right....

RESPONSE: As to the actual behavior.

MOSIER: Right......

RESPONSE: O.K. good!

MOSIER: And at the bottom of that page with respect to risk assessment, do you want to have anything about risks of violating operation constraints?

RESPONSE: Would you say that again?

MOSIER: Risks of violating operational constraints.

RESPONSE: Yes, I think we should put that in there. Mmhh.

MOSIER: OK, on to the next page. So, lets see. *Goals and functional characteristics.*

RESPONSE: O.K.

MOSIER: *Seem to be very similar.*

RESPONSE: Mmhh, that was brought up before I believe.

MOSIER: And um, a couple of times you're using the same term under different aspects of the model.

RESPONSE: Oh, OK.

MOSIER: Is that deliberate?

RESPONSE: No. That's just poor terminology on my part.

MOSIER: OK, because *I noticed that the functional characteristics that you define here is different than the functional characteristic under, um, lets see .... where is it under design criteria.*

RESPONSE: OK

MOSIER: I don't know if that would, you might want to make it deliberate and have it define something that, you know related things but slightly different depending on where it is in the model.

RESPONSE: Mmhh....lets see. Uh, well, I have to look at that because I'm looking at it now and. . .

MOSIER: *It's also true about literacy and you said that more than once.*

RESPONSE: OK. I will review those. Umhh..

MOSIER: A, moving on, page five.....

RESPONSE: Mmmhh.

MOSIER: *Compatibility, you don't say anything about integration of JPA*, you might want to address that.

RESPONSE: Yes ma'am. You're not the only one that's said that. Boy, great minds go in the same direction, don't they? Good, OK, yes, that will be addressed. Another SME referred to it as *intercompatibility*.

MOSIER: And also, do they know what each other are doing?

RESPONSE: Yes.

MOSIER: OK, moving on to page six, you have an extra comma.

RESPONSE: Yep, under motivation, I have it circled here.

MOSIER: OK, and then I wondered, when you say "define the factors that will enhance the probability that the end-user will effectively use the JPA under *motivation*. . .

RESPONSE: Mmhh.

MOSIER: OK, I was confused about *what you mean by effectively*. Do you mean with good results?

RESPONSE: Yes

MOSIER: OK, because. . .

RESPONSE: So that should be spelled out clearer?

MOSIER: Yes, because I thought it might mean in situations when you want it to be used.

RESPONSE: To form an accordance, I'm just jotting myself a note, with desired JPA or desired behavior or something like that. OK.

MOSIER: Oh, that was another one where you. . .

RESPONSE: Where was it? Oh yea. . .

MOSIER: And then I thought your evaluation stuff was uh, you know for turning in an evaluation, you did address, way on page ten, you did address limitations.. . and included them in there, and you did do a long term follow up, an confirmative evaluation which I thought was really necessary.

RESPONSE: OK.

MOSIER: And you did address all the components that I would have, you know everything that I could think of.

RESPONSE: Good.

MOSIER: So all the parts about implementation I thought, you know they were fine.

RESPONSE: Super!

MOSIER: Yes, the model looks good.

RESPONSE: Its getting' there. There's going to be some changes to it. Let me ask you a couple more opinions, and I don't want to keep you too long, because this is your nickel and I feel really bad about that.

MOSIER: Don't feel bad.

RESPONSE: Looking at the procedural design model again, um, at the 6:00 o'clock position, there's a component that says "synthesis".

MOSIER: Yea.

RESPONSE: Ah, one or a couple of the panel members didn't really care for that component. One of them suggested that, are you familiar with the term "rapid prototyping?"

MOSIER: Uh, sort of, it means that you come up quickly with something that's not perfect.

RESPONSE: Right!

MOSIER: Modified and kind of in process.

RESPONSE: In process, right. One of them suggested that the block, they said the elements of synthesis, when they were referring to the definitions, really is a rapid prototyping phase, and perhaps that component should be rapid prototyping. Another one of the experts suggested that if we are going to include rapid prototyping into the model, it should go before performance analysis up at the 1:00 o'clock position. Because the four components; performance analysis, design criteria, perceptual design and message design are actually components of rapid prototype. I'm not really sure how to address that. I just wanted to know if you could venture an opinion on that.

MOSIER: Well, I'm not an expert in rapid prototyping. It seems to me that umm.....if you wanted to do that, you could do that. But then you're leaving out the issues about the goals and objectives and organizations.

RESPONSE: Right.

MOSIER: What you might, well you could put that in as a rapid prototyping.

RESPONSE: One of the thoughts I had, see how this sounds to you. Was take the four components I just named; performance, design, perception and message, and somehow graphically, and I'm not sure how to do this just yet. But graphically connect them with some type of visual symbol that would, as an alternate course of action, a rapid prototype phase.

MOSIER: Right!

RESPONSE: Does that make sense?

MOSIER: No, I don't know. I think I would use the performance analysis to feed into a rapid prototyping.

RESPONSE: OK.

MOSIER: And then, your components might be the design criteria.

RESPONSE: OK, that makes sense. Alright, OK.

MOSIER: That would make more sense to me. But again, as I said, some of the people that you're talking to make be more experts on that than I am.

RESPONSE: You'd be surprised at the interesting things that you find, the things that come up with some of the people on the panel are instructional designers, some are with your type of background. When you feed off of both of them, its amazing what comes out. I mean, it, (laugh) this is going to work. So, OK, got anything else pressing? I mean really.........

MOSIER: That was, no, I mean most of my things that I've said, there's nothing real substantive. It's all you know kind of, it's clarity, kind of.

Interview: R. Westrum
Sept. 11, 1997

WESTRUM: OK, now lets deal first with figure 3 here. The JPA conceptual design model. Is there any direction to the circle?

RESPONSE: No, it is supposed to reflect an iterative process where this is not really a procedural model. It is supposed to reflect merely the variables identified that influenced the design. So there is not supposed to be going around in any particular order.

WESTRUM: Well, I would eliminate the circle altogether then. I'd just have the arrows going into the JPA procedural model.

RESPONSE: OK.

WESTRUM: You've got a part of the diagram which doesn't mean anything and that's why its good to eliminate

RESPONSE: Very good sir. I like that , mmhh

WESTRUM: Yeah now on the same chart where it says display, we don't have information arrangement, and that may or may not be a weakness but that's something worth thinking about.

RESPONSE: OK would you just give me your definition of information arrangement?

WESTRUM: Yes, *the graphical form in which the information is organized.*

RESPONSE: OK the hierarchy, etc. things like that? The visual structure, organizational structure?

WESTRUM: Yep

RESPONSE: OK, lets see, correct, very good sir.

WESTRUM: OK, now the other notation I made on this chart was on target population under analysis.

RESPONSE: OK, got to find it here.

WESTRUM: *I just wrote down needs more elaboration.* But I suppose that's true of all the things, they're all the headaches.

RESPONSE: One of the comments from one of the other SMEs was that under target population to put skills and attitudes to follow the term.

WESTRUM: Yeah, yeah.

RESPONSE: Do you like that?

WESTRUM: Yeah, and in some cases you might even thing about institutional or organizational history. Because that may affect how they respond to stuff that they get.

RESPONSE: Very good sir.

WESTRUM: Now on this next chart. . . On this next chart you do have an order, I believe. But there's no arrow indicating the order.

RESPONSE: OK, very good, yes, you're right. That was brought up by others to give a direction to go. I didn't show it I should show it.

WESTRUM: OK that's a missing element. OK, under *message design*, and I'm sure there's innumerable comments we can make about all this stuff. You need to have something about a, what I call redundancy or inherent checking of the message so that there are parts of the message that reinforce each other.

RESPONSE: OK

WESTRUM: Cause you've got message logic, perceptual organization, visual information structure which is essentially what I said previously. Literacy, ...but it doesn't really talk about redundancy, lets see and again what I said, self checking properties of the stuff. That would make an error stand out. I've been reading a book on anesthesia machines and how people make mistakes about which know to turn. And so I think about issues like them.

RESPONSE: Um, OK, this is very good. This is something new. I like that.

WESTRUM: OK

RESPONSE: You want to just give me a quick example of what they're saying about the knobs on the machine.

WESTRUM: Sure, on the problems of anesthesia machines, up until 1980, there was no International standard form of color coating, so the oxygen knob, obviously the most important one, it some cases it would be blue and in other cases it would be green. You can imagine what kind of problems that led to including some deaths.

RESPONSE: Would another term for redundancy, would *standardization* fit the mold of redundancy?

WESTRUM: No, because *standardization* simply implies this is the same between apparatuses in separate places. Although standardization is a big issue... But that's a different issue than the one I mentioned. The one I mentioned essentially would allow you to spot if different parts of the message or different parts of the, what am I trying to say here... What I'm trying to say is the job aid should encourage the person to make a check about the decision they've made so that the one part of the job aid would call for them to do something and the other part would allow them to check.

RESPONSE: Not to digress, under design criteria, where you see about half way down it says *transparency*?

WESTRUM: Yeah

RESPONSE: That's little bit about what the other person was talking about similar to what you were describing. But I like the idea of placing another message design factor there.

WESTRUM: In other words you want to get away from the single thread design. Where everything has to go exactly right and there's no step to check exactly what you've done.

RESPONSE: Got it

WESTRUM: So the message has to say something like you know, after you turn the thing look at the pointer, it should say X.

RESPONSE: OK, you get to vote here by the way. Uh, let me see if I can find it here. If you look under project analysis where it says start project............

WESTRUM: Yeah....................

RESPONSE: I have target population and I have the term end-user. It's been suggested that to use one term only, because in the definition section, I don't know if you got to read them all but it was confusing to some of the evaluators and they suggested picking one. I said what do you prefer? So I'm asking for your vote.

WESTRUM: No, *I think target population is better. End-user could be the organization that employs a person that makes the decision that's using the aid.*

RESPONSE: OK

WESTRUM: OK, moving onto the procedural job performance aid, design model. OK now there's an innumerable number of things that one could say about this but I'm just going to hit some highlights.

RESPONSE: Good

WESTRUM: Page one under functional characteristics. It says JPA "suppose" and there should be a "d" there.

RESPONSE: Oh, OK. If we go, let me turn you back to the design model again, the procedural design model. Another suggestions made, under the step of synthesis, it has been suggested to refer to that as rapid prototype/synthesis. And I don't know if you're familiar with rapid prototyping but...

WESTRUM: Yeah, synthesis is a bad word for it, it also appears to me that this particular step, at least my impression was that this particular step was not as well thought out as some others.

RESPONSE: OK.

WESTRUM: And what's under it is what I could describe as a conjuree of stuff which didn't fit somewhere else. So synthesis is not the right word. I certainly agree with that.

RESPONSE: OK, I think I'm just going to replace that with the rapid prototyping step which makes a lot more sense.

WESTRUM: Yes, uh, under target population, moving along on these definitions here. Uh, one of the things you don't mention is *cognitive orientation* and I'm not entirely sure what I mean by that but it might mean something like the Myers-Briggs orientation. It might mean, you know are we looking at predominantly visual people or people who are oriented for hearing things or so forth. If you're dealing with engineers, then the job aid probably needs to be visual because engineers tend to be more visual in things.

RESPONSE: Mmhh.

WESTRUM: But I think that is one of the issues, *what is the preferred channel by which the thing is going to operate as far as the target population is concerned?*

RESPONSE: That's OK, good.

WESTRUM: Next page here. Um, under *information properties, you say that it constantly changes. I would say that it's required updating.*

RESPONSE: OK

WESTRUM: It isn't that the information, yeah, constant change is one possibility, required updating is another issue.

RESPONSE: OK

WESTRUM: One of them may be something like a momentary change while the other would be weekly or longer, longer time frame change.

RESPONSE: This came out of one of the human factors books, where the article was on dynamic versus static information. And they used an altimeter as dynamic information.

WESTRUM: Right but there might be other things, for instance, where a calendar might be more appropriate. The issues is do you need something that is extremely time dependent like an altimeter? Or you know, some other.

