(NASA-CR-175584) NASA: MODEL DEVELOPMENT FOR HUMAN FACTORS INTERFACING Final Report, 15 Nov. 1984 - 15 Jul. 1984 (University of Central Florida) 116 p HC A06/MF A01 N85-21985

Unclas

CSCL 05H G3/54 14634

FINAL REPORT

NASA: Model Development for Human Factors Interfacing

National Aeronautics and Space Administration
Kennedy Space Center, Florida

GRANT NAG10-0010
15 Nov 83 - 15 Jul 84

September 15, 1984

prepared by

Leighton L. Smith, Ph.D.
Department of Industrial Engineering
University of Central Florida
Orlando, Florida

ABSTRACT

The results of an intensive literature review in the general topics of human error analysis, stress and job performance, and accident and safety analysis revealed no usable techniques or approaches for analyzing human error in ground or space operations tasks. A Task Review Model is described and proposed to be developed in order to reduce the degree of labor intensiveness in ground and space operations tasks. An extensive number of annotated references are provided.

FOREWORD

This grant (NAG10-0010) was directed by The Future Projects Office at Kennedy Space Center, Florida.

This report summarizes the results of Phase I. There are anticipated to be three successive Phases. Developed and validated will be two models for addressing the potential for human error in ground or space operations tasks. First will be The Task Review Model (TRM) which will reduce the degree of labor intensiveness in a task. Second a Human Role Evaluation Model (HREM) will determine a Role Criticality Criterion (RCC) for each human role in a task which has been reviewed by the TRM. There will be different levels of criticality in the RCC. In addition, for human roles with undesirable RCC values, the HREM will develop a Personnel Management Criterion (PMC) which will delineate skill-level and experience required and recommend work period, break period, and rest period durations.

ABSTRACT

The results of an intensive literature review in the general topics of human error analysis, stress and job performance, and accident and safety analysis revealed no usable techniques or approaches for analyzing human error in ground or space operations tasks. A Task Review Model is described and proposed to be developed in order to reduce the degree of labor intensiveness in ground and space operations tasks. An extensive number of annotated references are provided.

TABLE OF CONTENTS

CHAPTER I

FINAL REPORT

FINAL REPORT

NASA: Model Development for Human Factors Interfacing

Grant NAG 10-0010

Space systems operations comprise a broad spectrum of different activities. There are multiple checks of electrical, mechanical, and fluid connections; fuel and oxidizer transfers; onloading, activating/deactivating payloads/experiments; orbiter and space vehicle relocations, etc. A large portion of these operations are labor intensive in that many humans, many manual tasks, or a combination of both are involved. Many of these tasks are also hazardous toward personnel, systems, and missions due to the space environment and/or hazardous systems involvement. Due to the complexity of space operations, the involvement of hazardous systems, and the high degree of labor intensiveness, most space operations require long periods of time to accomplish. It is noteworthy that the time required for a human to successfully accomplish any task increases in direct proportion to the complexity of the task. It is anticipated that operations activities will be a primary limiting factor in determining future flight rates as well as the rate at which space experiments and activities can take place and that human errors could contribute significantly to a degradation of operational success. Therefore, methods to evaluate human involvement and to analyze the human role are necessary to ameliorate the potential for controlling critical errors.

Let the premise therefore be that there exists a potential for human error (hereinafter referred to as HEP: Human Error Potential) and that there are a large number of human errors which are deemed undesirable in ground and space systems due to the character, magnitude, severity, and/or timeliness of the consequences of such errors.

In order to address these two major issues of this premise, it is desirable to first quantify the HEP so as to be able to predict the likelihood of error commission in a given application. The ability to so predict would enable analysts to generally characterize the likelihood of severe consequences to possible human errors.

Secondly, it is desirable to delve into the causal factors which contribute (or induce) humans to commit errors. Clearly, if it is known what makes humans err, then it is presumed possible to modify the situation in some manner or form to reduce the HEP.

Therefore, the approach can be summarized as first being able to predict the HEP and second attempting to reduce this potential. It is fundamental that being able to predict HEP must come before being able to reduce it because if the potential cannot be reliably quantified, it would be difficult at best to characterize the efficacy of any HEP reduction efforts.

Before any attempts are made to address the issues of the premise in this manner, it is advisable to survey the field to ascertain what methods and techniques have already been developed to deal with HEP. The most logical (and usually the most effective) manner in which to survey the practices in use in the field is to conduct a review of the professional literature. In this instance the professional literature is construed to entail books, journals, dissertations, conference preceedings, published reports in the private sector, and reports in the public sector such as that which is available from the National Technical Information Service (NTIS).

The logic here is that there is no reason to reinvent the wheel, namely, if there is a valid, applicable technique reported in the field it is more effective use of the time to find it via a literature review than it is to develop a new technique from scratch.

It should be intuitively obvious that regarding the topic of HEP the 'field' is extraordinarily broad in scope simply because human beings are involved in nearly all activities. Therefore it was decided not to select a field of operation, say manufacturing or sports, and investigate what might be reported in literature related to that area. This approach would tend to grow in scope in direct proportion to the time invested and it could possibly overlook usable information available from sources not selected.

Consequently, an extensive review of the literature was conducted in the following manner. The purpose of the review was to determine what has been reported in the literature in the general areas of (a) human error analysis, (b) stress and job performance and (c) accident and safety analysis. Interest in area (a) was predicated on the assumption that effective techniques in dealing with the potential for human error have been developed which are applicable to ground (or space) operations tasks. Interest in area (b) was predicated on the contingency that tangible results of the first part of the review might not be realized. The rationale was that if no usable techniques in human error analysis are evident in the literature, then perhaps usable techniques in the area of stress and job performance have been developed and reported which could be used as a foundation for the development of a human performance analysis technique which could be used in dealing with HEP. Interest in area (c) was predicated on the idea that usable techniques have been developed through analysis of the periods following the occurrence of a human error.

The human error analysis portion of the literature review was planned to be as broad in scope as possible. Subtopics as classification schemes (taxonomies), error data banks, causes of human error, consequences of human error, and human reliability were investigated.

The stress and job performance portion of the review was planned also to be broad in scope. Included were such subtopics as job stress, stress due to non-job sources, means of measuring (and enhancing) job performance, psychophysical aspects of job performance, and fatigue.

The accident and safety analysis portion of the review concentrated on accident investigations and safety program development and evaluation. The general results of the literature are described in the following paragraphs. More specific information can be found in Appendices A and B. Appendix A contains a cross-sectiona' reference sheet for each of the first two areas of the literature review. These sheets reflect with respect to area subtopics the type of information found and the type of source which provided the information. Appendix B is a list of annotations of sources which were determined noteworthy. This appendix is broken down into three parts corresponding to the three areas of interest. Appendix D contains the references reviewed. This is a complete reference listing, meaning that the list cites all sources reviewed. Not all of the sources reviewed contained useful information. Those sources which contained the most useful information are specifically discussed in Appendix B.

The results of the review in the area of human error analysis were that in general there were predominantly only contributions made by theorists. There were very few reports made by empiricists and there were virtually no reports made by practitioners in human error analysis. In fact, the paucity of practitioner provided reports is evidence to the conclusion that human error analysis is not an area of practice at all. In addition, it appears that although there may be interest in HEP in the field no one is reporting on any direct application attempts to do anything about it.

There were only a handful of reports made by empiricists in the area of human error analysis and all of these were laboratory studies which addressed the characteristics of different types of human error (e.g., muscular coordination, mental computation, etc.), and consequently were not applications studies. For edification, applications studies are investigations which deal with a specific activity (or task) in its entirety. Such may be done in the laboratory or the field. The results of such studies are tangible and interpretable for applications to other similar activities. On the other hand, foundation level studies are invariably performed in the laboratory. These studies endeavor to establish a general data base in an area of human activity. The end result (after many studies) is a compendium of data which would provide general design guideline information for a series of related tasks. Therefore the results of individual studies of this type are not usable for applications, although such studies are highly meritorious due to their contributions made to the collective goal.

As yet these foundation studies have not been performed with enough breadth and depth for there to be any useful compendium of design guideline information in the area of HEP.

The reason why there are a low number of instances of reported empirical and practitioner studies is most likely due to the fact that those individuals interested in human error analysis can not identify worthy methods or approaches because the large number of theorists in this area are at odds with each other. A thorough reading of the published material from the theorists engenders a large tendency towards confusion. There appears to be no commonality of purpose and no commonality of approach. One group avers that HEP is pervasive and uncontrollable. There have been successful techniques developed to predict the error rates of humans, however. The most well known technique is The Technique for Human Error Rate Prediction - THERP (Swain, 1973).

In reviewing the sources located in this area a conclusion or generalization in spite of the tendency towards confusion does surface. This generalization is that human performance activities are not independent. Hence they do not lend themselves to traditional methods of analysis such as statistics (the techniques of which generally call for its events to be independent). In addition, it appears that most theorists agree that human activities are correlated to both the characteristics of the environment and the individual personality. In other words, it is thought that people do not err predictably in similar situations, nor do errors occur predictably person to person in the same situation.

Having ventured these generalizations, it should be recognized that unfortunately insofar as the immediate objective previously posed in the premise is concerned, there is no logical next step. These generalizations, although perhaps interesting and worthy of discussion do not lend themselves to the formulation or development of a solution to the stated problem. In fact, these generalizations are not sufficient guidance to design and conduct an intermediate study the results of which would be intended to address the stated problem. Error rate prediction techniques as mentioned previously could be utilized as evaluators, but short term success can only be expected for reasonably simple (non-complex) and/or unsophisticated systems.

The results of the review of the literature in the areas of stress and job performance and accident and safety analysis are basically similar to that of the first area of interest. In these areas there has been more agreement among the theorists.

But even though this fact would enable there to be a more uniform thrust by empiricists and practitioners such activity has not been reported. The bulk of what was reported has been done by theorists. Generally, the theorists agree that job performance can detrimentally be affected by either an overstress condition or an understress condition. In other words, people do their best work in job situations which are neither an overload (too many tasks, and/or too little time) nor an underload (not enough tasks, and/or too much time). This observation in itself may seem profound enough to lend itself to an application. This however is unfortunately not the case. The problem is that there is no concensus from the theorists (and there have been no reports of empirically based results) which quantitatively delineates how many tasks are too many or too few or how much time is too much or too little. Without this type of quantitative information job design (or redesign) is not a feasible approach to addressing HEP.

The general conclusion, then, based on the thorough review of the literature which has been conducted is that there have not been any techniques or approaches developed to address HEP or to conduct a human error analysis. Furthermore, since the sources reviewed were predominantly theoretical discourses, there are not enough tangible data to use to build or design a set of techniques or approaches to deal with HEP or to conduct human error analyses.

It would appear then that the objective of this study as has been stated previously in the premise cannot be supported by the results of the literature review. This is not the case. The fact that nothing has been done before in the empirical or practitioner communities (and reported in the literature) is not a preventative from doing anything original. The only reservation might be that an original approach has a certain degree of risk associated with it in that without documented support there is no assurance of success.

There are two general approaches which can be addressed at this juncture on an original approach. The first is to design a means of analyzing and quantifying (or predicting) HEP in some manner which will have usability with and application to typical ground (or space) operations tasks. This would be a foundation level type study. The second approach is to postpone any formal dealings with HEP and endeavor to reduce HEP in an informal or indirect manner. In other words, rather than confront HEP in ground operations tasks as a reality and try out heuristic innovations to deal with it, it might be more effective to initially try to deal with the major reason why HEP exists in the first place, namely the human being. If it were possible to reduce the number of human beings involved in a ground (or space) operations task, it is logical that the HEP associated with that task would go down. Recognize that it is not known how much the HEP would go down because it is not yet known how to reliably quantify HEP. But if this hypothesis that HEP is directly (or positively) correlated to the number of people (or more aptly, the degree of labor intensiveness) on a given task, is deemed valid, then it is recommended to adopt the second approach as the means of initially dealing with HEP at Kennedy Space Center.

Thus it is recommended that this project involve the development and validation of two Human Factors Models: The Task Review Model (TRM) and the Human Role Evaluation Model (HREM). The TRM is a means of analyzing a ground (or space) operations task. It will isolate the task's key objectives and functions and will perform a functional allocation process for each task in the interest of reducing the degree of labor intensiveness of the task. After space operations tasks have been reduced in labor intensiveness using the TRM, the HREM will be applied to those tasks identified through the use of the TRM as still labor intensive. The HREM will consist of two techniques, the Role Criticality Criterion (RCC) and the Personnel Management Criterion (PMC). The RCC will be a means of evaluating human roles to ascertain the severity of the possible consequences due to human errors. The RCC will assign a numerical quantity to the analyzed tasks and will be designed to be parallel to the criticality numerical quantity factors assigned in the standard NASA system hardware failure analysis schemes. After the RCC has been applied to tasks to determine their criticality, the PMC can then be applied to those tasks having an undesirable RCC. The PMC will be a specification of the skill level and experience required of humans to accomplish the specific task being analyzed and will delineate minimum/maximum (as appropriate) work period, break period, and rest period durations. The TRM will be developed and validated in Phase II and is described in detail as follows. Once a ground or space operations system has been reviewed by the TRM and HREM the next logical steps are one, to utilize an error rate prediction technique (e.g., THERP, referred to previously) to identify specific human actions which warrant further scrutiny, and two to delve into the psychophysical aspects of these identified actions.

Task Review Model

The purpose of the Task Review Model (TRM) is to objectively minimize the degree of labor intensiveness in a ground or space operations task. A minimization in the degree of labor intensiveness is interpreted to include either a reduction in the number of humans involved in the task, a reduction in the instances of manual operations in the task, or both of these reductions on an optimization basis within the limitations of current automation technology.

The TRM will be designed to be applied to any type of task in a manner which is independent of how the task is currently being conducted. This is anticipated to be accomplished by compiling information from such individuals as the task designer and the task supervisor rather than observing the actual execution of the task.

The anticipated results of a task reviewed by the TRM will be two-fold. First, the TRM will provide an objective description of what activities must be accomplished in order for the reviewed task to be accomplished. The result will be a description in the form of a tree diagram or an organizational chart. This task description will be streamlined and as parsimonious in the number of activities as possible. Hence such a description would form an ideal foundation for a contract bid proposal solicitation. Secondly, there will be an assignment made for each listed activity. The assignment will either be 'human' or 'non-human.' The human assigned activities are those which will be reviewed by the Human Role Evaluation Model (HREM) to be developed in Phases III and IV of this project. Similarly this activity assignment facet of the TRM results will provide qualified guidance to prospective contractors in how to prepare their bids. This requirement shall be realized as a benefit due to the fact that each prospective vendor will bid on the same conception of the task -- not on each individual interpretation of how the task can be executed.

Generally, the TRM is an analysis approach which endeavors to include only those activities which are necessary to satisfy the stated goal. Let this stated goal be called the Objective of the task. The definition which the Objective satisfies is: What is the task supposed to do? or Why is the task necessary? Therefore the first step of the TRM is to determine the Objective of the task. There must be a single simply stated Objective for each task. If a selected task cannot be described by a single Objective then it will be deemed a higher-order task and, as such. warrant a number of separate appl·cations of the TRM. Therefore an additional benefit of the TRM technique is to identify all the basic (zero-order) tasks which comprise a single ground (or space) operations system (where 'system' is used to be synonymous with a higher-order task).

For qualified basic tasks, the next step in the TRM is to identify, and label all those activities which are necessary to achieve the stated Objective. Allow for these activities now to be called Functions. The determination of those Functions which satisfy the stated Objective is the most involved portion of the

TRM. Not only must this portion ensure that there are enough Functions specified to fully support the stated Objective, but the descriptions of the Functions must be explicit enough for the TRM to make the human and non-human assignments to the Function in the next step.