RESPONSE: Oh hey, that's the magic word, how about time dependent, time dependence.

WESTRUM: Yeah, I was just reading an article on, you know taking a bearing on a ship, you know and it's a much more leisurely process than it is with an altimeter. But nonetheless. OK, moving on to the next one here, you had procedures and compliance. I think *you should simply call this compliance with rules and regulations, because that's really what it is.*

RESPONSE: OK.

WESTRUM: And the next one where it says *environment*, umh, you really need to have a determination of the probable and possible so *you want both the mean and the range of conditions in which the job performance aid will be used.*

RESPONSE: A comment made by someone else was to include another block social environment.

WESTRUM: Uh, good idea.

RESPONSE: OK,

WESTRUM: Well, why don't you just simply call it *social environment*?

RESPONSE: OK

WESTRUM: Another thing I mentioned here is *availability of outside checks.*

RESPONSE: Under environment

WESTRUM: Yeah, I mean for instance if you're in an airplane, you can check by looking out the window. If you're in a submarine, your pretty stuck with probably whatever you've got. But that's definitely an environmental thing.

RESPONSE: Absolutely, very good.

WESTRUM: Under context, I would call it what you've got as situational context as opposed to organizational context. *Environment and context. . . you really need to define each one more closely.*

RESPONSE: OK.

WESTRUM: OK, alright lets see here. I'm going to skip over some pages, to page four here.

RESPONSE: OK.

WESTRUM: In under *adhere*, I suggest you call it *flexibility* and I actually rewrote this and what you've got is a terrible sentence. *A determination of how likely it is that the end-user can or will deviate from the JPA displayed procedure.*

RESPONSE: Thank you

WESTRUM: But I think this is a key point is that there are really two things that you've gotten here. One of them is will the person survive if they *deviate*, but the other thing is what are the behavioral forces that are likely to get the person to deviate. I mean are the rules such that the person's not likely to follow them or did the population users likely to deviate just on general principles. . .

RESPONSE: Mmhh.

WESTRUM: *Formative* has to do with the design process but it wasn't transparent to me, this occurs in virtually all these things here. So maybe formative isn't the right word.

RESPONSE: I'm going to stick with formative.

WESTRUM: Its part of the language of the trade.

RESPONSE: Right and its not defined for you of course in these little definitions but it's defined in the body of the text. So I should have provided everybody a — there's where an assumption. . . everybody knows what that is — well everybody doesn't know what that is.

WESTRUM: Page five, middle of the page. Under *compatibility*, this is really the compatibility of aids so you should. . . what I'm always in favor of labeling stuff for what it is. Aids compatibility is really what you're talking about or aid *intercompatibility* as the case might be.

RESPONSE: Aid intercompatibility. OK.

WESTRUM: Alright lets see here where I was. Next page I didn't have any comments. . Now under message design on page seven. Under perceptual organization, you say the application of principles of Gestalt applied to message design. I think Gestalt is a distracter here. Really what you want to talk about is the. . . or maybe what you want is a small g or something. . . What you're really talking about is the *perceptual organization* of the visual organization here?

RESPONSE: Yes, visual organization. Maybe that's the term I should use.

WESTRUM: And not all job aids are visual.

RESPONSE: Yeah, well correct.

WESTRUM: Because you've got visual organization and structure below it. But under visual organization structure you have everything but what I would call the arrangement and flow of messages.

RESPONSE: See now that's where the perceptional comes in. Yeah, that's where the arrangement flows.

WESTRUM: You've got things like fonts and type sizes and so forth and headings and so forth but it doesn't talk about the special arrangement of the stuff on the page or the tag or whatever you've got.

RESPONSE: Yeah, that's what my intent was, those elements you were just speaking of , that's what falls under perceptual organization. That's what figure and ground, proximity, closure, connectiveness have to do with it.

WESTRUM: Maybe that, ok, so well I think you should just save the space or graphic or special arrangement of the stuff rather than....cause you mentioned all the features, proximity, similarity, continuity, closure, connectiveness.

RESPONSE: OK.

WESTRUM: OK this is where a Tufte came into my thinking. He's got a third book you know.

RESPONSE: No, I didn't know that.

WESTRUM: OK, here I'm moving right along to page nine. I'm down.....under revisions, it says this element allows for revisions to any discrepancies. Well you don't revise a discrepancy, you correct it.

RESPONSE: You know what I'm finding , this process is really worthwhile. It really works when you're developing something like this.

WESTRUM: OK

RESPONSE: Getting a half a dozen or more thoughts. . .

WESTRUM: Oh yeah, essentially a Delphi process when you think about it.

RESPONSE: Yeah, mmhhh.

WESTRUM: OK under, on page twelve,

RESPONSE: I didn't know that section had that many pages. Alright I'm there.

WESTRUM: *Well the thing that you left out is the likely forms of error. This is very critical.*

RESPONSE: OK.

WESTRUM: This is a key point about the way the job aids need to be designed.

RESPONSE: OK, now where do you see that falling in?

WESTRUM: Uh, well, its under evaluation. And if you've got stuff from what you call formative evaluation, or I would actually call it a beta fighters, a beta fight minus one or something. You ought to have some data on how things have gone wrong.

RESPONSE: Error tracking, or what did you call it?

WESTRUM: The forms taken by *error or error forms* I guess would be the phrase that would be similar with what else you've got here.

RESPONSE: Got it, I'll find a place to plug that in.

WESTRUM: Now, what is likely to go wrong with the job aid because that will tell you . . . how the next generation job aid should be designed to avoid errors.

RESPONSE: What is likely to go wrong or what has been found to go wrong?

WESTRUM: What has been found to go wrong.

RESPONSE: What's been found to go wrong. OK.

WESTRUM: I mean presumably, if it's likely to go wrong you would have designed it out of the aid.

RESPONSE: That's where rapid prototyping should solve that problem, and you know what? Error forms, that's where it should go, under the rapid prototype when they plug that in.

WESTRUM: That's great, and that's all my comments. . . I think it's really interesting, I think what you've got is really long there and I think one of the things you might think about is simplifying the number of steps you've got.

RESPONSE: Well my idea is that my process will work. The conceptual model of course is theoretical, the procedural model, the idea behind it, its intent is to depict or reflect all the possible steps that could be implemented and then you use what's called like a layers of necessity concept. You now go in there, based on your task specificity, and you draw the elements and you create a task specific model, drawn from the procedural model. And that's what I'm going to end up doing in the dissertation.

WESTRUM: Yeah, I think this is very promising.

RESPONSE: Thank you.

Interview: G. Miller
Sept. 12, 1997

MILLER: You know it's incredibly thorough. You know I mean it's more than I can even.....obviously I think it's a lot more than I even take into consideration, doing what I do. It's very thorough. You know I don't see anything on here. I've gone through it, as a matter of fact I've had to read it twice to try to understand it. You know some of it I do, especially in terms of the design criteria you know. But a lot of it Tony is beyond me. I mean in terms of really analyzing what you're doing. You're much more in depth than I am and I get sort of like left behind. But I know that it's not written for me, you know.

RESPONSE: But I want to emphasize to you though that even though you may feel that some of the stuff is beyond you it really isn't. If we had time to sit down and walk through it, you know step by step, you'd go "Oh yeah, I know what you're getting at." And I know it would, I think it would make a lot of difference.

MILLER: Yeah, the concept, I think I can grasp the concept if we did have time to do that. I would know, but I've read it twice and....

RESPONSE: See now the idea, what the ultimate use is, lets say if you were going to adopt the final version of the model, you would not use that very complex procedural model. The idea is the designer then, based on this expertise goes in to the procedural model and selects those elements that are applicable to the specific task. It's kind of like a layers of necessity, in other words, how deep do you want to go?

MILLER: Yeah, I could see that, because I guess I could see it from the standpoint that I saw items that related to how I go about doing things and things that I don't relate to at all, on terms of how I....what I do. Then I know that over the years and through the experience that I've gained in this industry doing what we do, I have created my own. It's sort of like __________ and some of these things come out of this. You know where you send something out and you get feedback or there may be a time when you have revisions because you can go along doing something over and over and over again, and assuming that it's right you know or assuming that it's the best way. Then all of a sudden......boom! You know, somebody comes up in **authority**, lets put it that way you know. Beyond just a customer thing, I don't like that, you know. Someone in authority and that's something that's very interesting and I've recently run into it as that, here is an illustration. One simple illustration I'd think is like ten years old and it's very plain, always been very plain to everyone that I've talked to about it. And I have never gotten a complaint about it and now here's someone who says this is unclear. And this person, here's the kink in your model. You've created this but then you go out to that one other area of expertise that happens to have weight. You know in terms of regulatory weight and that person is the person who your customer has to have approval from.

RESPONSE: Got it, loud and clear.

MILLER: You know and then all of a sudden you have to go back and change a perfectly good drawing because you're not going to sit there and get into an argument with this person. So there's an effect on a communication device, meaning this illustration, that really isn't relevant. It's strictly interpretation and **personal opinion** but the level of which it comes from forces the change.

RESPONSE: You know you just made a wonderful contribution to the conceptual model which... the conceptual models are the variables and affect design and this idea personal interpretation from someone in power, is an excellent little...................

MILLER: Yeah. You have to make everybody happy, you have to play **politics**. I could sit there and argue it conceptually and the transference of information on a conceptual basis, I could argue that with that person. But all it does is make that person upset with me and makes that person upset with the carrier who is my customer.

RESPONSE: You bet.

MILLER: I simply can't do it. I have to bite my tongue and act like a good little boy and try to come up with something that I can accept. You know I may come up with a second drawing that's very useful but.....you know I also may be spinning my wheels to try and satisfy somebody.

RESPONSE: That's an excellent point Greg, excellent. Hey the one thing I wanted you to vote on....I don't know if you've had a chance to look at the definition components. But I used a term, two terms. I used the term target population and I used the term end-user. The other panel experts all said, pick one, don't use them both. And so I'm putting to a vote, what would your preference be in a model? The term target population or term end-user?

MILLER: *I think in a model I might use the term target population.*

RESPONSE: OK, that's. . .

MILLER: You know I think when you actually created the job performance aid itself, you might, because I think what you're doing is going from conceptual model and then defining it and sending it out and getting right down to the aid, you might become more specific and say end-user.

RESPONSE: OK.

MILLER: But at this point I would, my first blush is target population.

RESPONSE: OK, I don't know if you have that model in front of you by any chance.

MILLER: Yeah, uhuh.

RESPONSE: But on the procedural design model , at the bottom it says synthesis, that block. Well I had some good feedback from other experts and they recommended that I replace that block with another block that is called rapid prototyping. I don't know if you're familiar with the term.

MILLER: No, a no I'm don't ....

RESPONSE: You probably do it all the time. That's where you actually before the project is complete. You go through production and everything and printing. You're actually build a pilot.

MILLER: Oh sure.

RESPONSE: And then it goes out for feedback, testing and this type of stuff and they suggested that I replace the synthesis. They also did the same thing, they also said about the same thing......it really is just kind of hanging there. It doesn't really mean anything and the idea came up to substitute rapid prototyping which involves organization, target population and performance.

MILLER: Yeah, I think the word *synthesis* to me seems to mean it's all boiled down to this. This is the compilation of everything, this is the synthesis and it may be too closed in for words.

RESPONSE: OK.

MILLER: *Rapid prototyping* is more like, describes and ongoing process rather than an end result.

RESPONSE: OK, you got anything else?

MILLER: No, glad I could help.

APPENDIX G

Subject-Matter-Expert Evaluation Package:

Second Round Formative Evaluation

[date]

Name
Address
City & State

Dear *recipient*:

To begin, let me first thank you for your time and effort in assisting me with this project. Your expertise and suggestions have provided me with a wealth of information. Thank you so much.

Please review the enclosed materials. This is the last (and hopefully final) round of the formative evaluation. If you concur with the results, you can advise me by E-mail. If you have further comments, you can also advise me by E-mail and I will arrange to telephone you for a further discussion.

Enclosed you will find the revised Job Performance Aid (JPA) models and a revised list of procedural model definitions. In the event that you misplaced the original package I sent you, I have included copies of the original conceptual and procedural models so that you may compare the changes made. The following is a brief description of the revisions made. The revisions were based on an analysis of the comments made by you and the panel of experts.

The JPA Conceptual Design Model

- The title of the model was revised to reflect a "generic" model that is applicable to a wide range of JPA designs and not just to "high risk" situations.
- The sub-title was changed to state "variables that influence..." in the place of "variables that provide..."
- The gray circle that connected the model's components was removed as the analysis indicated that it was confusing and added clutter.
- The descriptors for the applicable components were revised to use the term "variables" instead of "factors."
- Under the JPA REQUIREMENT component, "performance failure" was added as an element.
- Under DESIGNER EXPERTISE, the element of "requisite imagination" was added. A number of comments addressed the influence of the designer's imagination and the selected term is based on the past work of one of the panel members.
- Management expertise was added to the MANAGEMENT component. Additionally, the element of "evaluation processes" was removed.
- A sub-bullet titled "skills and attitudes" was added to the element of "target population" under the ANALYSIS component.
- The descriptor for STRATEGY was changed to more accurately define the purpose of this component. The element of "user perceptions" was revised to "target population perceptions." After considerable contemplation, I finally elected to use the term "target population" throughout the study. This was a tough call. There was not a clear majority reflected by the panel regarding "target population" or "end user." I hope you concur.

- The element of "information arrangement" was added to the DISPLAY component.
- The elements of the EVALUATION component were revised to simplify presentation. The types of evaluation were removed but are referenced in the JPA procedural model.

The JPA Procedural Design Model

- A sub-title was added to the main title that more accurately defined the purpose of the model.
- The gray circle was replaced with arrows that reflect the flow of the model.
- The element of "evaluation" was removed from each component and replaced with a large arrow that reflects the formative evaluation process flowing from the PROJECT ANALYSIS component to the DEVELOPMENT component.
- The center of the model was revised to reflect the JPA conceptual model as a whole versus a detailed representation.
- An End Project block was added.
- The SYNTHESIS component was eliminated.
- The TRAINING component was moved to precede the DEVELOPMENT component. It was concluded that much of the training design should take place before the implementation of a field trial.
- The graphic presentation of the PROJECT ANALYSIS component was revised to visually organize the elements.
- The elements of "project initiation, task identification," and "population characteristics" were added to the PROJECT ANALYSIS component. The elements of "performance need, end user," and "literacy" were removed. Additionally, the element of "procedures and compliance" was revised to "compliance."
- The elements of the PERFORMANCE ANALYSIS component were revised to more accurately address task identification and performance criteria including the factor of time.
- The elements of the DESIGN CRITERIA component were revised to more accurately define the procedural steps for this component. The element of "format strategy" was placed last in this component.
- The term of PERCEPTUAL DESIGN was changed to PERCEPTUAL FACTORS. The element of "action logic" was revised to "task logic."
- The element of "visual information structure" was removed from the MESSAGE DESIGN component as its function is covered by the element of "perceptual organization." Additionally a new element, "redundancy," was added. Please see the list of definitions for explanation.
- The element of "practice" was added to the TRAINING component.
- The element of "final formative evaluation" was added to the DEVELOPMENT component. It is the ending point for the Formative Evaluation Arrow.
- The Component of ASSESSMENT was changed to EVALUATION. The elements were revised to more accurately reflect the steps that make up this component and simplify presentation.

A suggestion was made during the formative evaluation to consider adding "rapid prototyping" as a component or alternate component to the model. After reviewing the comments of the panel, it was decided not to do so. I did not wish to include arguments for or against in this letter, but this subject I felt deserved it. My conclusion was primarily based upon the comments made by one of the panel who has and continues to study expertise and model development. The JPA procedural design model is linear in nature and to include rapid prototyping would require a "different conceptual framework."

List of Definitions

There was considerable revision to the element definitions. An attempt was made to synthesize the perspectives presented by the panel members representing the fields of instructional technology and human factors. Please note the elimination of "end user" and the selection of the term "target population." The entire list is provided for your review.

Another Word of Thanks

I know that your time is valuable and I cannot emphasize how much I appreciate your efforts. Thank you once again. Please advise me as soon as practical as to your findings. I sure want to get this done. I'd like to finish before they have to send my diploma to the "old age home."

Sincerely,

Anthony J. Adamski

AA/ta

Enclosure: 5 (1) Original Conceptual JPA Design Model,

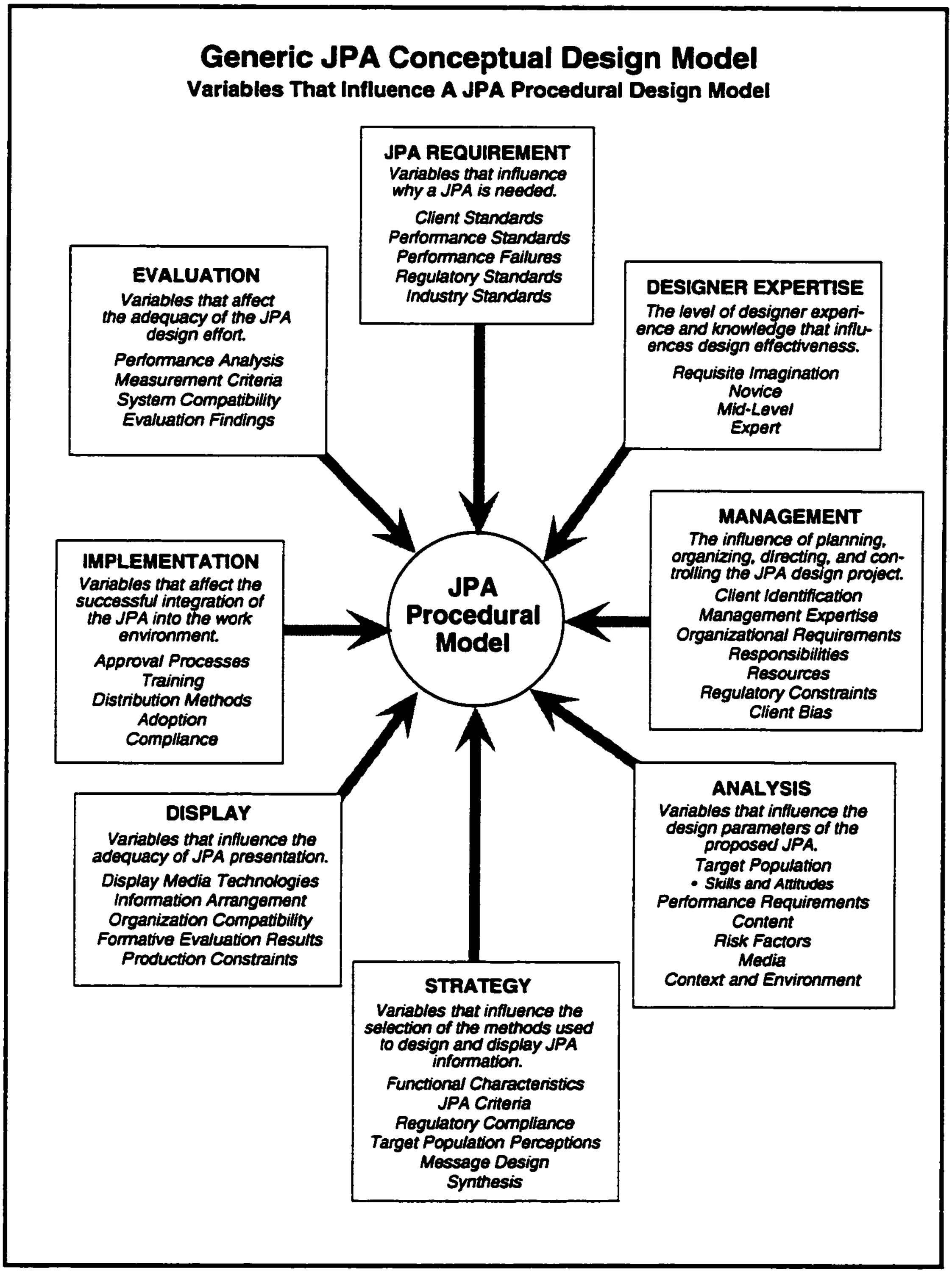
(2) Revised Conceptual JPA Design Model,

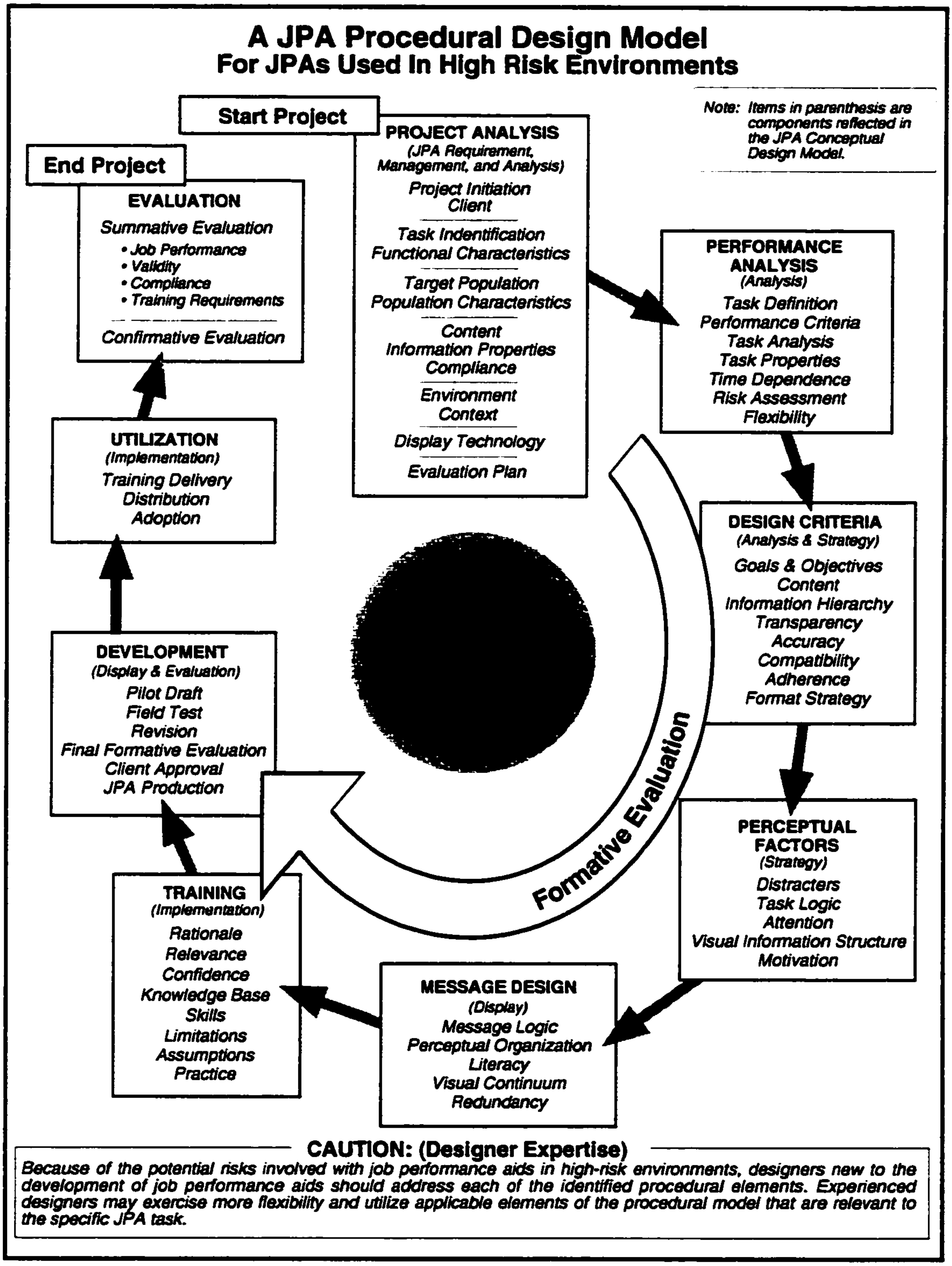
(3) Original JPA Procedural Design Model,

(4) Revised JPA Procedural Design Model, and

(5) Revised List of Definitions.