The next step in the TRM determines whether a human can or can not accomplish each listed Function of the task. Ordinarily, the Functional Allocation step makes this determination on the basis of how the human resources can best be utilized. In the design of the TRM for this application, the Functional Allocation determination will be made on the basis of how available non-human resources and technology can best be utilized, because, as stated previously, the primary purpose of this TRM is to minimize the degree of labor intensiveness in ground (or space) operations tasks. An illustrated example is provided in Appendix C.

Because the primary product of this project is a reduction in the potential for human error in ground (or space) operations tasks, the Functional Allocation step of the TRM will not provide specific descriptions of the character of the non-human allocations. Let it remain for subsequent projects to address this issue. As a departure point for prospective projects in this vein, the final deliverable of the TRM in Phase IV will include a detailed description of the logic applied in the Functional Allocation step which accomplishes the determination of whether the allocation is to be human or non-human.

It is noteworthy at this juncture to identify that the Functional Allocation step will be designed to make a human allocation primarily by default. That is, a human allocation will be made only if a non-human allocation cannot be supported by the Functional Allocation logic. This is because the primary purpose of the TRM is to minimize the degree of labor intensiveness in the targeted tasks.

The exact manner in which the TRM will be applied is as yet to be determined, but will most likely be of a computer software type. It is planned for the TRM to be fully interactive and for it to consolidate data gleaned from more than one source. Further, it is considered highly desirable for the final TRM deliverable to operate in real-time and be as easy to operate and apply as possible. The attainment of these characteristics will be given the highest of priorities in the design, prototype, and validation phases of the TRM development.

APPENDIX A

CROSS-SECTIONAL REFERENCE SHEETS

Included in this appendix are three cross-sectional reference sheets one each for the literature review areas of human error analysis, stress and job performance, and accidents and safety.

These sheets reflect the general types of activity considered by the references (SUBJECTS) and the general type of source of the references (SOURCES).

APPENDIX A: CROSS-SECTIONAL REFERENCE SHEETS

	SUBJECTS						SOURCES						
	AIRCRAFT	MOTOR VEHICLES	INDUSTRY	NUCLEAR	THEORY or BASIC RESEARCH	MILITARY	DISSERTATIONS	GOVERNMENT DOCUMENTS	CONFERENCE PROCEEDINGS	BOOKS	PERIODICALS	UNPUBLISHED ARTICLES	MILITARY
CLASSIFICATION SCHEMES			3		14		1	1	1	6	7	1	
DATA BANKS			1		2	1		1		1	2		
INCLUDING HE w/ M/C ERROR					1	2				3			2
DETERMINING SIGNIFICANCE of HE or CAUSES of HE	1		3	1	11	1	1		1	7	8		1
QT			4	2	17	1	1	1	9	3	7	1	3

APPENDIX A: CROSS-SECTIONAL REFERENCE SHEETS

	SUBJECTS										SOURCES				
	AIRCRAFT	NUCLEAR POWER	MILITARY	MEDICAL	INDUSTRY	MOTOR VEHICLES	POLICE	EDUCATION	INFORMATION PROCESSING	OTHER	BOOKS	PERIODICALS	GOVERNMENT DOCUMENTS	CONFERENCES PROCEEDINGS	DISSERTATIONS
GENERAL STRESS	11	1	2	3	10		1	3	1	20	15	20	16		1
OCCUPATIONAL STRESS			1		8						8	1			
HUMAN PERFORMANCE	12	1	12	8	21	1	2	4	2	10	15	35	8	10	7
SAFETY MANAGEMENT					2						2				
HUMAN RELIABILITY	2		1		1								2	2	
OCCUPATIONAL HEALTH	1				5					3	8	1			

APPENDIX A: CROSS-SECTIONAL REFERENCE SHEETS

	SOURCES: DISSERTATIONS	SOURCES: CONFERENCE PROCEEDINGS	SOURCES: GOVERNMENT DOCUMENTS	SOURCES: PERIODICALS	SOURCES: BOOKS	SUBJECTS: OTHER	SUBJECTS: THEORETICAL	SUBJECTS: RAILROAD	SUBJECTS: UNDER WATER	SUBJECTS: BOATS	SUBJECTS: FIRE/EXPLOSION	SUBJECTS: FARM	SUBJECTS: NUCLEAR POWER	SUBJECTS: INDUSTRY	SUBJECTS: HOME	SUBJECTS: HUMAN (SELF)	SUBJECTS: MOTOR VEHICLES	SUBJECTS: AIRCRAFT
STRESS					29		1			3			2	3			14	6
SAFETY					13		1					1	1	4	1	1	3	1
RISK					10		2								2		6	
ACCIDENT			2	3	63	2	5	1	1	1	1	1	2	14	4	2	35	8
HUMAN ERROR					5									2				3
MACHINE DESIGN					2									2				
UNSAFE ACTS					1									1				

APPENDIX B

ANNOTATED REFERENCES

The annotations are by alphabetical order according to author for easy reference and each paragraph gives information provided by one author.

PART I: Human Error Analysis

Adams (1982)

Feels that error is probabilistic and could be simulated using Monte Carlo techniques. Human error should be included with equipment analysis in determining the reliability of systems. Feels, however, this would be impossible. Feels that to be able to analyze error fundamental units of behavior whose success or failure would be used in the calculations must be established. These would be irreducible stimulus-response catagories. States that humans are a closed loop system. They can detect and correct their own errors. Expresses a common belief that error is multidimensional. A response can be omitted, performed out of sequence, transferred from another sequence, wrongly timed, or applied with inappropriate force. Has a current belief that human sequences of action are not independent therefore can not be calculated like machines. Bases a lot of his work on Swain.

Aitken (1982)

Feels that if faults are slow in developing, the system can alert humans to take corrective action, otherwise automatic controls are necessary. Factors which affect human response to an error conditions are: 1. the process which is being controlled, 2. knowledge of the status of the system, 3. prior knowledge of the effects of the control action, 4. human factors specifically relating to the operator and 5. training.

Altman (1964, 1967)

Tries to find a similarity among errors so one can 1. search for significant error 2. identify alternative ways to reduce error or its consequences, and 3. evaluate alternative solutions to error problems. Feels error classification schemes fall into three categories: 1. performance orientation (what a person is, or is supposed to be doing when an error occurs), 2. situational orientation, and 3. individual orientation (characteristics of the person). Associates psychological behavior levels and learning categories (e.g., sensing, tracking, and problem solving) with error behaviors. Attempts to link the basic research of psychology with error. Approaches the area of errors at a higher level -- managerial or technical. Feels errors should be indexed to the kinds and conditions of input and output devices or classified by skill and knowledge content. Goes along with situational causation of error. Constructs a block that relates consequences, revocability, and detectability to measure error tendency. Feels that in some cases the individual characteristics of the worker may be used to classify errors. In general each error possible situation has a best way of classification: performance, situational, or individual.

Askren and Regulinski (1969, 1971)

Feel that repetitive tasks can be modeled. State that human error research has fallen into the following categories: developing human error classification schemes, determining the significance of errors to system operations, establishing human error data banks, and devising models and methods for describing and including human error data in system reliability analyses. Define the following equation to describe reliability:

$$R(t) = e^{-\int_0^t [e(t)dt]}$$

where e(t) = error rate

This equation is supported with a very simplistic derivation and the knowledge that error distributions generally fit well with Weibull, gamma and log-normal distributions. Feel that this applies to continuous operation tasks such as vigilance, monitoring, and tracking.

Beek, Haynam and Markisohn (1967)

The authors were tasked by the Navy to research the Navy's human reliability statistics and suggest improvements. Thus, this study is specific to the Navy in operation and maintenance procedures. The procedure that will be described here was reviewed by Meister. The systems of error reporting used by the Navy were reviewed and critiqued. The authors describe in detail the intricacies of the two models mentioned below. This study did a small literature search. Most previous studies have substantiated the fact that a significant percentage of system unreliability is caused by human error. Feel it is impossible to get reliable data and it is virtually impossible to test people in a laboratory and use the results for predicting human performance under actual conditions. Even if this were possible the results would not apply to another person. Agree with setting up a data base as the forefront of the research effort on human error. Feel the need to be able to predict human error without depending on human performance data since it is unreliable. Human error predictions should be inferred from existing equipment performance data. Define human error as any action of the human element of a system that is inconsistent with a predetermined behavioral pattern established in the system specifications and in the resulting system design. System failure is subgrouped as total system failure and system degradation failure. Two approaches to quantative techniques were developed: 1. Elementary Reliability Unit Parameter Technique (ERUPT). This technique groups components of the system into elementary reliability units (ERUs), the lowest levels at which maintenance is performed. This uses existing equipment reliability data to predict human reliability. 2. Multivariate correlation techniques. These are used to relate personnel characteristics to failures. The problem with error reports is that people are reluctant to file them either because of the risk of self-incrimination or co-worker incrimination since many reports are used for disciplinary or promotion review purposes. Also, some systems give categories to choose from in filling out the report. If too many categories are given only a few actually get used. Refer to Shapero (1960) who said 20 to 54% of all system malfunctions in nine missile systems studied were caused by human error. People arbitrarily blame most problems on lack of training or failure of personnel to follow procedures. Feel a taxonomy is needed before anything else in human reliability research. Feel that human reliability lacks common definitions. Feel that the only errors to be included in reliability analysis are those that affect system performance. Examples of classifications: terminal error, design error, operating error, maintenance error, contributory error, performance of a required action incorrectly, failure to perform the required action, performance of a required action out of sequence, performance of a non-required action, errors of omission (1. errors of memory and 2. errors of attention), and errors of commission (1. errors of identification, 2. errors of interpretation, and 3. errors of operation). This report divides error into two categories: 1. Predictable - established between the inconsistent behavior and some external influence. This type of error can be reduced by human factors design. 2. Random errors -- usually when this is identified as the cause there is no further investigation. "All system failures and malfunctions (except certain laboratory tests) can eventually be traced back to some form of human error, whether it occurred on the drawing board, in fabrication, in testing, in operation, or in maintenance." To improve error reporting an impartial party should be used to evaluate the failure. The second method of multivariate correlation mentioned earlier correlates average pay grade, average time since educational training, average time to evaluation, and average formal education to human error.

Carnino and Griffon (1982)

Give the following catagories of human error 1. operating errors, 2. maintenance errors, 3. testing errors, and, 4. design errors. Support the situational cause of human error theory. Characteristics of the work station which have caused human error may be grouped into eight classes: 1. work organization, 2. design of the work station, 3. time and duration of work, 4. personnel education and training, 5. physical environment, 6. social environment, 7. history of the plant, and 8. individual performances. Give listings of these classifications in detail -- same idea as Performance Shaping Factors (PSF). [See Embrey and Swain] Most frequent causes of human failures are procedures, work organization, and lack of efficient controls. The role of procedures is expanded on since procedures are the interface between man and machine.

Childs (1980)

Discusses parametric tests of significance (on normally distributed scores) especially relative to error-time experiments. States Bradley's optimal-pessimal paradox and then refutes it. This work preceeds Askren (1982) and contradicts it. Bradley's optimal-pessimal paradox is stated as follows: If performance conditions are optimal, then parametric statistical tests tend to be pessimal and vice versa. These are the assumptions: 1. error probabilities are equal across all task segments and fit a Poisson distribution, 2. error commissions uniformly increase task execution times, 3. component error times are orthogonal, 4. robustness of parametric tests is greatly reduced by skewness, and 5. if errors are present there is greater variability in score distributions and hence tend to normalize the distribution. Refutes these assumptions because 1. people simply do not work this way, 2. errors depend on the response stimulus required, and 3. skewness does not matter as long as the distribution is homogeneous in form and variance for various treatments.

Cross (1982)

Looks at the quantitative evaluation area. Uses frequence-consequence diagrams to demonstrate total risk. Event trees show a cause-and-then-effect relationship where fault trees show a effect-and-then-cause relationship. Suggests constructing both to analyze a situation. The event tree can be time oriented and allows for dependencies between systems. The fault tree analyzes the failure of each system independently. These techniques are mainly used to gain a greater understanding of the system under consideration.

Embrey (1976, 1981, 1984)

Looks at Performance Shaping Factors (PSF) and expert judgement to analyze systems and evaluate the probability of failure. Uses the computerized Success Liklihood Index Method (SLIM) in conjunction with a Multi-Attribute Utility Decomposition (MAUD) routine to help reduce bias. In "Application of Human Reliability Assessment (HRA) Techniques to Nuclear Energy Process Plant Design" approaches HRA from a cost effectiveness standpoint. Analyzes effect of design changes on human error. Says that the growing application of computers for routine control functions pushes people to higher control levels which require decision making, diagnosis, trouble shooting, and planning. Different analytical techniques are needed for proceduralized actions and situations where decision making functions predominate. Possible analysis of Proceduralized Situations A. task analysis approach which includes 1. task step 2. inputs, 3. outputs, 4. feedback, 5. error potential, 6. system implications, 7. error recovery, and 8. design implications; B. event trees approach is warranted if task elements are discrete and form an ordered sequential sequence that moves forward in time. Possible analysis of Complex Situations (where thinking is required) A. operator action event tree (OAET) model which define operator actions associated with critical states of a sequence. B. critical decision/action (CDA) operator centered model -- defined in terms of consequences of the decision/action. If a CDA fails it will have a significant effect on safety, and/or production. The CDA model involves less routine decisions than those analyzed by the OAET model. Has developed a system for analyzing a situation with the CDAs. It is necessary to identify each CDA associated with changes of state. This is based on Rasmussen's model of the interaction of skill-, rule- and knowledge-based behavior. From analysis of error reports characteristic types of error can be associated with each CDA. For each CDA a diagram can be drawn for additional information. Discusses limitations of Technique for Human Error Prediction (THERP) - no sensitivity analvsis available and applies only to proceduralized tasks. Has developed a technique to overcome this. C. SLIM - task is evaluated as a whole. It is quantified via the structured application of explicit numerical judgements from groups of experts. (Success Likelihood Index Methodology). This is applied by computers using MAUD. Discusses algorithm using PSFs and expert judgements and SLIs. Since weights are used for each PSF a designer can see where improvements might have the most benefit, therefore the cost effectiveness criteria is satisfied. D. Influence diagram is discussed.

Feggetter (1982)

Uses a checklist based on a syst-ms approach for understanding human error and includes such headings as stress, fatigue, arousal, and personality. Feels we usually find the source of an error but don't really know why it occurred. Feels that it is not possible to categorize errors into unique classes and says that there seldom seems to be a single cause for error. Says there is a combination of cognitive, social, and situational factors which give rise to erroneous actions. These are elaborated on as follows. Cognitive System: acquisition, manipulation, use of information, allocation of attentional resources (overload), emotions, thought processes, past history, and experience. Social: role perception and pressures from other people. Situations: physical environment and stress. Thinks research should be shifted away from memory structures and over to memory processes. Produces a checklist based upon current knowledge of human behavior and the mechanisms and system characteristics which predispose the human operator to error.

Hunns (1982)

Feels that to analytically predict the full set of significant event chains associated with a given human/hardware system is not yet within our capabilities. Human error (or failure) carries connotations of blame and personal deficiency. This is the reason given for some of the inadequacy in error reports procedures. Since people take blame, they tend to not report errors as they should. The majority of human errors are corrected by the person concerned and never become evident to a third party. This goes along with the feedback principle mentioned in other literature. Feels current data approaches are ineffective. "So not only is the human factors data collection activity frustrated by the unyielding nature of the observation environment, but at an even earlier stage the process is confounded because no fundamental basis exists to define the type of information which is really required." This supports those who believe that a taxonomy is needed before human error research can progress. Goes into an elaborate discussion on how a data base should be built with backing from classical probability theory.