Note. The original conceptual and procedural JPA design models are not presented in this appendix to conserve space.


Generic JPA Conceptual Design Model
Variables That Influence A JPA Procedural Design Model
JPA REQUIREMENT
Variables that influence why a JPA is needed.
Client Standards
Performance Standards
Performance Failures
Regulatory Standards
Industry Standards
EVALUATION
Variables that affect the adequacy of the JPA design effort.
Performance Analysis
Measurement Criteria
System Compatibility
Evaluation Findings
DESIGNER EXPERTISE
The level of designer experience and knowledge that influences design effectiveness.
Requisite Imagination
Novice
Mid-Level
Expert
MANAGEMENT
The influence of planning, organizing, directing, and controlling the JPA design project.
Client Identification
Management Expertise
Organizational Requirements
Responsibilities
Resources
Regulatory Constraints
Client Bias
IMPLEMENTATION
Variables that affect the successful integration of the JPA into the work environment.
Approval Processes
Training
Distribution Methods
Adoption
Compliance
JPA Procedural Model
DISPLAY
Variables that influence the adequacy of JPA presentation.
Display Media Technologies
Information Arrangement
Organization Compatibility
Formative Evaluation Results
Production Constraints
ANALYSIS
Variables that influence the design parameters of the proposed JPA.
Target Population
• Skills and Attitudes
Performance Requirements
Content
Risk Factors
Media
Context and Environment
STRATEGY
Variables that influence the selection of the methods used to design and display JPA information.
Functional Characteristics
JPA Criteria
Regulatory Compliance
Target Population Perceptions
Message Design
Synthesis



A JPA Procedural Design Model
For JPAs Used In High Risk Environments
Note: Items in parenthesis are components reflected in the JPA Conceptual Design Model.
Start Project
PROJECT ANALYSIS
(JPA Requirement, Management, and Analysis)
Project Initiation
Client
Task Indentification
Functional Characteristics
Target Population
Population Characteristics
Content
Information Properties
Compliance
Environment
Context
Display Technology
Evaluation Plan
PERFORMANCE ANALYSIS
(Analysis)
Task Definition
Performance Criteria
Task Analysis
Task Properties
Time Dependence
Risk Assessment
Flexibility
DESIGN CRITERIA
(Analysis & Strategy)
Goals & Objectives
Content
Information Hierarchy
Transparency
Accuracy
Compatibility
Adherence
Format Strategy
PERCEPTUAL FACTORS
(Strategy)
Distracters
Task Logic
Attention
Visual Information Structure
Motivation
MESSAGE DESIGN
(Display)
Message Logic
Perceptual Organization
Literacy
Visual Continuum
Redundancy
TRAINING
(Implementation)
Rationale
Relevance
Confidence
Knowledge Base
Skills
Limitations
Assumptions
Practice
DEVELOPMENT
(Display & Evaluation)
Pilot Draft
Field Test
Revision
Final Formative Evaluation
Client Approval
JPA Production
UTILIZATION
(Implementation)
Training Delivery
Distribution
Adoption
EVALUATION
Summative Evaluation
• Job Performance
• Validity
• Compliance
• Training Requirements
Confirmative Evaluation
End Project
Formative Evaluation
CAUTION: (Designer Expertise)
Because of the potential risks involved with job performance aids in high-risk environments, designers new to the development of job performance aids should address each of the identified procedural elements. Experienced designers may exercise more flexibility and utilize applicable elements of the procedural model that are relevant to the specific JPA task.

Job Performance Aid (JPA) Procedural Design Model
For Use In HRHR Organizational Systems:
Revised Component and Element Definitions Based On First Formative Evaluation

Project Analysis

This component defines the purpose of the JPA, the type of audience, the job or performance requirement, the environment in which the JPA will be used, and organizational factors that affect JPA design, development, and implementation.

The analysis component consists of the following elements:

Project Initiation: This element defines who initiates a JPA project and why. For example, the initiator may be an organization such as an aircraft manufacturer that requests the development of an aircraft checklist, a regulatory body such as the Federal Aviation Administration that requires the development of a passenger safety information card, or an individual such as an airline safety director who identifies a gap in performance.

Client: This element defines who holds the ultimate authority for the JPA design project. It specifies who the decision makers are regarding project approval, control of resources, and application of evaluation results. The client may or may not be the project initiator.

Task Identification: This element defines the task(s) that the JPA is to display. This element examines gaps in actual performance or potential gaps in performance. It provides the background information and framework to define the functional characteristic of the JPA.

Functional Characteristics: This element defines the purpose of the JPA. It answers the question, "What is the JPA supposed to do?" For example, is the JPA intended to assist the decision making process? Is the JPA intended to depict the steps of a rarely performed task? Is the JPA intended to serve as a memory device for a simple or complicated task? Or, is the JPA intended to provide alternate courses of action when faced with a specific situation?

Target Population: This element defines the specific segment of the applicable organization's population for which the JPA is intended. It defines the task performer who will use the JPA. For example, the target population could consist of only pilots or only of flight attendants, or the target population could consist of a flight crew which is made up of pilots and flight attendants. Additionally, this element includes a determination of whether the JPA is intended for use by an individual, by a team, or both.

Population Characteristics: This element gathers data on the characteristics of the intended target population. User characteristics include skills and knowledge, attitudes, and levels of visual and textual literacy. The determination of the level of visual and textual literacy of the target population assesses the population's level of comprehension and provides a means to reduce the potential for procedural misinterpretation. Additionally, it assesses the influence of cultural and language differences if applicable.

Content: This element determines what content information is required to complete the task and what content information sources will be used. This element also determines the kind of information that will be displayed (e. g. , quantitative, qualitative, warnings, signals, system status).

Information Properties: This element determines whether the type of information that will be displayed in the JPA is static or dynamic. Static information, such as the information displayed in a printed trouble-shooting guide, does not change. Dynamic information, such as the information displayed in an automated electronic aircraft checklist, is susceptible to change or requires up-dating.

Compliance: This element determines the rules and regulations that the JPA must meet, including equipment manufacturer specifications, government regulations, organizational policies, and any other applicable regulatory constraints.

Environment: This element determines the physical and social environment in which the JPA will be utilized. It examines the probable and possible physical work conditions to determine both the mean and the range of conditions in which the JPA will be used. Physical conditions include such factors as lighting, noise, vibration, external cues, and physical accessibility of the JPA. Additionally, it examines the probable and possible social conditions in which the JPA will be used to determine if the JPA will be used on an individual basis or in a group setting.

Context: This element is an analysis of the range of circumstances under which the JPA will be used. The context element defines whether the JPA will be used in normal operating situations or emergency operating situations or a combination of both.

Display Technology: This element determines the technology that will be used to present the JPA based upon the analysis of the previous elements (e. g. , an automated electronic checklist, a printed operations manual, a printed trouble-shooting guide, a visual and audio warning device).

Evaluation Plan: This element determines the evaluation processes that will be employed during and after the JPA project. It addresses the means to focus on the evaluation processes, reach a state of agreement between the client and the designer, and establish the criteria for project evaluation.

Formative Evaluation

This component is reflected as an ongoing process throughout the JPA procedural design model. It begins with the completion of the project analysis component and ends as an element of the development component. Its purpose is to evaluate each component of the model as each element is completed, determine any corrections necessary, and determine if any corrections have an influence on previously completed design activities.

Performance Analysis

This component defines and determines the desired performance that is to be achieved by use of the JPA.

The performance analysis component consists of the following elements:

Task Definition: This element, based upon the initial task identification, defines the specific task(s) to be accomplished with the use of the JPA.

Performance Criteria: This element assesses and defines the level of performance required to complete the task(s) to meet operational and safety requirements.

Task Analysis: This element analyzes the task(s) to determine the steps and behaviors necessary to perform the task(s) to meet the performance criteria. Task analysis also incorporates an examination of task properties as defined below.

Task Properties: This element assesses the model-of-expertise that will be used as the basis for the desired performance. It examines the complexity of the task structure and the potential for ambiguity including an analysis of the types of decisions with which the target population will be faced. It determines if more than one course of action is possible and whether alternate-courses-of-action need be presented in the JPA. Additionally, this element re-examines the previously selected display technology to assure that the technology can display the type and amount of information required.

Time Dependence: This element examines and determines the factor of time on the desired outcome(s) and level of performance. It assesses whether the outcome(s) and performance are under any time constraint, and if so, defines that constraint.

Risk Assessment: This element examines potential risks while performing the task(s). It explores the types of risks involved including the physical and non-physical. Risk assessment determines the possibility of harm to people or equipment associated with the task(s) and provides the framework to determine if performance flexibility is available or desirable. Risk assessment also examines a personal assessment of value that the JPA may or may not have to the target population.

Flexibility: This element examines if any variance (and if possible, to what degree) is available to the task performer to deviate from the JPA's displayed procedures and to examine the risk associated with the application of individual heuristics by the task performer.

Design Criteria

The design criteria component is the process which sets forth the detailed specifications for the development of the JPA.

The design component consists of the following elements:

Goal(s) and Objectives: This element defines and prioritizes the specific goal(s) and objectives of the JPA design project. The goal(s) is a clearly defined general statement that broadly describes the purpose of the JPA design project. The objectives are clearly defined conditions and specifications of the steps necessary to meet the JPA design project goal(s).

Content: This element is a detailed specification of the information necessary to be displayed to achieve desired performance. This element also determines the information to display in the event alternate courses of action are deemed necessary.

Information Hierarchy: This element provides for a detailed specification of how the content information will be organized. It organizes and prioritizes the information for ease-of-use and comprehension.

Transparency: This element is an analysis of the necessary level of information detail required for systems understanding. It determines whether it is necessary to provide the task performer the rationale behind the recommended courses of action displayed in the JPA.

Accuracy: This element determines that the information to be presented in the JPA: (a) is reliable and accurate, and (b) maintains reliability and accuracy throughout the entire JPA display.

Compatibility: This element determines if any conflict exists between the intended JPA and other JPAs used in the specific work environment. It also determines the potential of multiple fault situations in which more than one JPA may be used. (e. g. , the use of two separate emergency checklists that each address a different system malfunction.)

Adherence: This element is a detailed specification of the level of compliance with the JPA that is required by the task performer. It examines if flexibility in performance is allowable and determines the liklihood that the task performer can or will deviate from the JPA's displayed procedures. Adherence determines when warnings, cautions, and notes that address the necessity of adherence to displayed procedures should be presented.

Format Strategy: This element determines the specifications for the JPA's physical and content format. It includes a determination of the amount of information to be displayed and a detailed specification of the display technology (e. g. , a printed trouble-shooting guide or an automated electronic checklist). Format strategies include: (a) a directive format that assumes the target population knows little or nothing about the task and the JPA displays all information necessary to complete the task, (b) a deductive format intended for a target population who have knowledge of the tasks and have had training or experience in performing the task and the JPA provides information which serves as a memory device for the task performer, or (c) a hybrid format that incorporates both directive and deductive strategies.

Perceptual Factors

This component addresses design considerations that influence information processing. It determines the detailed design specifications that encompass known perceptual factors which influence decision making associated with the desired task. This component also provides much of the framework for training content.

The perceptual factors component consist of the following elements:

Distracters: This element determines potential distracters that could degrade effective use of the JPA and identifies specific areas of the JPA's display which must be adjusted for distracters. Distracters include: (a) environmental factors such as heat, cold, light, noise, vibration, time constraints, and the physical working space; and (b) human factors such as biological, psychological, or sociological stressors, and (c) situational factors such as the operating conditions (normal or emergency) in which the JPA will be used.

Task Logic: This element determines the mental representation (the logic) of the task performance as viewed by an expert or experts who devised the instructions to conduct the task. It provides a means to match the expert's mental representation of the task with that displayed in the JPA.

Attention: This element specifies the physical properties of the JPA that affect the task performer's pre-attentive and attentive perceptions. It also details the specifications for the amount of contrast between levels of information, and provides for sufficient stimulation to compensate for predicted distracters.

Visual Information Structure: This element provides for detailed specifications of the selected display technology. It examines and details display methods which allow the task performer to construct a mental map of the information displayed. Visual information structure organizes the information into a logical sequence by use of typography, color, signaling, graphics, tables, etc.

Motivation: This element examines the factors that increase the probability that the task performer will use the JPA in the desired manner. Motivational factors include: (a) accessibility, (b) ease-of-use, (c) clarity, (d) relevance, (e) risk and potential for personal harm, (f) personal value, and (g) probability of success.

Message Design

The component of message design consists of the application of message design principles to the development of the JPA. Since the field of message design has numerous design principles and techniques, it is not the intent of the procedural JPA design model to provide specific message design methods; rather, the intent is to provide the designer with the primary message design factors applicable to JPAs that need to be addressed.

The message design component consists of the following elements:

Message Logic: This element determines the type of message that will be displayed in the JPA. This determination is based on the functional characteristics as determined during the project analysis. Message logic adapts the type of message to the purpose of the JPA. Message types may consist of (a) alert messages that call for action, (b) regulatory messages that present legally binding information or company rules, (c) procedural messages that depict the actions necessary to complete a specific task, (d) instructional messages that provide trouble-shooting information, and (e) integrated messages that have the elements of more than one message type.

Perceptual Organization: This element details the specifications for the visual organization of information by means of a visual information structure. This structure includes the principles of proximity, similarity, continuity, closure, and connectedness. Visual information structure is the application of message design techniques that provide for effective interpretation of the message (JPA). The techniques include the use of fonts and type sizes, typographical cues, the use of headings and advanced organizers, and the use of appropriate white space. Perceptual organization provides for an effective arrangement and visual flow of the message.

Literacy: This element applies the techniques of message design that are appropriate to the target population's visual and textual literacy that is based upon the previous determination of population characteristics.

Visual Continuum: This element determines the level of realism and detail that is to be displayed in the JPA. It determines and defines any symbols used and assesses the level of detail in any graphics or icons employed in the JPA. This element selects the most appropriate point on the visual continuum for the various segments of the JPA. The visual continuum ranges from the concrete to the abstract.

Redundancy: This element examines the need to provide a means to check that a performance step displayed in the JPA results in the desired outcomes. For example, if a procedural step states to place a throttle to the cut-off position, this element determines the information that should be presented in the JPA for the task performer to assure that the desired results take place.

Training

The training component determines the training content required and delivery methods necessary to implement the JPA effectively into the workplace.

The training component consists of the following elements which make up training content:

Rationale: This element presents the purpose of the JPA. It describes what the performance task is and how the JPA relates to the requirements of the task.

Relevance: This element presents the factors that make the JPA relevant to the required performance. It addresses the visible and invisible factors that form the rationale behind the development and use of the JPA.

Confidence: This element explores the reliability of the JPA, based on the analysis and design evaluations. Its purpose is to enhance the target population's confidence that the JPA will do what it is intended to do.

Knowledge Base: This element determine the prerequisite knowledge that is required for the target population to interpret and comprehend the information displayed in the JPA. Any knowledge deficiency is presented during training. Examples of knowledge areas may include such areas as equipment systems, environmental factors, teamwork, and situational factors.

Skills: This element determines the prerequisite skills necessary to perform the desired task with the JPA. Any skills that the target population does not possess are identified, described and practiced. Such skills may involve use of a new type of computer key board, scrolling an automated electronic checklist, interpreting digital data, interpreting specific icons or symbols used in the JPA, etc.

Limitations: This element presents the capabilities and limitations of the JPA. It describes what the JPA can be expected to do and what the JPA cannot do. System variables and human factors that may affect the capabilities or limitations of JPA interpretation are explained.

Assumptions: This element addresses any misconceptions or misunderstandings of the JPA's capabilities or limitations that are identified during the training program.

Practice: This element determines the need for and amount of practice required to effectively use the JPA.

Development

The component of development is the process of translating the design specifications into the JPA's physical form. It involves the processes by which the JPA is produced into its final form and its preparation for implementation into the workplace.

The development component consists of the following elements:

Pilot Draft: This element consists of the construction of a JPA prototype based upon the data collected from the project and performance analys components, design criteria component, perceptual factors component, and message design component.

Field Test: This element consists of testing the prototype JPA under actual or simulated field conditions with a representative sample of the target population. An evaluation is made to determine if the prototype JPA meets the needs of the project and performance analysis components, design component, perceptual factors component, and message design component. A pilot training program is also conducted in conjunction with the JPA field test. Findings are documented to validate design or to substantiate revisions.

Revision: This element provides for correcting the JPA's design or training for any discrepancies discovered during the field test.

Final Formative Evaluation: This evaluation is the final check that the JPA meets the goal(s) and objectives of the JPA project prior to the JPA going into final production.

Client Approval: This element provides for the final approval by the client prior to the JPA going into final production.

JPA Production: This element consists of the actual production of the approved JPA.

Implementation

This component involves the process of introducing the JPA into the workplace and checking on the status of adoption of the JPA by the intended target population.

The implementation component consists of the following elements:

Training Delivery: This element determines the means to most effectively deliver the required training to the organization's target population.

Distribution: This element determines the means by which the JPA will be installed inplace and made accessible to all required work stations and members of the target population.

Adoption: This element is a form of confirmative evaluation that evaluates whether the JPA is being properly used and accepted by the target population.

Evaluation

This component addresses summative and confirmative evaluations that are conducted after the JPA project is completed. Formative evaluations (the evaluations conducted after each component as reflected in the graphic model) were ongoing throughout the design process.

The evaluation component consists of the following elements:

Summative: This element is the evaluation process conducted shortly after the JPA project has been completed and implemented. This evaluation reviews all previous formative evaluation findings and determines whether any corrections to the JPA were effective. It also provides for an initial evaluation of how well the JPA has been adopted into the workplace. The summative evaluation includes exploring:

Job Performance: This sub-element explores how well the JPA met performance requirements. It answers such questions as was performance improved? Were performance gaps removed? Did the JPA project meet performance expectations?

Validity: This sub-element confirms that the JPA's information and displayed procedures are current and remain accurate in accordance with technical equipment specifications.

Compliance: This sub-element confirms that the JPA is in accordance with current organizational policies and regulatory requirements.

Training Requirements: This sub-element evaluates whether the training content and delivery methods meet the needs of the target population to effectively use the JPA.

Confirmative Evaluation: The process by which JPA effectiveness, accuracy, and regulatory compliance is examined at some time after the JPA has been inplace. The time intervals depend on the nature of the JPA, the frequency and impact of regulatory changes, revisions to manufacturing specifications, and revised operating procedures. Additionally, periodic confirmative evaluations determine the durability of the JPA. They assess how well the JPA has maintained its physical properties and withstood damage due to repeated use or long term storage in the work environment.

APPENDIX H

Prompt-Recall Interview Data

Prompt-Recall Interview Data

The following data presents the transcriptions of the prompt-recall interviews conducted with each subject of the experimental group. The data is presented by subject number. Questions or comments by the researcher are indicated as a probe and set in italics.

Subject 1

Time: 30 seconds

Initially I come out of the cockpit, I glance down but since we had taken a previous evacuation, I was kind of relying on the past experience of what happened before but I was looking down at the card and did notice the two minute and the ten second brace position on the card. However, training kicked in and I immediately noticed the baby and decided to move faster at that time.

Time: 60 seconds

I tried to get the passengers prepared by explaining the bracing positions and I also wanted to let them know the exit we were going out from and once again, some old training came in as far as advising the ladies sitting by the emergency exit.

Time: 90 seconds

So I couldn't remember if I did say a ten-second brace position signal. But I did say that, and I'm surprised. . . because I thought I didn't say that.

> *Probe: Do you think you were referring to the card at this time or are you just relying on memory?*

By the looks of the film I did, I think I looked down at the card.

> *Probe: But you don't remember?*

I don't remember! What I noticed just now just came to mind. I'm holding the card like a security blanket, and also, once again, looks like some old training is kicking in. I don't know if I'm using the card at this time. It's just a security blanket, I'm holding on to it, pointing around with it. Apparently, I think it was a combination of things, I looked at the card for the PIC Report which implies to the captain that the cabin has been prepared, but I think a reminder was the card and also training kicked in.

> *Probe: Do you think the card helped you remember the proper procedure as you're reviewing all this? Did it help you make any decisions at all?*

When I saw the clock and the time, yes, it did. . . The ten seconds.

> *Probe: OK, anything else?*

I liked the idea of it, I think the training would help better the procedure.

> *Probe: When you say the training, do you mean the training with the use of the card?*

Training with the card.

> *Probe: With the card, OK. Very good, thank you.*

Subject 2

Time: 30 seconds

Well the card helped me because it kept my thoughts aligned. When I went through the TEST on the card as far as telling the people the type of emergency, which exits we were going to use. I didn't get to the signals yet because I wanted to go ahead and move the lady with the baby. I got to the signals later.

> *Probe: What made you decide to move the lady with the baby at this point in time?*

Just because I knew to do it and my training kicked in. And I went ahead and did it.

Time: 60 seconds

OK, at this time I was just showing everybody how to brace and I don't know. . . I was just kind of going through the steps.

Probe: Based on. . .

Based on the card. . . the card helped me to remember to do that then. . . But I also kind of knew to go ahead and do the brace because I had gotten out of sync. I needed to get back in sync.

Probe: What was the clue that you needed to get back in sync? What did you see on the video tape that indicated you had to get back in sync?

Well I had moved the lady with the baby and I knew I was back on the same line I was on in the beginning which was to go ahead and do the brace positions.

Time: 90 seconds

OK, lets see, I had gone through the TEST and I was on the way to PREP and I was preparing the cabin and the people were getting pretty much prepared, then I started readying the cabin. That's the point I'm at right now.

Probe: I'm interested in why you zeroed in again with the lady with the baby.

Because I wanted to make sure that she didn't have the baby in the seatbelt with her.

Probe: OK. That was. . .

That's training!

Probe: Anything else?

Not at this point. . . I don't think. . . OK, I think the reason that I keep looking at the card is that I want to double check and make sure I haven't forgotten anything, and also, it seemed to be like a real safety net. You know its like if I forgot something. I knew I had it in my hand. I knew I could look down and then if I screwed up I had the card to help me unscrew. OK, now the reason I moved her is because I realized that I needed to be sitting in an aft facing seat. I'm not really sure what I looked at on the card that reminded me of that. I can't remember, but I think something must have triggered it.

Probe: When you were standing at the galley, I noticed you stopped, looked a the card for a few seconds and then you started moving again. You don't remember what you were looking at?

I think I was just reviewing it and I must have seen something about reviewing the brace because right at the bottom of PREP and under E, there's a thing on the card that says brace, am I right?

Probe: Yep.

And then I thought, I need to brace backwards and not forward and that's when I thought to review. Because to me that really. . . I didn't think I remembered that card but at that point in time I felt like I was very much ready to sit down and tell the captain. . . and I had glanced down and seen the last P and I knew I needed to go up and do that but I wanted to reassure the passengers before I did.

Probe: Why did you make that decision?

Because I thought they needed it. Because I asked if everyone was comfortable and they were all kind of going, aaaaahhhhhh...........so I thought maybe a little reassurance would be good. OK the only thing that wasn't on that card that I thought probably should have been, was the briefing card because I remembered at the end, and I should've. . . I told everybody to get it out and kind of have it in their hands. I don't like to tell them to go along with the card [the passenger safety information card]. I want them to listen to me and then, in the last few minutes if they have it in their hands, they can study it or look at it and I think that's good for them.