Lewis (1981)

Attempts to give a general purpose theory on error. Recognizes that most theoretical approaches are specialized and involve language, math, and the acquisition of perceptua motor skills. An error becomes an error by virtue of its failure to conform with some appropriately chosen standard of correctness. "Under conditions of felt urgency, we make mistakes. And, since error is inherently proliferous, yet more mistakes come piling in on top." Says that errors are self-limiting and people naturally want to rid themselves of them. Desired goals cannot be attained if error gets in the way. Management should not have to convince people to recognize their own erroneous thinking. Feels that of the current literature Swain and Guttman (1980) offer the best classification scheme: omission and commission with the subcategories of commission - extraneous acts, sequential errors, and time errors. Gives definitions of error change according to the situation and what is perceived to be a correct action. Error can occur because a situation was appraised incorrectly, or because inappropriate action was taken. Feels there are two types of error: 1. failure to make a distinction that needs to be made and 2. making of a distinction that does not need to be made (omission - commission dichotomy). Rewords these as 1. errors due to significant omissions and 2. errors due to misdirective inclusions. This was because of the trouble caused by the word "need" above. Says that human error is compounding.

Meister (1964, 1966, 1971, 1973, 1982)

Feels that simulation based methods are more powerful than non-simulation methods and that no general purpose methodology is yet available. Feels strongly there is a great need to develop data banks. Feels that much work needs to be done to solve the problem of task dependency relationships (this refers to those who say that classical probability theory does not apply to human error since there are dependent relationships involved.) Feels that most of the quantitative methods available today are special purpose or require a particular form of input and are still in the developmental stages. Says that the frequency of Human Initiated Failures (HIF), that is failures that result in degradation of performance of the system and reduce equipment, range from 20-80% of all failures reported. States that the distribution of individual operator errors tends to approximate a Gaussian distribution with the mean as constant error and the standard deviation as variable error. Says that operator errors compound linearly. Gives tables of error rates. Thinks we should concentrate on work situation to reduce errors, and that most errors are situation caused. Says a lot about what should be done and has a lot of criticism to hand out. Feels that human error includes causes of error built into the system, i.e. poor human factors design. Classifies error as to cause, effect, and stage of occurrence. Gives two catagories of operator error, idiosyncratic (aptitude and motivation) and situational (procedures and training). Types of error are system induced, design induced, and operator induced. Feels that the casual classifications of error do not imply understanding the error source or the mechanism of the error process. Makes the statement that errors made with discrete tasks are more quickly corrected than those made with continuous tasks. Feels that automation significantly increases the requirements of functional allocation, maintenance, and logistics. Feels that the causes of production error are: lack of training, lack of motivation, inadequate work space, poor layout, poor environmental conditions, inadequate human factors design, inadequate methods of material handling, inadequate procedures, and poor supervision. Says error causation is usually due to multiple factors. Says that errors are caused by a mismatch between the capabilities of the operator (idiosyncratic factors) and the demands of the job (situational factors). There is an error potential in man which is not realized until a predisposing condition, creating a mismatch, permits the error to occur. The predisposing condition is a catalytic agent which translates a potential into an actual error. Feels that nothing is inevitable about error. Errors occur when demands and capabilities do not match. To reduce error mismatching must be reduced. This contradicts a prevailing theory that to err is human and hence errors cannot be avoided. Feels that human variability is not the main cause for system degradation since errors do not build up. Humans are adaptable, and thus are desirable for many tasks. But this adaptability also makes humans one of the causes of error. Says in 1982 that random errors, i.e., those produced by the inherent variability of people, can be reduced by training and proper selection of personnel. Classifies types of errors as 1. fail to perform required action, 2. performance of unnecessary action, 3. performance of required action at an incorrect time, and 4. making a substandard response. Says 40% of equipment failures are the result of error, and as much as 82% of production defects are caused by human error. Defines idiosyncratic factors to include personal relationships, emotional conflicts, and attitudes. Gives a list of PSFs that predispose a human to error. Feels to evaluate a job a human factors expert should ask questions about each PSF along with: is task within worker's capability, does task cause fatigue or discomfort, is feedback provided, is too much precision required or too many movements, and is the physical environment adequate.

Petersen (1980)

Researches the fields of education, management, psychology and human factors engineering. Looks at basic research as well as applications. Intends for work to be used as a text book. Says an old view is that the prime causative factor in occupational injuries is human error rather than physical conditions. In 1939 Heinrich gave four basic motives for unsafe acts: improper attitude, lack of knowledge or skill, physical unsuitability, and improper environment. Says this view is seen as oversimplified, but this is what most industries use. Heinrich said managers control accident prevention. Says the behavior of people needs to be understood and controlled in order to prevent accidents. Supports the multiple causation theory of human error. Discusses a particular type of fault tree which is management based. Human error results from one or more of three things 1. overload (defined as a mismatch between a person's capacity and the load placed on him in a state), 2. a decision to err, and 3. traps that are left for the worker in the workplace (i.e., poor human factors design). Under the first category falls overload in the forms of physical, physiological, and psychological. Capacity is due to a combination of physical, physiological and psychological endowments, current physical condition, current state of mind, current level of knowledge, skill, temporary reduced capacity due to drugs, alcohol, pressure, and/or fatigue. Load is due to a combination of the quantity of information processing, environment, worry, stress, current state due to personal life, and/or hazards faced continuously. State is due to the level of motivation, attitude, arousal, and/or biorythmic state. The second category deals with peer pressure, pressure for production quotas, accident proneness, and the instance of risk taking because it is inappropriately considered unlikely for a mishap to occur at the time of the taken risk. The third category deals with incompatability between the human and the workplace. Human factors applications are generally used to correct this. Quotes Chapanis that humans commit errors because it is logical that they do so in the situation they are in. Says human errors are caused; they do not just happen. Situations cause error and the greatest gain in controlling human error can be made by altering the situation. Says that improvements from redesign of equipment are greater than that from selection of or training of personnel. It is easier to change equipment than people. Design characteristics which increase the probability of error commission include violations of operator expectations, mismatch of abilities and demands, induced fatigue causing circumstances, inadequate facilities or information, and difficult, unpleasant, or dangerous tasks. Says risk taking occurs because judgement of risk is not directly related to the hazard as measured by the worker's performance skills. Skilled workers take less risk than unskilled; younger persons take more risks of a more severe nature than older persons; females take less risks than males. A risk taker is a person with a high anxiety level, high sociability, and low emotional stability. No strong relation between vision acuity and accident repeaters was found. High or low arousal levels cause errors. Thinks an optimal arousal state for peak efficiency is needed. In discussing accident proneness, says that accident frequency is unrelated to intelligence when such is adequ·te for the situation. Individua's whose level of muscular reaction is above their levels of perception, are prone to more frequent and more severe accidents than those individuals whose level of muscular reaction is below their perceptual levels. Errors occur when man is used where a machine would be better. Poor adjustment causes accidents such as when a person starts a new job and has a hard time adapting. When people are down, they cause more accidents. To stop people from causing accidents 1. direct confrontation by management, 2. training or coaching from management, and/or 3. behavior modification techniques may be used. Group norms are perhaps the single most important determinant of worker behavior. To avoid the decision to err 1. positively reinforce safe behavior, 2. build strong work groups, 3. build attitudes conducive to safety, and 4. have management that is employee centered. Quotes Schulzinger (1956) that the tendency to have accidents is a phenomenon that passes with age. It decreases steadily after reaching a peak at age 21. Men are significantly more liable to accidents than women. Irresponsible and maladjusted individuals are significantly more liable to have accidents than normally adjusted individuals. Accident prone people make up a very small part of accident statistics, less than that attributable to chance as determined by a Poisson distribution. Goes into detail on how to specifically accomplish ways to avoid errors. Each topic is delved into in detail in separate chapters of the text. Most is involved with management theory.

Pickrel and McDonald (1964)

Feel that the extent and cost efforts to eliminate sources of human error should be commensurate with: 1. frequency with which the error is expected, 2. frequency with which a failure will occur as a result of the error, and 3. probable consequence of the failure condition. Task criticality ratings are determined from these points. Give a probability worksheet and criticality analysis, and feel that even though the method has shortcomings it is better than nothing. Feel that another method would be to come up with error probabilities.

Rasmussen (1982); Rasmussen, Pederson, Mancini, Carnino, Griffon, and Gagnolet (1981); and Rassmussen and Rouse (1981)

Say it is not good enough to study the effects of error, internal causes need to be looked at. Feel systems should be designed to tolerate error since human error can not be predicted reliably. This is consistent with Meister in the criticality of using quantitative methods for predicting error. This also implies the belief that to err is inevitable, which is stated later as human errors are the inevitable side of human adaptability. Say that centralization increases size and complexity of a system. Feel that recommendations for better training with stricter administrative controls is not the answer, better design is. This correlates to others that feel the situation causes more errors than the human alone. Caused errors are unfulfilled purposes. People find the easy way out. It is thought a solution to the cause for error has been found when something familiar is uncovered. Easy way to fix humans is to tell them to try harder but this is not a satisfactory solution. People generally don't commit errors because they want to. Most error reports are not reporting all the errors people commit. They indicate only the errors which are not corrected because they have an effect that is either irreversible or not immediately apparent to the person. Therefore, reports are biased by the potential for feedback. Say that 80-90% of the cases of errors fall into three catagories: ommission of steps, mistakes among alternatives (up/down, +/-), and operational "improvement" (people making up a "better way" as they go along). People typically know what to do and when, but not always how. Omissions and inadequate consideration of latent causes or inappropriate side effects in selecting procedural steps are the two main causes of error. Suggests feedback be used whenever possible since people correct their actions when it is provided. Suggest that control panels cause errors since people have to relate dial readings to the state of the system. Such calls for interpretation and integration. A lot of this work centers around nuclear power plants. Support the multiple causation theory. "In a system of balanced design major accidents will depend on a complex chain of events including equipment faults and latent risky conditions, together with human mistakes and errors." Gives a definition of accident as: "an unwanted transfer of energy because of lack of barriers and/or controls producing injury to persons, property, or process." Quote from Johnson: "Typically the effect of exotic and unpredictable human acts is masked by the frequency of trivial equipment faults." When humans are put into a system the risk taken is not that they will cause accidents, but rather that they may not succeed in preventing them. The problem in the present context is that people in the system must be considered as system components and that human error data are needed. Say that risk analysis (as compared with reliability analysis) involves the estimation of the probability of several categories of accidental event sequences related to the relevant categories of risk such as damage to people and environment as well as to loss of major equipment. This means that the overall probability related to a specific consequence must be calculated by a probability model derived from the family of relevant accidental event sequences together with data on the component failure modes involved. Collecting data for error rate information on humans is difficult due to feedback. Reliability of human performance in response to infrequent demands ranges from .2 to .6. Therefore error rates from general error reports will not apply to this situation. An accident is typically caused by a sneak path for events, created by the accidental timing of a considerable number of normal and erroneous human acts together with latent risky conditions and equipment failures. Define the external mode of malfunction as the immediate and observable effect of human malfunction upon task performance, as opposed to internal mode of malfunction which comes from within the person. Expand on the types of behavior and the errors classified under each: Automated skill-based behavior (types of error: task not performed, erroneous acts, and extraneous effects on other and nearby systems), Goal-oriented and rule-based behavior (types of error: deficiencies in coordinating segments of skill-based behavior, errors in recall of reference data, and mistakes among alternatives). Technique for Human Error Rate Prediction (THERP) is used here. Knowledge based, goal controlled behavior (latent effects of decisions come into play). This type of behavior can not be predicted. Regarding PSFs: "In general, it is advantageous to distinguish clearly between causes, which are changes or events followed by a change of events, and more general factors which influence the flow of events by modifying human behavior or probabilities of response."

Sheridan (1981)

Gives a little better definition of event trees and fault trees: event trees characterize with what probabilities different major events follow other events. Fault trees characterize how Boolean "and" and "or" logic determines the various ways that major system failures might occur, the "top events" of which are transferred to event trees. Says we can't treat human error like machine error because people fail differently than machines do and objectivity is more difficult. States theory that error occurs when a person's internal model is out of calibration with the real world or when the environment causes a person to commit an error. Feels in general the world of human error research is in great disarray -- no good definition of error (changes from place to place), no pinpointed cause (different theories), different classification schemes, human errors compound each other, people correct their own errors (these last two affect probability calculations), errors in one stage of development of a project compound with others later on. Agrees with biased error reports statements. Suggests rating errors with relationship to their effect 1. safety consequences, 2. economic consequences, and 3. personal consequences. Deals with humans as monitors of automated systems and the human's detection of an error condition in the mechanical system.

Siegel (1970)

Develops eight models with various characteristics. One even incorporates both equipment and human performance so as to yield a prediction of integrated system reliability. Feels there has been little effort towards human reliability in a system context and considering human reliability with equipment reliability to get system reliability. Acknowledges that behavioral studies are considerable in number but they are restricted in application. Believes that current system operator/maintainer unreliability situations contribute to total system unreliability more than hardware unreliability situations do. Therefore, considering only equipment reliability during design phases exposes a designer to the risk of a gross overstatement of system reliability. The models are stochastic since human behavior is dynamic and can not be represented by deterministic models. Human behavior is time varying. People learn, read differently under stress, vary in ability and attitudes. Leadership and personal factors affect human performance, humans get sick and fatigued. Decision making ability affects system performance. No two humans are alike. They are very flexible and adaptive. The models are stochastic digital simulations and sequentially simulate the acts and behaviors of the operators/maintainers in a man machine system as the tasks involved in mission performance are executed. "Current performance is based on such variables as past performance, the actions of other crew members, the current stress level, the input of individual proficiencies, and random fluctuations. All models consider the impact of initially unanticipated events such as malfunctions and emergencies on operator/system performance. Some even emphasize social interactive and group facilitative variables as well as individual performance variables."

Singleton (1972)

Feels that recent attempts to classify errors emphasizes the distinction between causes, effects, and remedies. Considers analytical techniques. Goes along with those who feel a taxonomy is needed before anything else. After practical experience with national reporting to the data base, a taxonomy would emerge. Points towards this philosophy in the techniques for improving production books. Says classifications have fallen under seven types: commission : omission; reversible : irreversible; systematic : random; detectable : undetectable; formal : substantive; recoverable by machine, man, or neither; inputs : outputs : decisions. Reviews each of these techniques from other sources and concludes that the existence of all these different techniques confirms the complexity of the problem. Discusses analytical techniques versus statistical techniques. Accidents are rare and the reporting of results is distorted. As for distribution curve fitting: "Poisson can usually be interpreted as resulting from a situation of equal risk, a negative binomial results from a situation where there are some higher risk elements all the time." Type A errors result from situations where all the elements are at a higher risk level for part of the time. The critical indicant method researches near-accidents and thus provides a larger sample size. Observation methods have a trained person investigate the accident immediately after it happens. The most obvious technique for dealing with human error is to automate. The practical situation turns out that machines are poor at error correction while people are exceptionally good in this area. In addition, proper human factors design techniques contribute to total error reduction. Allocation of function, interface and workspace design, selection and training, overqualified personnel, rigid procedures, contingency planning, human and hardware based monitoring, working hour controls, and other conditions all are contributory to error reduction. Reiterates problems in error investigation because of two theories: 1. to err is human and 2. humans are responsible for their own actions including errors. Placing the blame is involved and people will not own up to their mistakes in general. Recognizes that humans will make errors and classifies the kinds of errors which are likely to occur. Identifies their causes and effects and devises methods of minimizing error rates and the consequences of errors.