Probe: But you're referring to the passenger briefing card.

And I guess the reason why is because I have that card [JPA] in my hand the whole time and all of a sudden I remember, Oh, we have passenger safety cards on here. So that's why I said that at the end.

Probe: Good. Last comment?

Um, I thought that the card was KISS. It was short, simple, brief but it was really. . . It was just real easy to read. I didn't have to, you know when you're all nervous and crazy and spaced out.

Probe: Can you tell if it cued you into your past training?

It definitely cued me into past training. Without a doubt, it did that.

Probe: Do you feel that the card influenced your decision making?

Yes, I feel like it did influence my decision making. I am quite experienced, but no matter how experienced you are, I probably couldn't have done as good of a job preparing that cabin if I hadn't had that card in my hand. Absolutely.

Subject 3

Time: 30 seconds

OK, at this point I actually was readying the cabin. I had given the type of emergency, the exits to use and one of the two signals that I should have given, I didn't give a two-minute signal. I believe I had told them the time to go when I first started the briefing and I was at the point where I was preparing the cabin.

Probe: How did you find the use of the card at this time?

I had looked at the card before I had started the briefing to try to review what I needed to do. I like the card. So I had plenty of time to ready the cabin. . . then I wanted to make sure they knew how to do this, I was trying to take his briefcase, stow it. I was looking at what they had in their pockets, what they were wearing, whether or not I needed to take anything.

Time: 60 seconds

Probe: Do you remember looking at the card at all during this time?

Most from memory but I knew that I was failing the PREP part of it. . . and I had glanced at the PREP as I walked out. . . I started to look at the galley to get that completely ready and actually was checking the coffeepot to make sure it was secure when she asked me the question about the baby and went back up. So, I don't think at that point I had finished what I wanted to do.

Probe: It distracted you.

Yep, but I needed to answer the question so that she didn't go ballistic with the baby.

Time: 90 seconds

At that point I was trying to go through the evacuation review to make sure that I had someone who could open an exit and that she knew how to open it and get out. . . I think the card is great. I think the visual cues on it are a lot easier to follow. The visual cues on it were excellent. I wish that in the distraction period, I had glanced at it one more time to make sure that I was on target. I did leave out a few things that I should have put in. I know I didn't brief another passenger. I did eventually go back and redo the galley, etc. but I should have done that before I went out and reported.

Probe: Great, anything else?

Yea, I'd like to have one.

Subject 4

Time: 30 seconds

I just noticed that I wasn't sure what I still had to give out and I realized at that point that I needed to give out the signal.

Probe: Do you remember what you were thinking about there?

No, I was just trying to ready the cabin, but I'm not sure if I. . . yea, that's physically what I was trying to do. . . and also make sure that they understood how to brace.

Probe: Do you remember using the card at all?

At this point, using it for PREP. . . no, I don't think I looked at it again.

Time: 60 seconds

So I was looking at the PREP and I didn't realize this because......I don't remember at the time because I was so stressed. But yes, I was looking at the PREP.

Probe: Do you think that the card helped you keep your stress level under control?

Yes.

Time: 90 seconds

Probe: There you go to the cockpit. Anything else you want to say?

It's great to have, I mean the size I think is good. It's big enough to see because you can't study it. That's the problem of the other things that are handwritten out. And the pictures make total sense. Then if you have to study then you can look where you've actually given instructions and you will if you have to really get into it. . . In a real situation I'm sure you'll want to know as much information as you possibly can.

Subject: 5

Time: 30 seconds

I was just trying to remember all the things that I was supposed to cover to get the information and accomplish what I needed to accomplish. . . which was going down the TEST. I did refer to the card very quickly and easily. It gave me the signals there for what I was to do next. Then I shouldn't have done that quite yet but . . .

Probe: Do you remember before this?

Nope, I was told just trying and remember all the things that I was supposed to cover to clear the way. . .

Probe: Do you remember using the JPA at all?

Nope, at this point no, I was still working on that one, on the signals.

Probe: You dropped that in there, do you remember why you dropped that in there? I didn't see you look at the card, did you look at the card?

No, I didn't look at the card then, I think I just remembered to check that. . . to ready the cabin.

Time: 60 seconds

OK, I started to sit down and then I remembered I should tell the captain that the cabin was ready and then come back.

Probe: Did this card help you at all?

Yes, it did.

Probe: How?

It was very quick and easy to read. Very quickly it reminded me what I needed to do.

Probe: Do you think it helped you with any decisions in the cabin?

Any decisions, well following the procedure that I was supposed to, yes. . . to get back on track.

Subject 6

Time: 30 seconds

Well, lets see. I knew that I had to get her out of that seat because the baby was going to be moved over there. I can't think of anything else.

Probe: Do you remember looking at the card?

Yes, it helped very much. But I think I was out of sequence is what the problem was. I messed up because I started into something prior to double checking if they knew how to get in the brace position.

Probe: Did you get back on track?

Uhuh, I think it got me back on.

Time: 60 seconds

Probe: Did you remember what you were doing here?

I was going back to report to the cockpit that everything was ready.

Probe: OK, why? I saw something there, did you see it?

I looked at the card.

Probe: You don't remember looking at it, do you?

It's tough. No, now I remember seeing it. Yea.

Probe: How did the card help or not help you?

It kept me, if I'd really looked at it like I should have, it would have kept me in order. The procedures would follow.

Probe: Any follow up, anything you want to add?

I think it's very helpful, very useful and it's just right there, ABC. But TEST - PREP and if you look at it and follow it, you should get it right.

Probe: Do you think it helped you make any decisions?

Not that I can think of.

Probe: How important do you think training is?

Very, very, very important.

APPENDIX I

Subject Consent Form

Subject Consent Form

INTRODUCTION/PURPOSE: Thank you for your help. You are being asked to participate in a research study that examines the influence of a job aid on crewmember performance and decision making in preparing a cabin for an emergency landing. The purpose of this study is to examine the effectiveness of a design model for job aids. Your participation will provide essential information towards the validation of the model.

PROCEDURE: Before the simulation begins, you will be given the job aid that was discussed in the FACTS® class. You will be briefed by the acting pilot in the cockpit on the nature of the emergency and then you will conduct the procedures required to prepare the cabin for an emergency landing.

Please note, the simulation will end at the PIC Report & Position step of the procedure. There will not be a full evacuation conducted. The passengers will be non-crewmember participants and they will not be familiar with emergency procedures.

Your simulation will be video taped as were your class simulations. Upon completion of your simulation you will be asked to review the video tape and comment on your performance and decision making. A FACTS® instructor will lead you through a post-simulation interview while you watch the video tape. Your comments will be tape recorded for future content analysis. The purpose of the tape recording is to document common trends between you and other crewmembers who will perform the procedure. Please note: video and tape recordings will be destroyed upon project completion.

RISKS: There is no risk anticipated to you during the research project.

BENEFITS: The benefits of this research include (a) a determination of the influence of a job aid on your decision making during the performance of a complex procedure, (b) the enhancement of safety for you and your passengers aboard your aircraft, and (c) the opportunity to contribute to the safety posture of our industry.

VOLUNTARY PARTICIPATION/WITHDRAWAL: If for any reason you do not wish to participate in the study, you may withdraw at any time. Your participation is completely voluntary. Your withdrawal will have no effect upon your class grade nor will any entry on your student record be made indicating your withdrawal.

QUESTIONS: If you have any questions concerning your participation in this study now or in the future, Mr. Anthony J. Adamski can be contacted at (313) 484 1733, or you can contact FACTS® Training International at (360) 866 8663. And, if you have any questions regarding your rights as a research subject, Dr. Peter A. Lichtenberg, Chairman of the Behavioral Investigation Committee, Wayne State University, can be contacted at (313) 577 5174.

CONFIDENTIALITY: The information gathered during the simulation and your interview will be used only for research purposes. Your name and the name of your company will not be used in the study. You will referred to by subject number in the completed study. Additionally, your performance will not be discussed with any other crewmember participant or anyone not directly part of the research team.

CONSENT TO PARTICIPATE IN RESEARCH STUDY: I have read all the above information about this research study, including the research procedure, possible risks, and the likelihood of benefits to me and the aviation industry. The content and meaning of this information has been explained to me and is understood. All my questions have been answered.

I hereby consent and voluntarily offer to follow the study requirements and take part in the study by indicating my agreement by signing and dating this Subject Consent Form. I will be furnished a copy of this Subject Consent Form for my records.

______________________________ _______________

Subject signature — Date

______________________________ _______________

Anthony J. Adamski — Date

Principal Investigator

REFERENCES

Adamski, A. J., & Doyle, T. J. (1995). Introduction to the aviation regulatory process (3rd. ed.). Westland, MI: Hayden McNeil.

Adamski, A. J., & Stahl, A. F. (1997). Principles of design and display for aviation technical messages. Flight Safety Digest, 16 (1), 1 - 29.

Adelman, L., Cohen, M. S., Bresnick, T. A., Chinnis, J. O., & Laskey, K. B. (1993). Real-time expert system interfaces, cognitive processes, and task performance: An empirical assessment. Human Factors, 35 (2), pp. 243 - 261.

Altman, H. B. (1974). The use of pictorial materials in aircraft safety instruction. Unpublished Doctoral dissertaion, Claremont Graduate School, California.

Baker, W. H. (1994). How to produce and communicate structured text. Technical Communications, 41 (3), 456 - 466.

Battle, M. V. (1994). A new/old strategy for reading and writing technical documents. Technical Communications, 41 (1), 81 - 88.

Bell, M. E. (1981). Information-processing theory: The missing component in instructional design. Journal of Instructional Psychology, 8 (4), 165 - 169.

Berkshire, J. R. (1954). Field evaluation of a troubleshooting aid (AFPTRC-TR-54-24 (AD 537 25)): Air Force Personnel and Training Research Center.

Berlin, J. I. , Gruber, E. V. , Holmes, C. W. , Jensen, P. K. , Lau, J. R. , Mills, J. W. , & O'Kane, J. M. (1982). Pilot judgment training and evaluation. Report No. DOT/FAA/CT/82/56-I. Atlantic City, NJ:Federal Aviation Adminstration Technical Center.

Blanchard, R. E., Smillie, R. J., & Connor, H. B. (1984). Enlisted personnel individualized career system (EPICS): Design, development and implementation (NPRDC TR 84-15). San Diego, CA: U. S. Navy Personnel Research and Development Center.

Brown, H. T. (1964). Evaluation of a head-worn audio-visual aid (FR 64-10-333): Ground Systems Group, Hughes Aircraft Company.

Bullock, D. H. (1982). Guiding job performance with job aids. Training and Development, 36 (9), 36 - 42.

Carlisle, K. E., & Coulter, P. D. (1990). The performance technology of job aids. Educational Technology, 30 (5), 26 - 31.

Chalupsky, A. B., & Kopf, T. J. (1967). Job performance aids and their impact on manpower utilization (Office of Manpower Policy, Evaluation and Research, U. S. Department of Labor. WDL-TR3276): Philco-Ford Corporation: Western Development Laboratories.

Chechile, R. A., Eggleston, R. G., Fleischman, R. N., & Sasseville, A. M. (1989). Modeling the cognitive content of displays. Human Factors, 31, 131 - 43.

Christensen, J. M. (1987). The human factors profession. In G. Salvendy (Ed.), Handbook of human factors (pp. 3-16). New York: John Wiley & Sons.

Davies, I. K. (1996). Educational technology: Archetypes, paradigms and models. In D. P. Ely & T. Plomp (Eds.), Classic writings on instructional technology (pp. 15 - 30). Englewood, CO: Libraries Unlimited.

Degani, A. (1992). On the typography of flight-deck documentation (NCC2-327): National Aeronautics and Space Administration.

Degani, A., & Wiener, E. L. (1994a). On the design of flight-deck procedures (NCC2-327 and NCC2-581): National Aeronautics and Space Administration.

Degani, A., & Wiener, E. L. (1994b). Philosophy, policies, procedures and practices: The four P's of flight deck operations. In N. Johnston, N. McDonald, & R. Fuller (Eds.), Aviation psychology in practice (pp. 44 - 67). Aldershot, England: Avebury Technical.

Dessinger, J. D. (1989). A study of the effect of adult user characteristics and job performance aid formats on the accuracy and speed of technical troubleshooting. Unpublished Doctoral dissertation, Wayne State University, Detroit.

Dick, W., & Carey, L. (1996). The systematic design of instruction (4th ed.). New York: Harper Collins.

Dörner, D. (1996). The logic of failure: Why things go wrong and what we can do to make them right. New York: Metropolitan Book, Henry Holt and Company.

Drury, C. G., Paramore, B., Van Cott, H. P., Grey, S. M., & Corlett, E. N. (1987). Task analysis. In G. Salvendy (Ed.), Handbook of human factors (pp. 370 - 401). New York: John Wiley and Sons.

Duchastel, P. (1985). Marginalia. In D. H. Jonassen (Ed.), The technology of text (Vol. 2, pp. 210 - 236). Englewood Cliffs, NJ: Educational Technology Publications.

Duffy, T. M., & Waller, R. (Eds.). (1985). Designing usable texts. Orlando, FL: Academic Press.

Duncan, C. S. (1985). Job performance aids. Performance & Instruction, 24 (4), 1–4.

Edwards, E. (1988). Introductory overview. In E. L. Wiener & D. C. Nagel (Eds.), Human factors in aviation (pp. 3 - 25). San Diego: Academic Press.

Fisher, D. L., & Tan, K. C. (1989). Visual displays: The highlighting paradox. Human Factors, 31 (1), pp. 17 - 30.

Fleming, M., & Levie, W. H. (Eds.). (1993). Instructional message design: Principles from the behavioral and cognitive sciences (2nd. ed.). Englewood Cliffs, NJ: Educational Technology Publications.

Foley, P., & Moray, N. (1987). Chapter 2.1: Sensation, perception, and systems design. In G. Salvendy (Ed.), Handbook of human factors (pp. 45 - 71). New York: John Wiley & Sons.

Folley, D. D., Jr. (1961). A preliminary procedure for systematically designing performance aids (ASD 61-550 (AD 270 868)). Wright-Patterson AFB, OH: Aeronautical

Systems Division, Air Force Systems Command.

Folley, J. D., Jr. (1961). Research problems in the design of performance aids (ASD-TR 61-548 (AD 270 866)): Aeronautical Systems Division, Air Force Systems Command.

Folley, J. D., Jr., & Munger, S. J. (1961). A review of the literature on design of informational job performance aids (ASD Tech Report 61-549 (AD 270 867)): Aeronautical Systems Division, Air Force Systems Command.

Folley, J. D., Jr., & Shettel, H. H. (1962). Tryout of a preliminary procedure for systematically designing performance aids (MRL-TDR-62-20 (AD 283 605)): Aeronautical Systems Division, Air Force Systems Command.

Foshay, W. R., & Moller, L. (1992). Advancing the field through research. In H. D. Stolovitch & E. R. Keeps (Eds.), Handbook of human performance technology (pp. 701 - 714). San Francisco: Jossey-Bass.

FSF ICARUS Committee. (1996). Aviation safety: Airline management self-audit. Flight Safety Digest, 15 (11), 1 - 6.

Fuller, R. (1994). Behavior analysis and aviation safety. In N. Johnston, N. McDonald, & R. Fuller (Eds.), Aviation psychology in practice (pp. 173 - 189). Aldershot, England: Avebury Technical.

Gagné, R. (1984). The conditions of learning (4th ed.). New York: Holt Rinehart.

Gagné, R. M., Briggs, L. J., & Wager, W. W. (1992). Principles of instructional design (4th ed.). Fort Worth: Harcourt Brace Jovanovich.

Gall, M. D., Borg, W. R., Gall, J. P. (1996). Educational research: An introduction (6th. ed.). White Plains, NY: Longman.

Geis, G. L., & Smith, M. E. (Eds.). (1992). The Function of Evaluation. San Francisco: Jossey-Bass.

Gordon, J. R. (1991). A diagnostic approach to organizational behavior (3rd. ed.). Boston: Allyn and Bacon.

Grabowski, B. L. (1991). Message design: Issues and trends. In G. J. Anglin (Ed.), Instructional technology: Past, present, and future (pp. 202 - 212). Englewood, CO: Libraries Unlimited.

Grau, J. A. (1986). Job aids and motivation. Performance and Instruction, 25 (4), 10 - 11.

Gross, R. L. (1995). Studies suggest methods for optimizing checklist design and crew performance. Flight Safety Digest, 14 (5), 1 - 10.

Hannafin, M. J., Hannafin, K. M., Land, S. M., & Oliver, K. (1997). Grounded practice and the design of constructivist learning environments. Educational Technology Research and Develoment, 45 (3), 101 - 117.

Harless, J. H. (1984). Dialogue: When to/when not to develop job aids. Newnan, GA: Harless Performance Guild.

Harless, J. H. (1986). Guiding performance with job aids, in Introduction to performance technology . Washington, DC: National Society for Performance and Instruction.

Hawkins, F. H. (1987). Human factors in flight. Aldershot, England: Gower Technical.

Hellebrandt, J., & Russell, J. D. (1993). Confirmative evaluation of instructional materials and learners. Performance & Instruction, 32 (6), 22 - 27.

Herry, N. (1987). Errors in the execution of prescribed instructions: Design of process control work aids. In J. Rasmussen, K. Duncan, & J. Leplat (Eds.), New technology and human error (pp. 239 - 245). New York: John Wiley & Sons.

Hill, W. F. (1963). Learning: A survey of psychological interpretations. San Francisco: Chandler.

Hoehn, A. J., & Lumsdaine, A. A. (1958). Design and use of job aids for communicating technical information (AFPTRC-TR-58-7 (AD 152 109)): AF Personnel and Training Research Center.

Hooprich, E. A., & Steinemann, J. H. (1965). An investigation of the utility of a conversion chart as a job aid for electronics technicians (Technical Bulletin STB 66-13 (AD 624 608)): U. S. Navy Personnel Research Activity.

Jensen, P. K., Lau, J. R., Mills, J. W., & O'Kane, J. M. (1982). Pilot judgment training and evaluation: Volume I (Final Report DOT/FAA/CT/82/56-I). Atlantic City Airport, NJ: Federal Aviation Administration Technical Center.

Jensen, R. S., & Benel, R. A. (1977). Judgment evaluation and instruction in civil pilot training (NTIS No. AD AO57440): Aviation Research Laboratory, University of Illinois.

Jonassen, D. H. (Ed.). (1982). The technology of text: Principles for structuring, designing, and displaying text. Englewood Cliffs, NJ: Educational Technology Publications.

Jonassen, D. H. (Ed.). (1985). The technology of text: Principles for structuring, designing, and displaying text (Vol. 2). Englewood Cliffs, NJ: Educational Technology Publications.

Kaempf, G. L., & Klein, G. (1994). Aeronautical decision making: The next generation. In N. Johnston, N. McDonald, & R. Fuller (Eds.), Aviation psychology in practice (pp. 223 - 254). Aldershot, England: Avebury Technical.

Kantowitz, B. H., & Sorkin, R. D. (1983). Human factors: Understanding people-system relationships. New York: John Wiley & Sons.

Keller, J. M. (1987). The systematic process of motivational design. Performance & Instruction, 26 (10), 1 - 8.

Keller, J. , & Burkman, E. (1993). Motivation principles. In M. Fleming & W. H. Levie (Eds.), Instructional message design: Principles from the behavioral and cognitive sciences (pp. 3 - 53). Englewood Cliffs, NJ: Educational Technology Publications.

Kern, R. P. (1985). Modeling users and their use of technical manuals. In T. H. Duffy & R. Waller (Eds.), Designing usable text (pp. 341 - 375). Orlando, FL: Academic Press.

Keyes, E. (1993). Typography, color, and information structure. Technical Communications, 40 (4), pp. 638 - 654.

Kirlik, A. (1993). Modeling strategic behavior in human-automation interaction: Why an "aid" can (and should) go unused. Human Factors, 35 (2), 221 - 242.

Kjellen, U. (1987). A changing role of human actors in accident control: Implications for new technology systems. In J. Rasmussen, K. Duncan, & J. Leplat (Eds.), New technology and human error (pp. 169 - 175). New York: John Wiley & Sons.

Mager, R. F. (1988). Making instruction work or skillbloomers. Belmont, CA: Lake.

Marca, D. A., & McGowan, C. L. (1988). SADT: Structured analysis and design technique. New York: McGraw-Hill.

Marr, D. (1982). Vision. New York: Freeman.

Matthews, M. L. (1986). The influence of visual workload history on visual performance. Human Factors, 28 (6), 623 - 632.

Meister, D. (1971). Human factors: Theory and practice. New York: Wiley-Interscience a division of John Wiley & Sons.

Meister, D. (1987). System design, development, and testing. In G. Salvendy (Ed.), Handbook of human factors (pp. 17 - 41). New York: John-Wiley & Sons.

Merrill, D. M. (1983). Component display theory. In C. M. Reigeluth (Ed.), Instructional-design theories and models (pp. 279 - 333). Hillsdale, NJ: Lawrence Erlbaum Associates.

Misanchuk, E. R. (1992). Preparing instructional text. Englewood Cliffs, NJ: Educational Technology Publications.

Moseley, J. L., & Larson, S. (1992). A job performance aid evaluation tool. Performance and Instruction, 31 (8), 24 - 26.

Mosier, K. L. (in press). Myths of expert decision making and automated decision aids. In C. Zsambok & G. Klein (Eds.), Natural decision making. Hillsdale, NJ: Lawrence Erlbaum Associates.

Mosier, K. L., & Skitka, L. J. (in press). Humans and automation: Made for each other. In R. Parasuraman & M. Mouloua (Eds.), Automation and human performance: Theory and applications. Hillsdale, NJ: Lawrence Erlbaum Associates.

Mosier, K. L., Palmer, E. A., & Degani, A. (1992, October 12 - 16). Electronic checklists: Implications for decision making. Paper presented at the 36th Annual Meeting of the Human Factors Society, Atlanta, GA.

National Transportation Safety Board. (1985). Airline passenger safety education: A review of methods used to present safety information (NTSB/SS-85/09). Washington, DC: Author

National Transportation Safety Board. (1988). Aircraft accient report, DC-9-82 N312RC, Detroit Metropolitan Wayne County Airport, Romulus Michigan (NTSB/AAR-88/05). Washington, DC: Author.

National Transportation Safety Board. (1995). Runway overrun following a rejected takeoff, Continental Airline Flight 795, McDonnell Douglas MD-82, N18835, LaGuardia Airport, Flushing, New York, March 2, 1994 (NTSB/AAR-95-01). Washington, DC: Author.

Orasanu, J. M. (1994). Shared problem models and flight crew performance. In N. Johnston, N. McDonald, & R. Fuller (Eds.), Aviation psychology in practice (pp. 255 - 285). Aldershot, England: Avebury Technical.

Patrick, J. (1987). Information at the human-machine interface. In J. Rasmussen, K. Duncan, & J. Leplat (Eds.), New technology and human error (pp. 341 - 345). New York: John Wiley & Sons.

Perrow, C. (1984). Normal accidents: Living with high-risk technologies. New York: Basic Books.

Pipe, P. (1992). Ergonomic performance aids. In H. D. Stolovitch & E. J. Keeps (Eds.), Handbook of human performance technology: A comprehensive guide for analyzing and solving performance problems in organizations (pp. 352 - 364). San Francisco: Jossey-Bass.

Reason, R. (1990). Human error. Cambridge: Cambridge University.