Swain (1964, 1967, 1970, 1973)

Was the develo, ~ of THERP (Technique for Human Error Rate Prediction) a quantitative technique for predicting human reliability. Constructs a fault tree to show relationships between tasks performed by a human being. Uses the AIR Data Store (Payne and Altman 1964) along with expert judgement as to individual probabilities of success and applies probability theory to arrive at a final reliability figure. The AIR Data Store was the first attempt at a human error data base. Also had contributed to the development of SHERB (Sandia Human Error Rate Bank). Believes a data bank should come before all other research. Set up forms to be used and a filing system for all the information gathered. These techniques are used for proceduralized cases. Feels that modeling efforts have been adequate and researchers should concentrate in other areas. Says human errors occur when people 1. fail to perform a task, 2. perform a task incorrectly, 3. put in wrong task, 4. perform task out of sequence, or 5. fail to perform task in allocated time. Feels that efforts should now be concentrated on a data bank. Analysts should not consider the consequences of error in a data bank, only the probability of error. Should develop a bank first. After analysis of the bank, a taxonomy should be developed. Computerization is not universally recommended. Is the originator of the Performance Shaping Factor (PSF). Suggests making a list of PSFs and rate each one for each human error reliability analysis. This is basically a quantified subjective judgement of the PSF. Feels that forms for reporting errors and those put in the data bank should be unstructured. Should be able to repeat the error by the description, like describing an experiment. Should record preceding tasks and following tasks. Suggests that substitution of machines for human functions often decreases rather than increases system reliability. Says the techniques for error quantification as of 1964 are trees, scaling, experimentation, and literature search. Lists the factors of error: conditions of learning, performance capacity, attention or alerting conditions, information given by instructions, feedback conditions, environmental variables, and effect of personal equipment and clothing. Feels that taxonomy and modeling techniques are needed. Says there is always a tradeoff between costs and error reduction. Says that most errors are caused by the design of the work situation rather than by imcompetence, poor motivation or carelessness. Situations cause most of the errors. The situation in which a worker performs is controlled by management and can affect motivation and job satisfaction. Errors are when an action exceeds tolerable limits. Errors are inevitable unless 1. there are no tolerable limits set, 2. tolerance limits exceed the range of human variability, or 3. opportunities to commit errors are small. Says that error is a natural and inevitable function of human variability. People err because they can do so many different things in so many different ways. Feels that there is no such thing as error proneness. Recommends taking the work situation approach, that is matching a job's demands and people's abilities. Feels that preventative measures are more effective than remedial ones. Provides a definition of error: conflicts between extra- and intra-individual factors cause errors. Types of error are 1. fails to perform task, 2. performs task incorrectly, 3. introduces extraneous task elements, 4. performs task out of sequence, or 5. fails to perform task in allotted time. Hence behavior reduces the success of system. Gives a comprehensive listing of the PSFs. Discusses research done on rest periods by the English.

VanCott and Kinkade (1971)

Discuss variable and constant errors. Provide the definitions which are commonly accepted by the discipline. This is a landmark foundational compendium of design guideline information for equipment design. Attempts to apply classical probability theory to human errors and to calculate the probability of occurrance of human error. Agree with Askren in that measurements of human characteristics follow a Gaussian distribution including errors which follow a bell-shaped curve. Allow the mean to be characterized by constant error and the standard deviation to be characterized by variable error. In the case of variable error, they feel that human errors compound linearly with go-no-go situations.

Wheale and O'Shea (1982)

Study the effect of noise on error rate. The hypothesis was that noise affects performance by increasing arousal. Extroverts scored more errors than introverts and high neuroticism scale people also had more errors. The results showed that intense noise does not have any harmful effect. In fact it masks distracting stimuli. Level of arousal was also not related to noise. It tended to stabilize and to suit task demands. Theorize that noise should have affected a short-term memory task. Intermitent noise has the greatest effect on increasing the error rate. Noise increases arousal only when the task is challenging and the noise represents a potential threat to the satisfactory completion of the task. Extroverts have sociability and impulsiveness. Impulsiveness is related to destractability which increases errors. Their final result: noise does not affect the level of arousal but the level of arousal does affect the error rate of humans.

PART II: Stress and Job Performance

Alluisi (1978)

References Chiles (1967) and his four problems of performance assessment: 1. criterion, 2. task taxonomy, 3. reliability of performance measures, and 4. role of face validity. Comments that by 1978 only problem 1. is still pertinent. Further, reports that the U.S. Supreme Court has endorsed that performance-based criteria be required for acceptance validation of selection techniques, and that a test validated on one task cannot be used for another task unless in can be shown there are no significant differences between the two tasks.

Cox (1978)

Provided are three approaches to studying stress: 1. the dependent variable is a person's response to a disturbing environment, 2. the independent variable is the stimulus characteristics of a disturbing environment, and 3. investigate the difference between the stimulus and the response as an indication of "lack of fit." Also provided is a response-based model of stress which relates a stressor-to-stress relationship to a stimulus-to-response relationship with respect to physiological and psychological forms of stress. Indicates that it has been empirically shown that conditions thought to cause stress do not always cause performance degradation. Identifies three difficulties with stimulus based definitions of stress: 1. it can not be reliably identified what aspects of real-life are actually stressful, 2. stress present in an individual can not be quantified, and 3. human variability across conditions has not been adequately investigated. Finally, the investigator is cautioned to self-examine the experimental design because it is usually not clear whether the stress exists in the eye of the subjects or in the eye of the empiricist.

Cox and MacKay (1981)

Provided is the transactional model of stress: stress is correlated to a particular relationship between humans and their environment. There are five stages in a typical stress experience cycle: 1. the relationship of the person to the sources of a demand, 2. the person's perception of the demand and his/her ability to cope, 3. the person's psychophysical reaction to the imbalance between the actual demand and the person's actual ability to cope, 4. the impact of the person's coping responses, and 5. the level and character of feedback in the loop. Generally extremes of sensory stimulation (auditory noise, heat (or lack of heat), humidity, isolation, congestion, etc.) and extremes of workload are considered to be stressful.

Embrey (1978)

Uses Meister's (1977) human performance model. States that the term stress is used indiscriminately in reliability literature. Stress is often discussed in connection with the effectiveness of a human operator in coping with various types of system emergencies. Others use stress only in explaining the effects induced when inadequate time is available to accomplish a series of tasks. Besides extreme conditions, one is also interested in the implication of stress for day-to-day reliability. States that a human functions best under conditions when there is a moderate load. The performance would be less than maximal either if the demand is too high or if the demand is too low. Suggests that Hebb's (1955) arousal theory implies that a certain amount of variety is necessary for minimizing the effects of load stress. Defines stress based on McGrath (1970) as the result of an imbalance between demand and the organism's capacity to meet that demand. States that this is, in turn, a function of the intrinsic capability of the operator, his training, and his physical state when confronted with a demand. Refers to the Eysenck Personality Inventory and its indication of extroversion and introversion personality traits. It is recommended that extremes of these traits should be avoided when placing humans in a monitoring task (calling for extroversion). Says effective training can considerably reduce stress produced by emergency situations. Presents the following measures that should be considered to ensure reliable operator performance in stressful conditions: 1. incorporation of human factors principles, 2.

selection of operators based on their ability to cope with stress, 3. emphasis on training in stressful situations, 4. provision of a task specification with a reasonable level of built-in activity in order to provide the operator with an optimal level of activation, and 5. consideration of using mediation techniques to increase the individual's resistance to stress.

Finley (1969, 1970)

Addresses the taxonomies developed by Alluisi, Miller and Meister for task analysis. Also discusses the Fleishman-Parker approach which is based on the method of differential psychology and ability identification. Took the reports of operational task analysis and used Meister's taxonomy to develop a set of 75 behavioral dimensions. These were divided into six classes: 1. individual gross body movement abilities, 2. conceptual and thinking abilities, 3. psycho-motor abilities, 4. perceptual-cognitive abilities, 5. memory functions, and 6. adjustment potential.

Hogan and Hogan (1982)

State that the Stress Activation Syndrome (SAS) entails all processes connoted by the term 'stress.' There are three components: 1. stressors, 2. stress responses, and 3. subjective or psychological factors that mediate between 1 and 2. Stressors are defined as physical (stimuli that palpably and noxiously impinge on an individual) and psychological (stimuli that generate the anticipation of harm -- either physical or social). There are five general categories of stress responses: 1. General Adaption Syndrome (GAS) which is a psychological phenomenon describing the relationship between alarm coping and exhaustion, 2. fight vs. flight where physiological changes in the GAS serve to energize the system to one or the other, 3. becoming ill which is a completely involuntary complex function of several co-occurring conditions, 4. psychosomatic disorders which lie between the realms of psychology and medicine, and 5. long term performance decrement due to a combination of illness, distractability, inattention, fatigue, and stress related abuse. Present five theories to stress: 1. emotional homeostasis -- the stressful state is characterized by emotional arousal (usually anxiety), somatic changes, and certain kinds of cognitive activity in response to stressors, 2. person to environment fit -- good match leads to high performance, expressed satisfaction, and low stress whereby a poor match leads to performance decrement, dissatisfaction, anxiety, depression, elevated blood pressure and heart rate, and somatic complaints,

3. sociological -- advocating that the causes of stress are found in the structural features of the social environment not in the individual, 4. Type A Behavior -- which is the behavior pattern characterized by excessive aggressive drive, impatience, a sense of time urgency, a compulsive need for achievement, and a need for extreme job involvement, and 5. Life Changes -- based on Social Readjustment Ruling Scales (SRRS) which are currently being investigated on how they relate to illness onset. Discuss four problems with stress research: 1. personality measures are not powerfully associated with the magnitude of stress responses, 2. there is a conceptual confusion due to a lack of common terms and descriptors, hence making it difficult to correlate independent studies, 3. the fact that psychoanalysis is solving problems but not in the manner of it being research from which conclusions, results, etc. can be derived and used for the general good, and 4. there still exists an undeveloped measurement base for stress. States a socioanalytic theory of stress which conceptualizes the subjective factors which mediate stress responses by characterizing the human as a group-living and culture-using animal who needs a character structure (rules, values, and expectations) and a role structure (individual perception of rules, values, and expectations). State that stress proneness (or vulnerability) is a direct function of self esteem which is an indirect and complicated function of the character and role structures. Recommend to first establish an adequate measurement base then study the relationship among personality structure, stress vulnerability, and vocational placement.

Howarth (1978)

Provides four theoretical views of stress: 1. biological (human lifestyle differs too much from current level of adaption), 2. developmental (human is unprepared for the demands of chosen lifestyle), 3. social (exposure to conflicting social pressures compels human to play inconsistent roles, and 4. phenomenological (there is a discrepancy between the human's lifestyle and his/her aspirations).

Kahn (1981)

Presents the quality of employment survey and provides a factor structure which analyzes the importance of the job characteristics derived from the survey. A job is divided into eight basic aspects: 1. task content, 2. autonomy and control, 3. supervision and resources, 4. relations with co-workers, 5. wages and rewards, 6. promotions, 7. working conditions, and 8. organizational context. Argues that most people want to work (beyond the need for economic gain) and that deprivation of work is a stressful and potentially damaging situation.

Lazarus (1976)

Provided an interactional definition of stress: stress occurs when there is a demand which taxes or exceeds one's adjustive resources. States that frustration is a form of harm already evident in a human. Threat is anticipation of harm. Harm is physical, psychological, or social damage. Defined demand as a request or requirement of physical or mental action and implies some time restraint. Four comprehensive observations are made: 1. stress develops from a particular relationship between the person and his/her environment, 2. the social background of stress experience is a critical factor, 3. a major problem with laboratory studies is that the subjects usually are instructed (or they expect) that the stress experience is controlled and will be of short durations, and 4. there is too much ambiguity in a vast catalog of terms used in the stress area, hence making subjective response data subject to scrutiny. Coping with demands is both psychological (cognitive and behavioral strategies) and physiological. If normal coping is ineffective, stress is prolonged and abnormal responses may occur. Prolonged stress may result in functional and/or structural damage.

McGrath (1976)

States that stress occurs when a human confronts a demand which is perceived to be beyond his/her capabilities, given that the human wishes to cope with the demand. Makes the controversial statement that situations of small disparity between the demand and one's perception of capability to cope are more stressful than the opposite.

Peterson (1980)

Refers to stress as load and breaks it into long-term and short-term categories. Short-term is defined as the present work situation. Short-term load is a function of current and outside influences and internal feelings. Factors involved are the task in itself, the psychological load e.g., task ambiguity, task success criteria, feedback, task confusion, shifting goals and tasks, environmental load, fatigue, and boredom. Long-term is defined as relating to the effect of stressors associated with life situations or current mental health. Long-term load is the relationship between a person's life situation and his likelihood of being involved in accidents.

Weitz (1970)

Provided eight sources of stress: 1. accelerated information processing, 2. noxious environmental stimuli, 3. perceived threat, 4. disrupted physiological function due to a disorder, 5. isolation and confinement, 6. blocking, 7. group pressure, and 8. frustration. Source 8 was redefined by Frankenhauzer (1975) as a lack of control over events.

Welford (1973)

Stated that stress arises whenever there is a departure from optimum conditions of demand which the person is inhibited from rectifying. Agrees with Hebb (1955) that a plot of performance versus demand is a convex parabolic curve which indicates low performance for both low and high demand.

PART III: Accidents and Safety

Anderson, R. (1983)

Discusses the data collected in slipping, falling, and tripping accidents. It induces training and experience, number of hours worked, form of payment.

Corbett (1978)

Emphasizes the need of an accident causation model based on psychological processes for adequate analysis of accidents. The logic of the psychological aspects of accident occurrences is presented as memory interpretation and identification. This logic results in sensory inputs which produce failure and incorrect output.

Craven (1981)

Emphasizes the importance of using a formal strategy in fire and explosion investigations so that evidence is not disturbed and opinionating is supressed. Suggests a checklist of common categories of behavior [taxonomy] which may be associated with intentional fires.

Danaher (1980)

States that controller errors are not due to the mechanical systems but are due to human mistakes in attention, judgement, and communications among personnel and supervisors.

Fowler (1980)

Desires for the human error analysis problem readdressed with air traffic controllers. The idea is not to reduce error potential but to increase the number of aircraft under positive control by a single controller. The operators (controllers and pilots) must be understood and appreciated in terms of their capabilities and limitations.

Kletz (1976)

Asks for a different approach in accident data collection. Questions whether industry accident reports are ever read. States that current approach is to try to devise a means of identifying hazards so as to determine which warrant revision. Calls for a data bank which includes near-misses, and a need to train operators to better recognize human errors as they occur.

Levine (1976)

States that industrial accidents have been reduced significantly by considering the hazardous properties of machines, lighting, noise, and physiological limitations of operations. Behavioral scientists have introduced social and psychological attributes (including life situations) of workers as additional dimensions of accident etiology.

Patnoe (1978)

States that it is generally agreed in the field of accident investigation that 80% of all accidents are the result of human failure and the other 20% are attributable to mechanical failure or acts of God. States that Holmes and Rake (1967) conducted a landmark study on social stressors and the Social Readjustment Rating Scale (SRRS). States that test data from Holmes and Masuda (1974) establishes a consideration between life events of the individual and accident causation.

Piniat (1978)

There is a need to place greater emphasis on the control of unsafe acts. Examines principles of motivation theory as a potential tool for the safety professional to minimize the frequency and severity of harmful events by controlling unsafe acts. Stresses job satisfaction factors. The safety professional must be able to utilize the most valuable resource at his disposal, the employee, to optimize the efficacy of his efforts towards a safe and healthful environment.

Slovic (1982)

Refers to Wilder's theory of risk homeostasis which is a hypothesis that people have a target level of risk in different activities and these are not necessarily the same target for all activities. This will cause safety measures to be ineffective from time to time. Feels that reducing people's tolerance for risk should have a salutory effect on safety.

Smillie and Ayoub (1976)

Present a simulation modeling approach for aiding in the discovery of potential hazards that are essential for the functioning of the accident process. This model is a closed-loop system which considers the major factors of presented, expected, and perceived information, the actions of the situation, and the feedback to the human. Incorporate new features into model of Hale and Hale (1970) and include the flow of information constructed according to a multilinear events sequencing approach suggested by Brenner (1975).

Swain (1972)

States that occupational accidents are frequently written off as results of human error or poor workmanship. Provides four models: 1. single, 2. sequential, 3. logic diagram, and 4. dynamic models. Suggests that ergonomists should concentrate on making improvements in the working environment instead of making unfruitful attempts to reduce natural variations of human behavior.

Weiner (1980)

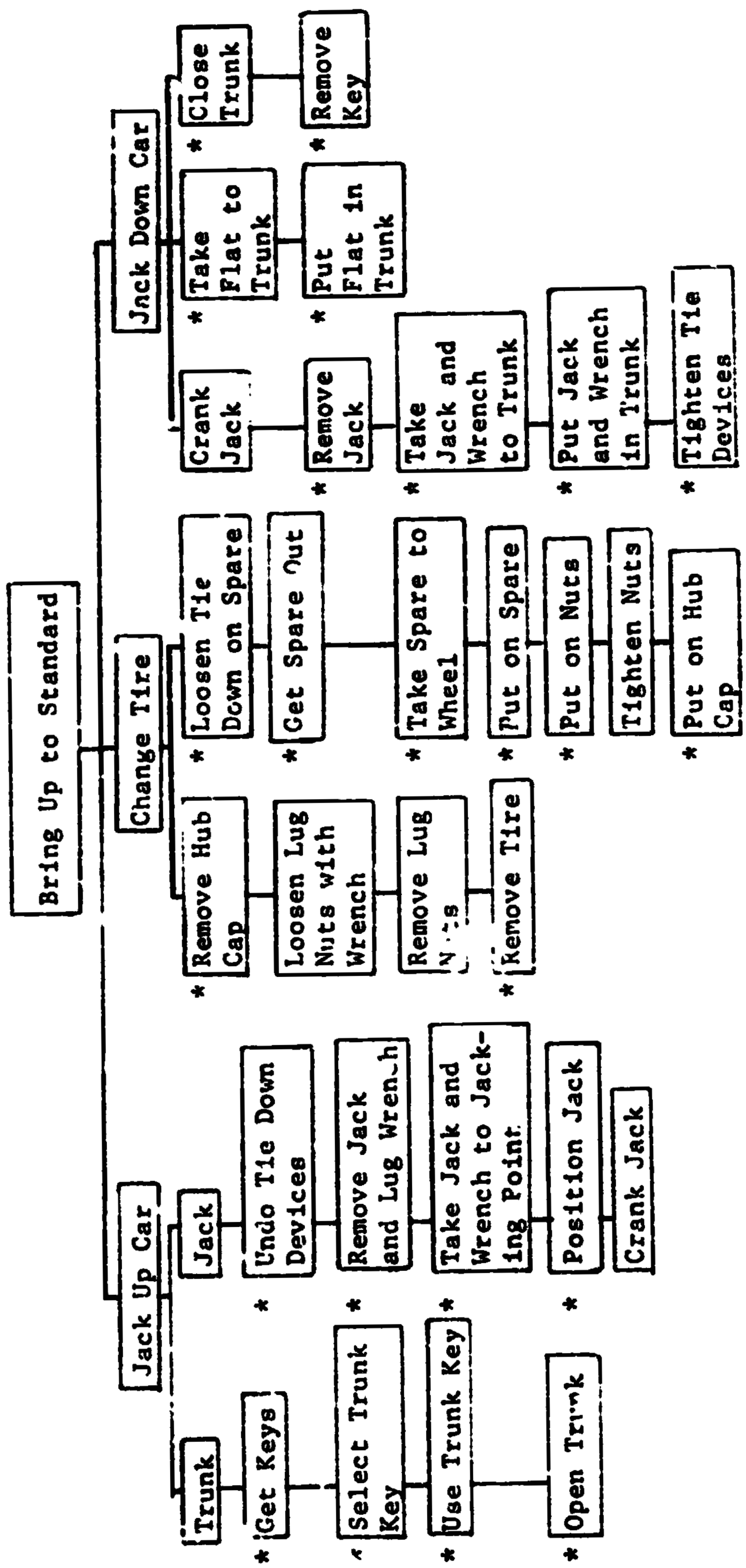
Sees airline collisions as results of system induced errors, resulting from a system that emphasizes airspace allocation and political compromise rather than dealing directly with the various problems facing controllers and pilots.

APPENDIX C

ILLUSTRATED EXAMPLE OF A TASK REVIEWED BY THE TRM

APPENDIX C: Illustrated Example of a Task Reviewed by the TRM

TASK NAME: Changing a Flat Tire
TASK OBJECTIVE: Bring Vehicle Mobile Suppport System up to Minimum Standard



(All Functions designated by an * have been allocated to humans. All others have been allocated to non-humans.)

APPENDIX D

REFERENCES

REFERENCES

Abbott, R., and Longhofer, D.L. General aviation fatigue loads - a comparison of analytical and recorded spectra (SAE Report No. 770463 for meeting, Mar 29 - Apr. 1, 1977). Warren, PA: Society of Automotive Engineers, 1977.

Accidents causing death of several persons in U.S. since 1940. Population, 27(3), 525-526, 1972.

Adams, J.A. Issues in human reliability. Human Factors, 1982, 24(1), 1-10.

Aitken, A. Fault analysis. In A.E. Green (Ed.), High risk safety technology. New York: Wiley Interscience, 1982.

Alkersten, P.A., Johansson, S., and Wirstad, J. Survey of the maintenance of a nuclear power plant with reference to the risk of human errors. Results from the preliminary study at the Ringhals Plant. Karlstad, Sweden: Ergonomrad AB, 1981. (NTIS No. DE 81700083)

Alkov, R.A., Borowsky, M.S., and Gaynor, J.A., Stress coping and the U.S. Navy aircrew factor mishap. Aviation, Space, and Environmental Medicine, 1982, 53(11), 1112-1115.

Alluisi, E.A. Performance measurement technology: Issues and answers. In L.T. Pope and D. Meister (Eds.), Proceedings of the Symposium on Productivity Enhancement: Personnel Performance Assessment in Navy Systems. San Diego: Navy Personnel Research and Development Center, 1977, 343-360.

Alluisi, E.A. Stress and stressors, commonplace and otherwise. In E.A. Alluisi and E.A. Fleishman (Eds.), Human performance and productivity volume 3: Stress and performance effectiveness. Hillsdale, NJ: Lawrence Erlbaum Association, Inc., 1982, 1-10.

Alluisi, E.A., Coates, G.D. and Morgan, B.B., Jr. Effects of temporal stressors on vigilance and information processing. In R.R. Mackie (Ed.), Vigilance: Theory, operational performance and physiological correlates. New York: Plenum Press, 1977, 361-424.

Alluisi, E.A. and Fleishman, E.A. (Eds.) Human performance and productivity volume 3: Stress and performance effectiveness. Hillsdale, NJ: Lawrence Erlbaum Associates, Inc., 1982.

Alluisi, E.A. and Morgan, B.B., Jr. Temporal factors in human performance and productivity. In E.A. Alluisi and E.A. Fleishman (Eds.), Human performance and productivity volume 3: Stress and performance effectiveness. Hillsdale, NJ: Lawrence Erlbaum Associates, 1982, 165-247.

Altman, J.W. Improvements needed in a central store of human performance data. Human Factors, 1964, 6(6), 681-686.

Altman, J.W. Classification of human error. In W.B. Askren (Ed.), Symposium on Realiability of human performance in work (Report No. TR 67-88). Wright Patterson Air Force Base, OH: Aerospace Medical Research Lab, Aeronautical Systems Division, USAF, May 1967. (NTIS No. AD-659140)

Altman, J.W. The progressive inference approach to development of data resources for predicting human reliability. Proceedings of the US Navy Human Reliability Workshop. Washington, DC: Department of Navy. Office of Naval Research, 1971. (NTIS No. AD 722689)

Anderson, C.R. Coping behaviors as intervening mechanisms in the inverted U-stress performance relationship. Journal of Applied Psychology, 1976, 61(1), 30-34.

Anderson, K., and Revelle, W. Impulsivity, caffeine and proofreading: A test of the Easterbrook hypothesis. Journal of Experimental Psychology: Human Perception and Performance, 1982, 8(4), 614-624.

Andersson, R., and Lagerlof, E. Accident data in the new Swedish information system on occupational injuries. Ergonomics, 1983, 26(1), 3-42.

Antonovsky, A. Health, stress, and coping. San Francisco: Jossey-Bass, Inc., Publishers, 1979.

Argiero, L. Evaluation of hazards in high power electronic systems. Eletcrotecnica, 1976, 63(11), 931-945.

Armstrong, J.W. The effects of concurrent motor task on performance of a voice recognition system. Monterey, CA: Naval Post Graduate School, September, 1980. (NTIS No. AD-A093 557/7)

Arsenault, A. and Dolan, S. The role of personality, occupation and organization in understanding the relationship between job stress, performance and absenteeism. Journal of Occupational Psychology, 1983, 56(3), 227-240.

Asher, J.W., Doty, L.A., Hanley, T.D., and Steer, M. An investigation of monaural and binaural auditory discrimination in noise (Report No. NAVTRADEVCEN 104-2-49). Lafayette, IN: Purdue University, 1957. (NTIS No. AD125185)

Asher, J.W., Doty, L.A., Hanley, T.D., and Steer, M.D. A study of the effects of stress on speaking and listening abilities (Report No. NAVTRADEVCEN 104-2-50) Lafayette, IN:

Purdue University, 1957. (NTIS No. AD 639107)

Askren, W.B., and Regulinski, T.L. Mathematical modeling of human performance errors for reliability analysis of systems (Report No. AMRL-TR-6893). Wright Patterston AFB, OH: Aerospace Medical Research Laboratory, January 1969.

Askren, W.B., and Regulinski, T.L. Quantifying human performance reliability (Report No. AFHRL-TR-71-22). Wright-Patterson AFB, OH: Air Force Human Resources Laboratory, 1971.

Ayoub, M.A. The problem of occupational safety. Industrial Engineering, 1975, 7, 16-23.

Ayoub, M.M. , and Ramsey, J.D. Hazards of vibration and light. Industrial Engineering, 1975, 7(11), 40-44.

Bachman, J.C. Effect of non-traumatic audible stress on learning of 2 motor-skills. Journal of Motor Behavior, 1977, 9(3), 243-245.

Bainbridge, L. Forgotten alternatives in skill and work load. Ergonomics, 1978, 21(3), 169-185.

Beattie, J.D., and Iwasa-Madge, K.M. A taxonomy for human reliability analysis. In Proceedings of the 1984 International Conference on Occupational Ergonomics, Rexdale, Ontario: Human Factors Conference, Inc., 1984, 72-76.

Beek, C., Hayman, K. and Markosohn, G. Human reliability research (Report No. PRR-67-2). Washington, DC: New Developments Research Branch, Bureau of Personnel, U.S. Navy, September 1967. (NTIS No. AD 664495)

Bell, B.J. Human reliability analysis for probabilistic risk assessment. In Proceedings of the 1984 International Conference on Occupational Ergonomics. Rexdale, Ontario: Human Factors Conference, Inc., 1984, 35-40.

Bell, B.J., and Swain, A.D. A procedure for conducting a human reliability analysis for nuclear power plants (Report No. NUREG/CR-2254). Albequerque, NM: Sandia National Laboratories, May 1983.

Bennett, E.M. Human factors in technology, New York: McGraw-Hill, 1963.

Bharucha-Reid, R., and Kiyak, H.A. The concept of dissonance and too much personal space. Journal of Non-Verbal Behavior, 1979, 4(2), 123-125.

Billings. C.E., and Reynard, W.D. Human factors in aircraft incidents: Results of a 7-year study. Aviation, Space, and Environmental Medicine, 1984, 55(10), 960-965.

Bjorkman, M. Do subjects give priority to small errors or task regularity? Acta Psychologica, 1982, 51(1),1-11.

Blanchard, R.E. Human performance and personnel resource data store design guidelines. Human Factors, 1975, 17(1), 25-34.

Boyles, W.R. Background and situational confidence their relation to performance effectiveness (HumRRO Professional Paper No. 22-68). Alexandria, VA: Human Resources Research Organization, 1968.

Bozick, B.J. An investigation into the effects of post hypnotic sugestion on the performance of selected motor skills by males under stress conditions which produce anxiety. Dissertation Abstracts International, 1977, 38(2A), 692.

Brayfield, A.H., and Crockett, W.H. Employee attitudes and employee performance. Psychological Bulletin, 1955, 52(5) 396-424.

Brenner, L. Jr. Accident investigations: Multilinear events sequenching methods. Journal of Safety Research, 1975, 1, 67-73.

Brewer, N., and Smith, G.A. Cognitive processes for monitoring and regulating. American Journal of Mental Deficiency, 1982, 87(2), 211-222.

Brouha, L., Smith, P.E., Jr and Stopps, G.J., M.D. Industrial physiology as affected by the workload and the environment. In A.J. Fleming, C.A. D'Alonzo and J.A. Zapp (Eds.), Modern occupational medicine. Philadelphia: Lea and Febiger, 1960.

Bryant, J.E., and Cline J.L., An analytical approach to accident control. In Proceedings of human Factors Society, 25th Annual Meeting. Santa Monica, CA: Human Factors Society, 1981, 301-305.

Butt, J.G. Anxiety and learning from social cues. Dissertation Abstracts International, 1980, 40(9A), 4961-4962.

Cahoon, R.L. Simple decision making at high altitudes. Ergonomics, 1972, 15(2), 157-164.

Card, S.K. The model human processors: A model for making engineering calculations of human performance. In Proceedings of Human Factors Society, 25th Annual Meeting.

Santa Monica, CA: Human Factors Society, 1981, 301-305.

Carnino, A., and Griffon, M. Causes of human error. In A.E. Green (Ed.), High risk safety technology. New York: Wiley Interscience, 1982.

Carruthers, M. Hazardous occupations and the heart. In C.L. Cooper and R. Payne (Eds.), Current concerns in occupational stress. New York: John Wiley & Sons, Ltd., 1980,3 - 22.

Chaffin, D.B., Herrin, G.D., Keyserling, W.M., and Garg, A. Method for evaluating biomechanical stresses resulting from manual materials handling jobs. American Industrial Hygiene Association Journal, 1977, 38(12), 662-675.

Chambers, R.M., and Ross, B.M. Effects of transverse g-stress on running memory. Perceptual and Motor Skills, 1967, 24, 423-35.