Redding, R. E., & Seamster, T. L. (1995,). Cognitive task analysis for human resources management in aviation: Personnel selection, training and evaluation. Paper presented at the Proceedings of the 21st Conference of the European Association for Aviation Psychology (EAAP).

Richey, R. (1986). The theoretical and conceptual basis of instructional design. London: Kogan Page.

Richey, R. C. (1995, February 8). Expanding instructional technology's foundation of conceptual theory. Paper presented at the Association for Educational Communications and Technology, Anaheim, CA.

Richey, R. C., & Nelson, W. A. (1996). Developmental research. In D. H. Jonassen (Ed.), Handbook of research for educational communications and technology (pp. 1213 - 1245). New York: Simon & Schuster Macmillan.

Richey, R. C., & Tessmer, M. (1995). Enhancing instructional systems design through contextual analysis. In B. Seels (Ed.), Instructional design fundamentals: A reconsideration (pp. 185 - 195). Englewood Cliffs, NJ: Educational Technology Publications.

Rigney, J. S., Fromer, R., Langston, E. T., & Adams, H. C. (1965). Evaluation of an experimental fault location device: I. fault location by radio operators (Technical Report 43): University of Southern California, Department of Psychology, Electronics Personnel Research Group.

Romiszowski, A. J. (1988). The selection and use of instructional media: For improved classroom teaching and for interactive, individualized instruction (2nd ed.). London, England: Koran Page.

Rossett, A. (1991). Job aids in a performance technology world. Performance & Instruction, 30 (5), 1–6.

Rossett, A. (1992). Analysis of human performance problems. In H. D. Stolovitch & E. J. Keeps (Eds.), Handbook of human performance technology: A comprehensive guide for analyzing and solving performance problems in organizations (pp. 97 - 113). San Francisco: Jossey-Bass.

Rossett, A., & Gautier-Downes, J. (1991). A handbook of job aids. San Diego: Pfeiffer & Company.

Rothwell, W. J., & Kazanas, H. C. (1992). Mastering the instructional design process: A systematic approach. San Francisco: Jossey-Bath.

Rowland, G. (1993). Designing and instructional design. Educational Technology Research and Development, 41 (1), 79 - 91.

Rude, C. (1988). Format in instruction manuals: Applications of existing research. Journal of Business and Technical Communications, 2 (1), 62 - 77.

Ryder, J. M., & Redding, R. E. (1993). Integrating cognitive task analysis into instructional system development. Educational Technology Reserach & Development, 41 (2), pp. 75 - 96.

Salisbury, D. F. (1990). General systems theory and instructional systems design. Performance and Instruction, 29 (2), 1 - 11.

Sanders, M. S., & McCormick, E. J. (1987). Human factors in engineering and design (6th ed.). New York: McGraw-Hill.

Savenye, W. C., & Robinson, R. R. (1996). Qualitative research: Issues and methods. In D. H. Jonassen (Ed.), Handbook of research for educational communications and technology (pp. 1171 - 1195). New York: Simon & Schuster Macmillan.

Schiffman, S. S. (1991). Instructional systems design: Five views of the field. In G. L. Anglin (Ed.), Instructional Technology: Past, present, and future (pp. 102 - 116). Englewood, CO: Libraries Unlimited.

Schneider, W. (1985). Training high-performance skills: Fallacies and guidelines. Human Factors, 27 (3), 285 - 300.

Schon, D. A. (1983). The reflective practitioner: How professionals think in action. New York: Basic Books.

Scriven, M. (1994). Product evaluation: The state of the art. Evaluation Practice, 15 (1), 45 - 62.

Seels, B. (1989). The instructional design movement in educational technology. Educational Technology, 29 (5), 11 - 15.

Seels, B. B., & Richey, R. C. (1994). Instructional technology: The definition and domains of the field. Washington, DC: Association for Educational Communications and technology.

Shriver, E. L., & Trexler, R. C. (1965). Application and test of the FORECAST concept of electronics maintenance on NAVY LORAN equipment (Technical Report 65-3 (AD 616 753)):

Shrock, S. A. (1991). A brief history of instructional development. In G. J. Anglin (Ed.), Instructional technology: Past, present, and future (pp. 11 - 19). Englewood, CO: Libraries Unlimited.

Skinner, B. F. (1960). The science of learning and the art of teaching. In A. A. Lumsdaine & R. Glaser (Eds.), Teaching machines and programmed learning: A source book (pp. 99 - 113). Washington, DC: Department of Audio-Visual Instruction, National Education Association.

Smillie, R. J. (1985). Design strategies for job performance aids. In T. M. Duffy & R. Waller (Eds.), Designing usable text (pp. 213 - 243). New York: Academic.

Snow, N., & Newby, T. J. (1989). Ergonomically designed job aids. Performance and Instruction, 28 (3), 26–29.

Stewart, T. R., Roebber, P. J., & Bosart, L. F. (1997). The importance of the task in analyzing expert judgment. Organizational Behavior and Human Decision Processes, 69 (3), 205 - 219.

Stokes, A. F., Barnett, B. J., & Wickens, C. D. (1987,). Modeling stress and bias in pilot decision making. Paper presented at the Annual Conference of the Human Factors Association of Canada.

Stolovitch, H. D., & Keeps, E. J. (Eds.). (1992). Handbook of human performance technology: A comprehensive guide for analyzing and solving performance problems in organizations. San Francisco: Jossey-Bass.

Storrs, G. (1997) Introduction to human-computer interaction in safety-critical systems. In F. Redmill, & J. Rajan (Eds.), Human factors in safety-critical systems. Oxford, England: Butterworth-Heinemann.

Streit, L. D., Stern, S., & Collins, R. H. (1986). Managing training materials with structured text design. Performance and Instruction, 25 (1), 10 - 12.

Swezey, R. W. (1987). Design of job aids and procedure writing. In G. Salvendy (Ed.), Handbook of human factors (pp. 1039 - 1057). New York: John Wiley & Sons.

Sylla, C., Drury, C. G., & Babu, A. J. G. (1986). A human factors design investigation of computerized layout system of text-graphic technical materials. Human Factors, 30 (3), 347 - 358.

Tessmer, M. (1993). Planning and conducting formative evaluations. London: Kogan Page.

Tessmer, M. (1994). Formative Evaluation Alternatives. Performance Improvement Quarterly, 7 (1), 3 - 18.

Tilaro, A., & Rossett, A. (1993). Creating motivating job aids. Performance & Instruction, 32 (9), 13 - 20.

Severe icing causes multiple engine failures. (1996). Transport Canada: Aviation Safety Letter, 3–5.

Trollip, S. R., & Sales, G. (1986). Readability of computer-generated fill-justified text. Human Factor, 28 (2), 159 - 163.

Turner, J. W., Huntley, J., M. S., & Volpe, J. A. (1991). The use and design of flightcrew checklists and manuals (Final Report DOT/FAA/AM-91/7). Washington, DC: Office of Aviation Medicine.

Von Glinow, M. A., & Mohrman, S. A. (1990). Managing complexity in high technology organizations. New York: Oxford Press.

Waller, R. (1982). Text as diagrams. In D. H. Jonassen (Ed.), The technology of text, (Vol. 1, pp. 137 - 166). Englewood Cliffs, NJ: Educational Technology Publications.

Westrum, R. (1993). Cultures with requisite imagination. In J. Wise and D. Hopkin (Eds.), Verification and validation: Human factors aspects (pp. 401-416). New York: Springer.

Westrum, R. (1995). Organisational dynamics and safety. In N. McDonald, N. Johnston, & R. Fuller (Eds.), Applications of psychology to the aviation system, (Vol. 1, pp. 75 - 80). Aldershot, England: Avebury Aviation.

Westrum, R., & Adamski, A. J. (in press). Organizational factors associated with safety and mission success in aviation environments. In D. J. Garland, J. A. Wise, & V. D. Hopkins (Eds.), Aviation human factors. Hillsdale, NJ: Lawrence Erlbaum Associates.

Will, R. P. (1991). True and false dependence on technology: Evaluation with an expert system. Computers in Human Behavior, 7, 171 - 183.

Wilson, J. R., & Rutherford, A. (1989). Mental models: Theory and application in human factors. Human Factors, 31 (6), pp. 617 - 634.

Winn, W. (1976). The structure of multiple free associations to words, black-and-white picture, and color pictures. AV Communication Review, 24 (3), 273 - 294.

Winn, W. (1990). Some implications of cognitive theory for instructional design. Instructional Science, 19, 53 - 69.

Winn, W. D. (1993). Perception principles. In M. Fleming & W. H. Levie (Eds.), Instructional message design: Principles from the behavioral and cognitive sciences (2nd. ed., pp. 55 - 126). Englewood Cliffs, NJ: Educational Technology Publications.

Winn, W., & Snyder, D. (1996). Cognitive perspectives in psychology. In D. H. Jonassen (Ed.), Handbook of research for educational communications and technology (pp. 112 - 141). New York: Simon & Schuster Macmillan.

Zeitlin, L. R. (1994). Failure to follow safety instructions: Faulty communications or risky decisions. Human Factors, 36 (1), 172 - 181.

ABSTRACT

THE DEVELOPMENT OF A SYSTEMS DESIGN MODEL FOR JOB PERFORMANCE AIDS: A QUALITATIVE DEVELOPMENTAL STUDY

by

ANTHONY J. ADAMSKI

May 1998

Advisor: Dr. Rita Richey

Major: Instructional Technology

Degree: Doctor of Philosophy

This study was an effort to develop and validate a model for constructing job performance aids for use in high risk environments. The study resulted in the development of a generic conceptual design model that was applicable to a wide variety of job performance aid designs and the development of a task-specific procedural design model targeted to high risk situations.

The models were based upon a synthesis of instructional technology and human factor literature and a series of interviews with instructional design and human factor experts. A job performance aid was developed using the procedural design model for use by corporate aviation cabin crewmembers. The procedural design model was then validated by comparing the performances of an experimental group and a control group of professional cabin crewmembers who conducted an emergency procedure in an aircraft cabin simulator. The experimental group used the job performance aid and the control group did not.

The findings of this study indicated that: (a) the development of a conceptual model was an important factor in the development of a procedural model, (b) project analysis was a critical step in job performance aid design for high-risk environments, (c) the job performance aid improved performance, and (d) training was an important consideration for job aid design and that it was an important factor in job aid implementation into high-risk environments.

The study discussed modeling, the role of imagination, and implementation considerations for the successful creation and use of job performance aids. It was argued that it was necessary to identify and explore the variables that influenced job performance aid design. Furthermore, it was argued that imagination took a new role in job performance aid design which included the prediction of potential design errors. And, it was argued that training was a necessary ingredient for successful implementation of job performance aids in high-risk environments.

Based on the findings of this study, recommendations were made to practitioners in the field and recommendations were made to researchers for areas that warranted future study.

AUTOBIOGRAPHICAL STATEMENT

Name:	Anthony J. Adamski
Education:	Wayne State University Instructional Technology Doctor of Philosophy, 1998
	Eastern Michigan University Technology Masters of Liberal Science, 1990
	Wayne State University Advertising and Design Bachelor of Fine Arts, 1963
Work Experience:	Eastern Michigan University Assistant Professor of Aviation Management Technology 1997 - present
	Anthony J. Adamski, Inc. Aviation Safety Consulting Services 1987 - 1997
	Chrysler Pentastar Aviation Vice-President of Flight Support 1980 - 1987
	Chrysler Corporation Department of Air Transportation 1969 - 1980
	U.S. Air Force Strategic Air Command, KC-135 Pilot 1965 - 1969
Publications:	Adamski, A. J., & Stahl, A. F. (1997). Principles of design and display for aviation technical messages. <u>Flight Safety Digest</u>, <u>16</u>, (1) 1-29
	Adamski, A. J. & Doyle, T. J. (1994). <u>Introduction to the aviation regulatory process</u>. Westland, MI: Hayden McNeil.