Chaney, R.E., and Parks, D.L. Visual-motor performance during whole body vibration. Wichita, KA: Boeing Company, 1964. (NTIS No. AD-456 271)

Chapanis, A.R.E. Man-machine engineering. California: Wadsworth Publication Company, Inc., 1966.

Cherniss, C., Egnatios, E.S., and Wacker, S. Job stress and career development in new public professionals. Professional Psychology, 1976, 7(4), 428-436.

Childs, J.M. Time and error measures of human performance: A note on Bradley's optimal-pessimal paradox. Human Factors, 1980, 22(1), 113-117.

Chiles, W.D. Methodology in the assessment of complex performance. Human Factors, 1967, 9, 523-392.

Chiles, W.D. Workload, task and situational factors as modifiers of complex human performance. In E.A. Alluisi and E.A. Fleishman (Eds.), Human performance and productivity volume 3: Stress and performance effectiveness, Hillsdale, NJ: Lawrence Erlbaum Associates, Inc., 1982, 16-56.

Chisholm, R.F., Kasl, S.V., and Eskenazl, B. The nature and predictors of job related tension in a crisis situation. Reactions of nuclear workers to the Three Mile Island accident. Academy of Management Journal, 1983, 26(3), 385-405.

Clark, A.W., and Prolisko, A. Social-role correlates of driving accidents. Human Factors, 1979, 21(6), 655-659.

Clarke, R.M. and Miller, J.M. Boating operator performance stressors. In Proceedings of the Human Factors Society, 18th

Annual Meeting. Santa Monica, CA: Human Factors Society, 1974, 512-522.

Clayton, S.H. Moderators of the relationship between individual task structure congruencies and job satisfactions and performance. Dissertation Abstracts International, 1981 42(3A), 1235.

Coates, G.D. and Kirby, R.H. Organismic factors and individual differences in human performance and productivity. In E.A. Alluisi and E.A. Fleishman (Eds.), Human performance and productivity volume 3: Stress and performance effectiveness, Hillsdale, NJ: Lawrence Erlbaum Associates, Inc., 1982, 91-140.

Cohen, C.J. Human circadian-rhythms in heart-rate response to a maximal exercise stress. Ergonomics, 1980, 23(6), 591-595.

Cohen, H.H. Causal factors in select work accidents: Investigation of worker fatalities. In Proceedings of the 6th Congress of the International Ergonomics Association and Technical Program of the 20th Annual Meeting of the Human Factors Society. Santa Monica, CA: Human Factors Society, 1976, 240-242.

Cohen, S. After effects of stress on human performance and social behavior - a review of research and theory. Psychological Bulletin, 1980, 88(1), 82-108.

Collins, A., and Frankenhaeuser, M. Stress responses in male and female engineering students. Journal of Human Stress, 1978, 4(2), 43-48.

Colquhoun, W.P., and Edwards, R.S. Interaction of noise with alcohol on a task of sustained attention. London: Royal Naval Personnel Research Committee, 1972. (NTIS No. AD-787 015/7)

Cooper, C.L., and Green, M.D. Coping with occupational stress among Royal Air Force personnel on isolated island bases. Psychological Reports, 1976, 39(3 part 1), 731-734.

Cooper, C.L., and Marshall, J. Sources of managerial and white collar stress. In C.L. Cooper and R. Payne (Eds.), Stress at work. New York: John Wiley & Sons, Ltd., 1978, 81-105.

Cooper, C.L. and Payne, R. (Eds.) Current concerns in occupational stress, New York: John Wiley and Sons, Ltd., 1980.

Cooper, C.L., and Payne, R. (Eds.) Stress at work. New York: John Wiley & Sons, Ltd., 1978.

Cordain, L., Johnson, S.C., and Ruhling, R.O. Description of a low-cost microcomputer system interfaced to exercise stress-testing equipment. Research Quarterly for Exercises and Sport, 1982, 53(1), 73-77.

Corlett, E.N., and Gilbank, G. A systemic technique for accident analysis. Journal of Occupational Accidents, 1978, 2, 25-38.

Corlett, E.N., and Richardson, J. (Eds.) Stress, work design and productivity. New York: John Wiley and Sons, Ltd., 1981.

Cote, G.A., and Withey, S.B. Risk of aggregation. Risk Analysis, 1982, 2(4), 243-247.

Cox, T. Stress. London: Macmillan Co., 1978.

Cox, T., and Mackay, C. A transactional approach to occupational stress. In E.N. Corlett and J. Richardson, (Eds.), Stress, work design, and productivity. New York: John Wiley & Sons, Ltd., 1981, 91-113.

Cozad, C.P. The polygraph-A misapplication of human resources. Human Factors Society Bulletin, 1984, 27(5).

Craig, A. Effect of prior knowledge of signal probabilities on vigilance performance at a two-signal task. Human Factors 1980, 22(3), 361-371.

Craven, A.D. Fire and explosion investigation: A formal strategy. Journal of Occupational Accidents, 1981, 3, 207-216.

Creamer, L.R., Wheeler, D.E., Gabriel, R.F., Tarr, J.S., and Baldwin, J.A. Human error research and analysis program, summary and final report: Data handling and fatigue studies. Long Beach, CA: Douglas Aircraft Company, 1970. (NTIS AD-869 266/7)

Cross, A. Fault trees and event trees. In A.E. Green (Ed.), High risk safety technology. New York: Wiley Interscience, 1982.

Cumming, R.W., and Croft, P.G. Human information processing under varying task demand. In A.T. Welford (Ed.), Man under stress. London: Taylor and Francis Ltd., 1974, 15-20.

Cunningham, J.B. Gathering data in a changing organization. Human Relations, 1983, 36(5), 403-420.

D'Accardi, R.J. Time-series modeling and analysis of several non-stationary phenomena that affect systems performance. Dissertation Abstracts International, 1978, 42(6B), 2490.

Danaher, J.W. Human error in ATC system operations. Human Factors, 1980, 22(5), 535-545.

Daniel, J. Effect of repetition of experiment on the parameters of psychic and physcial load. Studia Psychologica, 19̈7, 19(4), 287-300.

Dannhaus, D.M., and Halcomb, C.G., Methodology for the prediction of complex skill performance. Proceedings of Human Factors Society, 19th Annual Meeting. Santa Monica,CA: Human Factors Society, 1975, 140-144.

Davey, C.P. Physical exertion and mental performance. In A.T. Welford (Ed.), Man under stress. London: Taylor and Francis, Ltd., 1974, 29-33.

Davis, C.W. The effects of training upon the effectiveness, dogmatism and stress of first year paraprofessinals within a university setting. Dissertation Abstracts International, 1979, 39(7A), 4055.

Davis, K. Human behavior at work. New York: McGraw-Hill Book Company, 1972.

Dougherty, T.W. Role-based stressors: An investigation of relationships to personal and organizational outcomes. Dissertation Abstracts International, 1981, 42(3B), 1217.

Drapeau, R.A. A twofold inquiry into the implication of the theory of biorhythms as a significant variable in human task performance and decision strategies under time-stress conditions. Dissertations Abstracts International, 1981, 41(7A), 3176-3177.

Drury, C.G. Talk analysis methods in industry. Applied Ergonomics, 1983, 14, 19-28.

Drury, C.G., and Fox, J.G. (Eds.) Human reliability in quality control, New York: Halsted Press, 1975.

Drury, C.G., and Sinclair, M.A. Human and machine performance in an inspection task. Human Factors, 1983, 25(4), 391-399.

Dunnette, M.D., and Fleishman, E.A. (Eds.) Human performance and productivity volume 1: Human capability assessment. Hillsdale, NJ: Lawrence Erlbaum Associates, 1982.

Eid, A.M. Road traffic accidents in Qatar: The size of the problem. Accident Analysis Prevention, 1980, 12(4), 287-298.

Electric Power Research Institute. Role of personnel errors in power plant equipment reliability (Report No. EPRI AF

1041). Palo Alto, CA: Failure Anaylsis Association, April 1979.

Embrey, D.E. Human reliability in complex systems: - overview. (Report No. R10). Warrington, England: National Centre of Systems Reliability, UKAEA, 1976.(NTIS No. N77-307486).

Embrey, D.E. The use of quantified expert judgement in the assessment of human reliability in nuclear power plant operation. In Proceedings of the Human Factors Society, 25th Annual Meeting. Santa Monica, CA: Human Factors Society, 1981, 96-99.

Embrey, D.E. The use of performance shaping factors and quantified expert judgement in the evaluation of human eeliability. (Report No. NUREG/CR-2986). New York: Brookhaven National Laboratory, March 1983.

Embrey, D.E. Human reliability. Paper presented at the 1984 International Conference on Occupational Ergonomics, Toronto, Canada, May 7-9, 1984.

Embrey, D.E. Application of human reliability assessment techniques to process plant design. Paper presented at the Institute of Chemical Engineers Symposium on Ergonomics Problems in Process Operations, July 1984. Dalton, England: Human Reliability Associates, Ltd., 1984.

Embrey, D.E., Humphreys, R., Rosa, E.A., Kirwan, R., and Rea, K. SLIM-MAUD: An approach to assessing human error probabilities using structured expert judgement volume 1: Overview of SLIM-MAUD (Report No. NUREG/CR-3518). Upton, NY: Brookhaven National Laboratory, March 1984.

Evans, L., and Wasielewski, P. Do accident-involved drivers exhibit riskier everyday driving behavior? Accident Analysis Prevention, 1982, 14(1), 57-64.

Everly, G.S., Jr. and Girdano, D.A. The Stress mess solution: The causes and cures of stress on the job. Bowie, MD: Robert J. Brady Co., 1980.

Eyssen, G.M., Hoffman, J. E., and Spengler, R. Managers attitudes and the occurence of accidents in a telephone company. Journal of Occupational Accidents, 1980,2, 291-304.

Fell, J.C. Motor vehicle accident causal system - the human element. Human Factors, 1976, 18(1), 84-94.

Fell, J.C. Motor vehicle accident causal system: The human element. Proceedings of the Human Factors Society, 19th Annual Meeting. Santa Monica, CA: Human Factors Society, 1975, 42-48.

Finkelman, J.M., Zeitlin L.R., Romoff, R.A., Friend, M.A., and Brown, L.S. Conjoint effect of physical stress and noise. Human Factors, 1979, 21(1), 1-6.

Finkleman, J.M., and Kirschner, C. An information-processing interpretation of air traffic control stress. Human Factors, 1980, 22(5), 561-567.

Finley, D.L. Obermayer, R.W., Bertone, C.M., Meister, D., and Muckler, F.A. Human performance prediction in man-machine systems volume I: A technical review (Report No. NASA CR-1614). Canoga Park, CA: Bunker-Ramo Corporation, 1970.

Finley, D.L. Obermayer, R.W., Bertone, C.M., Meister, D., and Muckler, F.A. Human performance prediction in man-machine systems volume III: A selected and annotated bibliography (Report No. NASA CR-73428). Canoga Park, California: Bunker-Ramo Corp., 1969.

Fisk, A., and Schneider, W. Control and automatic processing during tasks requiring sustained attention: A new approach to vigilance. Human Factors, 1981, 23(6), 737-750.

Fleishman, E.A. Toward a taxanomy of human performance. American Psychologist, 1975, 30, 1127-1149.

Fleming, A.J., D'Alonzo, C.A., and Zapp, J.A. (eds.) Modern occupational medicine. Philadelphia: Lea & Febiger, 1960.

Flight Safety Foundation. Safety in the terminal environment. In Proceedings of the Corporation Aviation Safety Seminar, 23rd Annual Meeting. Arlington, VA: Flight Safety Foundation, 1978.

Ford, G.L., and Geddes, L.A. Transient ground potential rise in gas insulated substations assessment of shock hazard. IEEE Transportation Power Apparatus System, 1982, PAS-101(10), 3620-3629.

Foreman, E.I., Ellis H.D., and Beavans, D. MEA CULPA - A study of the relationships among personality traits, life events and ascribed accident causation. British Journal of Clinical Psychology, 1983, 22, 223-224.

Fortenberry, J.C., and Smith, L. An analysis of human risk taking in simulated occupational situations. Proceedings of Human Factors Society, 19th Annual Meeting. Santa Monica, CA: Human Factors Society, 1975, 145-149.

Fowler, F.D. Air traffic control problems: A pilot's view. Human Factors, 1980, 22(6), 645-653.

Frankenhaeuzer, M. Experimental approaches to the study of calecholamines and emotion. In L. Levi (Ed.), Emotions: Their parameters and measurement. New York, Raven Press, 1975.

Frankenhaeuzer, M. Sympathethic-adrenomedullary activity, behaviour and the psychosocial environment. In P.H. Venables and M.J. Christie (Eds.), Research in psychophysiology. New York: Wiley, 1975.

Franklin, M.R. Examiner error in intelligence testing: Are you a source? Psychology in the Schools, 1982, 19(4), 563-569.

Friedland, N. and Keinan, G. Patterns of fidelity between training and criterion situations as determinants of performance in stressful situations. Journal of Human Stress, 1982, 8(4), 41-46.

Friedman, M., and Rosenman, R.H. The key cause - type A behavior pattern. In A. Monat and R.S. Lazarus (Eds.), Stress and coping: An anthology. New York: Columbia University Press, 1977, 203-212.

Friend, K.E. Stress and performance: Effects of subjective work load and time urgency. Personnel Psychology, 1982, 35(3), 623-633.

Gardner, D.J., and Rockwell, T.H. Two views of motorist behavior in rural freeway construction of maintenance zones: The driver and the state highway patrol man. Human Factors, 25(4), 415-424, 1983.

Garner, K.C. Evaluation of the human operator coupled dynamic systems. In W.T. Singleton, R.S. Esterby, and D.C. Whitfield (Eds.), The human operator in complex systems. London: Taylor and Francis Ltd., 1967.

Glass, D.C. Effect of task overload upon cardiovascular and plasma catecholamine responses in type A and type B individuals. Basic and Applied Social Psychology, 1980, 7(3), 199-218.

Gleick, J.G. Solving the mathematical riddle of chaos. The New York Times Magazine, June 10, 1984, 30ff.

Gliner, J.A., Horvath, S.M., and Mihevic, P.M. Carbon-monoxide and human-performance in a single and dual task methodology. Aviation, Space and Environmental Medicine, 1983, 54(8), 714-717.

Gmelch, W.H. Stress for success: How to optimize your performance. Theory into Practice, 1983, 22(1), 7-14.

Goldberger, L., and Breznitz, S. Handbook of stress:

Theoretical and clinical aspects. New York: Free Press, Div. of Macmillan Publishing Co, Inc., 1982.

Golder, T.V. P-3 pilot errors: A conceptual approach. Newport, RI: Naval War College, Center for Advanced Research, June 1978. (NTIS No. AD-A059 842/5)

Graham, C., and Cohen, H.D. Task validation for studies on fragmented sleep and cognitive efficiency under stress (Report No. MRI-2007-E). Kansas City, MO: Midwest Research Institute, November 1982. (NTIS No. AD-A130 26013).

Grivel, F. Influence of ambient and body heat on human work without important physical load. explanatory models on specific-heat stress effects on psychomotor and mental performance. Travail Humain, 1976, 39(2), 311-327.

Grondstrom, R., Jarl, T., and Thorson, J. Serious occupational accidents - an investigation of causes. Journal of Occupational Accidents, 1980, 2, 283-289.

Gustafson, H.W. Efficiency of output in self-paced work, machine-paced rest. Human Factors, 1982, 24(4), 395-410.

Hacker, W., Plath, H.E., Richter, P., and Zimmer, K. Internal representation of task structure and mental load of work: Approaches and methods of assessment. Ergonomics, 1978, 21(3), 187-194.

Hale, A.R., and Hale, M. Accidents in perspective. Occupational Psychology, 1970, 44, 115-121.

Hamilton, B., Simmons, R.R., and Kimball, K.A. Psychological effects of chemical defense ensemble imposed heat stress on army aviators (Report No. USAARL-83-6). Fort Rucker, AL: Army Aeromedical Research Laboratory, 1982. (NTIS AD-A121 95617)

Hammer, W. Occupational safety management and engineering. New Jersey: Prentice-Hall, Inc., 1981.

Handy, C. Understanding organizations. Middlesex, England: Pequin Books, 1976.

Hanscom, F.R. Human factors in skidding: Causation and prevention. Transportation Research Board Transportation Research Record, 1976, 623, 40-47.

Ha per, M. The influence of encoding context in the false recognition of errors of children and adults. Journal of General Psychology, 1982, 107(1), 57-58.

Harris, D.H., and Chaney, F. Human factors in quality assurance. New York: John Wiley & Sons, Inc. 1969.

Harrison, D. Instrumentation measurement error in hypertension research. Behavioral Engineering, 1982, 7(4), 149-153.

Harrison. V.R. Person environment fit and job stress. In C.L. Cooper and R. Payne (Eds.), Stress at work. New York: John Wiley and Sons, Ltd., 1978, 175-205.

Hartman, B.O., Storm, W.F., Vanderveen, J.E., Vanderveen, E., Hale, H.B., and Bollinger, R.R. Operational aspects of variations in alertness (Report No. AGARD-AG-189). London: Technical Editing and Reproduction Ltd., 1974.

Harvey, J. Matching words to phenomena: The case of the FAE. Journal of Personality and Social Psychology, 1982, 43(2), 345-346.

Hashimoto, K., Morioka, M., and Aoki, M. Analytical procedures on causes of human errors in plant accidents. Ergonomics, 1982, 25(6), 543.

Hebb, D.O., Drives and the C.N.S. (conceptual nervous system). Psychological Review, 1955, 62, 243-254.

Hedkin, B.C. Langworthy, O., and Kouwenhoven, W.B. Effect on breathing of an electric shock applied to the extremities. IEEE Transactions Power Apparatus Systems, 1973, PAS-92(4), 138-1391.

Heinrich, H.W. Industrial accident prevention. New York: McGraw-Hill, 1959.

Hoag, L.L., Hancock, W.M., and Chaffin, D.B. Prediction of physiological strain of workers on the production floor. International Journal of Production Research, 1971, 9(4), 457-471.

Hogan, R., and Hogan, H.C. Subjective correlates of stress and human performance. In E.A. Alluisi and E.A. Fleishman (Eds.), Human performance and productivity volume 3: Stress and performance effectiveness. Hillsdale, NJ: Lawrence Erlbaum Associates, Inc., 1982, 141-163.

Holland, C.L., Jr. Performance and physiological efects of long term vibration (Report No. AMRL-TR-66-145). Marietta, GA: Lockheed Georgia Research Laboratory, October 1966. (NTIS No. AD-649 366)

Hollnagel, F., Pederson, O.M., and Rasmussen, J. Notes on human performance analysis (Report No. Riso-M-2285). Roskilde, Denmark: Riso National Laboratory, June 1981.

Hollon, C.J., Machiavellianism and managerial work attitudes

C-2

and perceptions. Psychological Reports, 1983, 52(2), 432-434.

Holmes, T.H. and Masuda, M. Life change and illness susceptibility. In B.S. Dohrenwend and B.P. Dohrenwend, Stressful life events: Their nature and effects. New York, John Wiley and Sons, 1974, 45-72.

Holmes, T.H. and Rahe, R.H. The social readjustment rating scale. Journal of Psychosomatic Research, 1967, 11, 213-218.

Holt, R.R. Occupational stress. In L.Goldberger and S. Breznitz (Eds.), Handbook of stress: Theoretical and clinical aspects. New York: Free Press, Division of Macmillan Publishing Co., Inc., 1982, 419-444.

Hornby, R.C., and Wilson, R. The effects of extended practice on performance in a tracking task (Report No. ARC-29887). London: Aeronautical Research Council, December 1967. (NTIS No. AD-670 303)

Howell, W.C., and E.A. Fleishman, (Eds.) Human performance and productivity volume 2: Information processing and decision making. Hillsdale, NJ: Lawrence Erlbaum Associates, Inc., 1982.

Hughes Aircraft Co. Human Reliability Study: Phase 1 (Report No. KSC GP 891). Cape Canaveral, FL: Kennedy Space Center, 1971.

Hunns, D.M. Discussion around a human factors data base: An interim solution - the method of paired comparisons. In A.E. Green (Ed.), High risk safety technology. New York: Wiley Interscience, 1982.

Hyyppa, M.T., Aunola, S., Lahtela, K., Lahti, R., and Marniemi, J. Psychoneuroendocrine responses to mental load in an achievement oriented task. Ergonomics, 1983, 26(12), 1155-1162.

Ioseliani, K.K. The effect of vibration and noise on the noise on the mental faculty of man under time stress (Report No. NASA-TT-F-11142). LaCanada, CA: Scientific Translation Service, July 1967.

Irwin, I.A., Levitz, J J., and Freed, A.M. Human reliability in the performance of maintenance. In Proceedings of the Symposium on Quantification of Human Performance. Albuquerque, NM: Human Factors Society, Electronic Industries Association, 1964.

Ivancevich, J.M. Effects of the shorter workweek on selected satisfaction and performance measures. Journal of Applied Psychology, 1974, 59(6), 717-721.

Ivancevich, J.M. and Lyon, H.L. The shortened workweek: A field experiment. Journal of Applied Psychology, 1977, 62(1), 34-37.

Ivancevich, J.M., and Smith, S.V., Job difficulty as interpleted by incumbents: A study of nurses and engineers. Human Relations, 1982, 35(5',391-412.

Johansen, R. Stress and socio-technical design: A new ship organization. In C.L. Cooper & R. Payne (Eds.), Stress at work. New York: John Wiley & Sons, Ltd., 1978, 223-256.

Johnson, W. (Ed.) New approaches to safety in industry. London: InComTec, 1972.

Johnson, W.G. The management oversight and risk tree, MORT (Report No. USAEC, SAN 821-2, UC-41). Washington, DC: U.S. Atomic Energy Commission, 1973.

Johnson, W.L. Job satisfaction and biographic characteristics as predictors of public welfare employee turnover. Dissertation Abstracts International, 1982, 43(8B), 2734.

Jonah, B.A., and Engel, G.R. Measuring the relative risk of pedestrian accidents. Accidents Analysis Prevention, 1983, 15(3), 193-206.

Jones, J.C. The designing of man-machine systems. In W.T. Singleton, R.S. Esterby, and D.C. Whitfield (Eds.), The human operator in complex systems. London: Taylor and Francis Ltd., 1967.

Jones, T.O., Kelly, A.H., and Johnson, D.R. Half a century and a billion kilometers safely (SAE Report No. 780621 for meeting June 5-9) Warren, PA: Society of Automotive Engineers, 1978.

Kahn, R.L. Work and health. New York: John Wiley & Sons, Inc., 1981, 42-66,101-120, 178-185.

Kalsbeek, J.W.H. The production of behavior and its accompanying stresses. In E.N. Corlett and J. Richardson (Eds.), Stress, work design, and productivity. New York: John Wiley & Sons, Ltd., 1981, 59-75.

Kandelin, W.W., Krahenbuhl, G.S., and Schacht, C.A. Athletic field microclimates and heat-stress. Journal of Safety Research, 1976, 8(3), 106-111.

Kantor, J.E., Klinestiver, L., and McFarlane, T.A. Methodolgy to assess psychological stress and its impact in the air combat environment. Brooks AFB, TX: Human Resources

Laboratory, March 1978.

Karlin, R.A., and Epstein, Y.M. Acute crowding: A reliable method for inducing stress in humans. Research Communications in Psychology, Psychiatry and Behavior, 1979, 4(4), 357-370.

Karvonen, M.J. Ergonomic criteria for occupatioral and public health survey. Ergonomics, 1979, 22(6), 641-650.

Kasl, S.V. Epidemiological contribution to the study of work stress. In C.L. Cooper and R. Payne (Eds.), Stress at work. New York: John Wiley & Sons, Ltd., 1978, 3-48.

Kirkpatrick, M., and Mallory, K., Substitution error potential in nuclear power plant control rooms. Proceedings of Human Factors Society, 25th Annual Meeting. Santa Monica, CA: Human Factors Society, 1981, 163-167.

Kletz, T.A. Accident data - the need for a new look at the sort of data that are collected and analysed. Journal of Occupational Accidents, 1976, 1, 95-105.

Klier, S., and Linskey, J. Selected abstracts from the literature on stress (Report No. NATRADEVCEN 565-1). Port Washington, NY: U.S. Naval Training Device Center, November 1960. (NTIS No. AD 253068)

Klier, S., and Schneider, W. Effects of induced stress in a naval training school (Report No. NAVTRADEVCEN 565-3). Port Washington, NY: U.S. Naval Training Device Center, July 1962. (NTIS No. AD 284679)

Knight, J.L., Geddes, L.A., and Salvendy, G. Equipment note: Continuous, unobtrusive, performance and physiological monitoring of industrial workers. Ergonomics, 1980, 23(5), 501-506.

Koyano, E. A basic study of the prediction method for clerical human errors based on pulse speed variability. Ergonomics, 1982, 25(6), 476.

Krahenbuhl, G.S., Darst, P.W., Marett, J.R., Reuther, L.C., Constable, S.H., Swinford, M.E., and Reid, G.B. Instructor pilot teaching behavior and student pilot stress in flight training. Aviation, Space and Environmental Medicine, 1981, 52(10), 594-597.

Krahenbuhl, G.S., Marett, J.R., and Reid, G.B. Task-specific simulator for pretraining and in-flight stress of student pilots. Aviation, Space and Environmental Medicine, 1978, 49(9), 1107-1110.

Krueger, L.E., and Shapiro, R.G. Search for a matching or mismatching letter pair. Perception and Psychophysics, 1982, 31(5), 484-492.

Kurtz, A.K., and Smith, M.C. Annotated bibliography of human factors laboratory reports (1945-1968) (Report No. NATRADEVCEN IH-158). Orlando, FL: Naval Training Device Center, February 1969.

Langer, P. Varsity football performance. Perceptual and Motor Skills, 1966, 23(3 part 2), 1191-1199.

Latman, N. Human sensitivity intelligence and physical cycles and motor vehicle accidents. Accident Analysis Prevention, 1977, 9(2), 109-112.

Latman, N.S., and Garriot J.C. Analysis of biorhythms and their influence on motor vehicle fatalities. Accident Analysis Prevention, 1980, 12(4), 283-286.

Laughery, K.R. Industrial accidents: Data and analysis. Paper presented at workshop on Safety Measurements Systems at the International Conference on Occupational Ergonomics, Toronto, Canada, May 7-9, 1984.

Lawrence, A.C. Human error as a cause of accidents in gold mining. Journal of Safety Research, 1974, 6(2), 78-88.

Lazarus, R.S. Psychological stress and the coping process. New York: McGraw-Hill, 1966.

Lazarus, R.S. Patterns of adjustment. New York: McGraw-Hill, 1976.

Leplat, J. Accident analyses and work analyses. Journal of Occupational Accidents, 1978, 1(4), 331-340.

Leung, Y.C., Tarriere, C., Fayon, A., Mairesse, P., Delmas, A., and Banzet, P. Comparison between part 572 dummy and human subject in the problem of submarining. Proceedings of StappCar Crash Conference, 23rd. Warrendale, PA:Society of Automotive Engineers, 1979, 677-719.

Levi, L. (Eds.) Stress and distress in responses to psychosocial stimuli. New York: Pergamon Press, 1972, 22-25.

Levine, J.B., Lee, J.O., Ryman, D.H., and Rahe, R.H. Attitudes and accidents aboard an aircraft carrier. Aviation, Space, and Evironmental Medicine, 1976, 47(1), 82-85.

Lewin, I. Driver training: a perceptual-motor skill approach. Ergonomics, 1982, 25(10), 917-924.

Lewis, B.N. An essay on error. Instructional Science, 1981, 10, 237-257.

Lidberg, L., and Seeman, K. Psychomotor performance before and after confinement in a shelter (Report No. 9). Karolinska, Sjukhuset: Laboratory for Clinical Stress Research, 1969.

Liden, R.C., and Graen, G. Generalizability of the vertical dyad linkage model of leadership. Academy of Management Journal, 1980, 23(3), 451-465.

Linn, B.S., and Zeppa, R. Stress in junior medical students - relationship to personality and performance. Journal of Medical Education, 1984, 59(1), 7-12.

Locke, B. Task monotony and performance efficacy of mentally retarded young adults. American Journal of Mental Deficiency, 1982, 87(2), 173-179.

Lomov, B.F. Human reactions to stress in specific situations. Washington, DC: Joint Publications Research Service, 1968. (NTIS No. JPRS 45562) (Translation of Problemy Inzheneroi Psikholgil (USSR), 1967, 5, 58-78, 82-86.)

Lord, F. The standard error of equipercentile equating. Journal of Educational Statistics, 1982, 7(3), 165-174.

Mackay, C., and Cox, T. Stress at work. In T. Cox (Ed.), Stress, London: Macmillan Co., 1978, 147-173.

Mann, F.C., and Williams L.K. Some effects of the changing work environment in the office. Journal of Social Issues, 1962, 18(3), 90-101.

Marett, J.R. Simulation and transfer of learning in a stressful environment. Dissertation Abstracts International, 1979, 39(7A), 4078.

Maritime Transportation Research Board. Human error in merchant marine safety. Washington, DC: National Research Council, June 1976. (NTIS No. AD-A028 371/3)

Margolis, B. Psychological behavioral factors in accident control.In D. Petersen and J. Goodale (Eds.), Readings in industrial accident prevention. New York: McGraw-Hill Book Company, 1980.

Mathews, J.J., and Cobb, B.B. Relationships between age, ATC experience, and job ratings of terminal area traffic controllers. Aviation, Space, and Environmental Medicine, 1975, 45, 56-60.

Mayer, R.E., and Treat, J.R. Psychological, social and cognitive characteristics of high-risk drivers: A pilot study. Accident Analysis Prevention, 1977, 9(1), 1-8.

Mayers, M.R. Occupational health hazards of the work environment. Baltimore, MD: Williams and Wilkins Co., 1969.

McAloon, F.W. The inhibition process, stress, and qualitative performance. Dissertation Abstracts International, 1969, 29(8B), 3089.

McCormick, E.J. Human factors engineering. New York: McGraw-Hill, 1970, 38-40.

McCormick, E.J. Human factors in engineering and design. New York: McGraw-Hill, 1976, 21-28.

McCubbin, J.A., Richardson, J.E., Langer, A.W., Kizer, J.S., and Obrist, P.A. Sympathetic neuronal function and left-ventricular performance during behavioral stress in humans. The relationship between plasma-catecholamines and systolic-time intervals. Psychophysiology, 20(1), 102-110, 1983.

McFarland, R. Application of human factors engineering to safety engineering problems. In J. Widner (Ed.), Selected reading in safety. Macon, GA: Academy Press, 1973.

McGrath, J.E. (Ed.) Social and psychological factors in stress. New York: Holt, Rinehart and Winston, Inc., 1970.

McGrath, J.E. Stress and behavior in organizations. In M.D. Dunnette (Ed.), Handbook of industrial and organizational psychology. Chicago: Rand McNally, 1976.

McKenna, F.P. Accident proneness: A conceptual analysis. Accident Analysis Prevention, 1983, 15(1), 65-71.

McMichael, A.J. Personality, behavioural, and situational modifiers of work stressors. In C.L. Cooper and R. Payne (Eds.), Stress at work. New York: John Wiley & Sons, Ltd., 1978, 127-147.

Meister, D. Methods of predicting human reliability in man-machine systems. Human Factors, 1964, 6(6), 621-646.

Meister, D. Human factors in reliability. In W.G. Ireson (Ed.), Reliability handbook. New York: McGraw-Hill, 1966,n 12-2 - 12-38.

Meister, D. Criteria for development of a human reliability methodology. Proceedings U.S. Navy Human Reliability Workshop. Washington, DC: Department of Navy, Office of Naval Research, 1971. (NTIS No. AD722689).

Meister, D. Human factors: Theory and practice. New York: Wiley Interscience, 1971.

Meister, D. A critical review of human performance reliability predictive methods. IEEE Transactions on Reliability, 1973, R22(83), 116-123.

Meister, D. Reduction of human error. In G. Salvendy (Ed.), Handbook of industrial engineering. New York: John Wiley and Sons, Inc., 1982.

Meister, D., and Rabideau, G.F. Human factors evaluation in system development. New York: John Wiley & Sons, Inc., 1965

Meister, D., and Sullivan, D.J. A further study of the use of human factors information by designers. Canoga Park, CA: Bunker-Ramo Corporation, 1967. (NTIS No. AD 651 076)

Mellina, R.E. Nomothetic versus idiographic personality research: A compromise proposal. Dissertation Abstracts International, 1983, 44(8B), 2562.

Menor, J., and Brewer, J. The management of ineffective performance. In M. Dunnette (Ed.), Handbook of industrial and organizational psychology. Chicago: Rand McNally, 1976.

Metwally, A.M., and Husseiny, A.A. Quantitative evaluation of human reliability for operating tasks in nuclear power plants. Proceedings of the Human Factors Society, 26th Annual Meeting. Santa Monica, CA: Human Factors Society, 1982, 799-802.

Miller, R. A finite state description of coordination in a two handed target acquisition task. IEEE Transactions on Systems, Man and Cybernetics, 1982, 12(4), 529-538.

Miller, D., and George, C. Interference and fatigue in multitask training situations. Lubbock, TX: Texas Technological University, August 1971. (NTIS No. AD-727 698).

Miller, W.B., Jr., and Zatek, J.E. According to proposed OSHAct standard: Working with ammonia. National Safety News, 1976, 114(6), 58-61.

Mills, R.G. Some recent efforts toward the development of a human performance reliability data system and supportive human performance reliability principles. Proceedings of U.S. Navy Human Reliability Workshop. Washington, DC: Department of Navy, ffice of Naval Research, July 1971. (NTIS No. AD722689).

Minor, J., and Brewer, J. The management of ineffective performance. In M. Dunnette (Ed.), Handbook of industrial and organizational psychology. Chicago: Rand McNally, 1976.

Moeller, D.W., and Sun, L.S. Personnel overexposures at commercial nuclear power plants (Jan. 1, 1976-June 30, 1980). Nuclear Safety, 1981, 22(4), 498-504.

Monohan, L. The effects of sex differences and evaluation on task performance and aspiration. Sex Roles, 1983, 9(2), 205-215.

Monat, A., and Lazarus, R.S. (Eds.) Stress and coping: An anthology, New York: Columbia University Press. 1977.

Murphy, D.J. Farm safety attitudes and accident involvement. Accident Analysis Prevention, 1981, 13(4), 331-337.

Myers, E.L., Cronin, R., David, N., and Robertson, M.A. Multidisciplinary accident study, Pacific Northwest (Report No. DOT-HS 800-962). Menlo Park, CA: Stanford Research Institute, November 1973. (NTIS No. PB-226 867/0)

Nakano, S., Ogawa, N., Kawazu, Y., and Osato, E. Effects of anti-anxiety drug and personality on stress - inducing psychomotor performance test. Journal of Clinical Pharacology, 1978, 18(2-3), 125-130.

National Highway Traffic Safety Administration. Multidisciplinary accident investigation summaries, volume 4, number 8 (Report No. DOT-HS-601 551). Washington, DC: Department of Transportation, Office of Accident Investigation and Data Analysis, October 1973. (NTIS No. PB-277 130/2)

National Highway Traffic Safety Administration. Multidisciplinary accident investigation summaries, volume 4, number 9 (Report No. DOT-HS-601 602). Washington, DC: Department of Transportation, Office of Accident Investigation and Data Analysis, October 1973. (NTIS No. PB-277 131/0)

National Highway Traffic Safety Administration. Multidisciplinary accident investigation summaries, volume 4 (Report No. DOT-HS-601 499). Washington, DC: Department of Transportation, Office of Accident Investigation and Data Analysis, November 1973. (NTIS No. PB-227 129/4)

Newell, K.H. The relationship of impulse to response timing errors. Journal of Motor Behavior, 1982, 14(1), 24-25.

Noma, K., Tanaka, H., and Asai, K. Fuzzy fault tree analysis for accident caused by human errors. Ergonomics, 1982, 25(6), 543.

Norman, R.M., and Geddie, J.C. The increasing influence of gunnerlay error on first-round hit probability for tanks (Report No. HEL-TN-2-81). Aberdeen Proving Ground, MD: Human Engineering Laboratory, February 1981. (NTIS No. AD-A097 76816)

Ohanlon, J.F., and Horvath, S.M. Interrelationships among performance, circulating concentrations of adrenaline, noradrenaline, glucose, and free fatty acids in men performing a monitoring task. Psychophysiology, 1973, 10(3), 251-259.

Olsen, R.A. Driver as cause or victim in vehicle skidding accidents. Accident Analysis Prevention, 1978, 10(1), 61-67.

O'Mara, P.A., Stamper, D.A., Lund, D.J., and Beatrice, E.S. Chromatic strobe flash disruption of pursuit tracking performance. San Francisco, CA: LeHerman Army Institute of Research, 1980 (NTIS No. AD-A0949115)

O'Neill, M.W., Hanewicz, W.B., Fransway, L.M. and Cassidy-Riske, C. Stress inoculation training and job performance. Journal of Police Science and Administration, 1982, 10(4), 388-397.

Orr, L. Goals, risks, and choices. Risk Analysis, 1982, 2, 239-242.

Orpen, C. The effect of social support on reactions to role ambiguity and conflict: A study among white and black clerks in South Africa. Journal of Cross Cultural Psychology, 1982, 13(3), 375-384.

Owens, A.G. The performance and selection of men in small Antarctic groups (Report No. 4/74). Australia: Australian Army Psychological Research Unit , July 1975.

Palesy, S.R. A behavioral theory of product manager motivation and performance. Dissertation Abstracts International, 1978, 38(9A), 5676.

Panov, G.E., and Artamonov, V.S. Investigation of the causes of traumatism in drilling deep wells, using the filming method. Izv Vyssh Uchhebn Zaved, Neft i Gaz, 1975, 5, 21-24.

Parasuraman, S. Sources and outcomes of organizational stress: A multidimensional study of the antecedents and attitudinal and behavioral indices of job stress. Dissertation Abstracts International, 1978, 38(9A), 5584.

Parker, D.B., Pickrel, E.W., and McDonald, T.A. Elimination of potential sources of critical human induced failures in space systems. In Symposium and Workshop on the Quantification of Human Performance. Huntington Beach, CA:

Douglas Space Systems Center, 1964.

Patnoe, R.L., and Vessell, B.P. Human factors: A positive emphasis to dealing with stress. Professional Safety, 1978, 23(8), 23-27.

Pestonjee, D.M., and Singh, V.B. Neuroticism-extraversion as correlates of accident occurence. Accident Analysis Prevention, 1980, 12(3), 201-204.

Peters, G.A., and Hussman, T.A., Jr. Human factors in systems reliability. Human Factors, 1959, 1(2), 38-42.

Petersen, D. Techniques of safety management. New York: McGraw Hill Book Company, 1978.

Petersen, D. Human error reduction and safety management. Colorado Springs, CO: University of Northern Colorado, 1980.

Pfeiffer, M.G., Siegel, A.I., Taylor, S.E., and Schuler, L. Background data fo. the human performance in continuous operations guidelines. Catalog of Selected Documents in Psychology, 1980, 10, 100-101.

Pickrel, E.W., and McDonald, T.A. Quantification of human performance in large, complex systems. Human Factors, 1964, 6(6), 647-662.

Piniat, A.J. Controlling unsafe acts: A behavioral approach. National Safety News, 1978, 117(2), 53-58.

Pontecorvo, M.M. A method of predicting human reliability. Annals of Reliability and Maintenance, 4, 337-342.

Poock, G.K., and Armstrong, J.W. Effect of operator mental loading on voice recognition system performance. Monterey, CA: Naval Postgraduate School, 1981. (NTIS No. AD-A107 477/2)

Posner, B.Z., and Randolph, W.A. Moderators of role stress among hospital personnel. Journal of Psychology, 1980, 105(2), 215-224.

Postans, R.L., and Wilson, W.T. Close-following on the motorway. Ergonomics, 1983, 26(4), 317-327.

Potter, E.H., and Fiedler, F.E. The utilization of staff member intelligence and experience under high and low stress. Academy of Management Journal, 1981, 24(2), 361-376.

Poulton, E.C. Blue collar stressors. In C.L. Cooper and R. Payne (Eds.), Stress at work. New York: John Wiley and Sons, Ltd., 1978, 52-79.

Proctor, R. Null effects of exposure duration and heterogeneity of difference on the same-different disparity in letter matching. Perception and Psychophysics, 1983, 33(2), 163-171.

Prunkl, P.R., and Boyles, W.R. A preliminary application of the critical incident technique to combat performance of Army aviators (HumRRO Professional Paper No. 24-68). Alexandria, VA: Human Resources Research Organization, 1968.

Ramsey, J.D., and Beshir, M.Y. Subjective estimates of physiological responses and perceptual-motor performance in the heat. Applied Ergonomics, 1980, 11(4), 194-198.

Rasmussen, J. What can be learned from error reports? In K.D. Duncan, M.M. Gruneberg, and D. Wallis (Eds.), Changes in working life. New York: John Wiley and Sons, Ltd., 1980.

Rasmussen, J. Human reliability in risk analysis. In A.E. Green (Ed.), High risk safety technology. New York: Wiley Interscience, 1982.

Rasmussen, J., Pedersen, O.M., Mancini, G., Carnino, A., Griffon, M., and Gagnolet, P. Classification system for reporting events involving human malfunctions (Report No. RISO-M-2240). Roskilde, Denmark: Riso National Laboratory, March 1981.

Reeder, G. Let's give the fundamental attribution err another chance. Journal of Personality and Soci Psychology, 1982, 43(2), 341-344.

Regulinski, T.L., Quantification of human performance reliability: Research method rationale. Proceedings of United States Navy Human Reliability Workshop. Washington, DC: Department of Navy, Office of Naval Research, 1971. (NTIS No. AD 722689)

Reid, L.D. Survey of recent driver streeing behavior models suited to accident studies. Accident Analysis Prevention, 1983, 15(1), 23-40.

Renshaw, J.R. An exploration of the dynamics of the overlapping worlds of work and family. Family Process, 1976, 15(1), 143-165.

Rigby, L.V. The Sandia human error rate bank (SHERB). Paper presented at Symposium on Man-Machine Effectiveness Analysis: Techniques and Requirements, Santa Monica, CA, June 15, 1967.

Ringeisen, R.D., and Shingledecker, C.A. Combined stress and human-performance - a weighted digraph model. Mathematical Social Sciences, 1981, 1(3), 297-305.

Rook, L.W., Jr. Reduction of human error in industrial production (Report No. SCTM 93-62(14)). Albuquerque, NM: Sandia Corporation, June 1962.

Rook, L.W., Motivation and human error (Report No. SC-TM-65-135). Albuquerque, NM: Sandia Corporation, 1965.

Rook, L., Altman, J., and Swain, A.D. Human error quantification (Report No. SCR-610). Albequerque, NM: Sandia Corpor ation, April 1983.

Rose, R.M., Jenkins, C.D., and Hurst, M.W. Health change in air traffic controllers: A prospective study. I. Background and description. Psychosomatic Medicine, 1978, 40(2), 142-165.

Schriesheim, C.A., and Murphy, C.J. Relationships between leader behavior and subordinate satisfaction and performance: A test of some situational moderators. Journal of Applied Psychology, 1976, 61(5), 634-641.

Schulzinger, M. Accident syndrome. Springfield, IL: C.C.Thomas, 1956.

Seibel,R., Christ, R.E., and Teichner, W.H. Perception and short term memory under work load stress (Report No. NAVTRACEN 1303-2). Orlando,FL: Orlando Training Center, July 1964. (NTIS No. AD 604866)

Sell, R.C., Crawley, J.E., Crockford, G.W., and Fox, J.G. (Eds.) Human factors in work, design and prduction volume 1: Case studies in ergonomics practice. London: Taylor and Francis, Ltd., 1977.

Senneck, C.R. Over-3-day absences and safety. Applied Ergonomics, 1975, 6(3), 147-153.

Sergeev, G.A. An experimental investigation of the self-adaption functions of the human operator (Report No. FTD-HT-67-337). Wright-Patterson AFB, OH: Foreign Technology Division, September 1967. (NTIS No. AD-673 784)

Shank, R.C. Dynamic memory: A theory of reminding and learning on computers and people. Massachusetts: Cambridge University Press, 1982, 54-56.

Shapero, A. Human engineering testing and malfunction data collection in weapon system test programs (WADD Technical Report No. 60-36). Wright-Patterson AFB, OH: Wright Air Development Division, Air Research and Development Command, February 1960.

Shaw, L., and Sichel, H. Accident proneness: Research in the occurrence, causation, and prevention of road accidents. Oxford, England: Pergamon Press, 1971.

Shectman, F. DeSocio, E., and Walker, N.K. Further work on the use of tracking tasks as indicators of stress. Washington, DC: Washington School of Psychiatry, October 1964. (NTIS AD 450 861)

Sheridan, J.E., and Vredenburgh, D.J. Usefulness of leadership behavior and social power variables in predicting job tension, performance, and turnover of nursing employees. Journal of Applied Psychology, 1978, 63(1), 89-95.

Sheridan, T.B. Understanding human error and aiding human diagnostic behavior in nuclear power plants. In J. Rasmussen and W.B. Rouse (Eds.), Human detection and diagnosis of system failures. New York: Plenum, 1981.

Shinar, D., McDonald, S.T., and Treat, J.R. Interaction between causally-implicated driver mental and physical conditions and driver errors causing traffic accidents. 6th Congress of the International Ergonomics Association and Technical Program of the 20th Annual Meeting of the Human Factors Society. Santa Monica, CA: Human Factors Society, 1976, 329-334.

Siegel, A.I. Developing a human reliability prediction method. In Proceedings of U.S. Navy Human Reliability Workshop. Washington, D.C.: Department of Navy, Office of Naval Research, 1970. (NTIS No. AD-722 689).

Siegel, A.I., and Federman, P.J. Prediction of human reliability part 1: Development test of a human reliability predictive technique for application in elelctronic maintainability prediction (Report No. 7172-2). Wayne, PA: Applied Psychological Services, 1971. (NTIS No. AD 738 572)

Siegel, A.I., Wolf, J.J. and Lautman, M.R. A family of models for measuring human reliability. In Proceedings Annual Reliability and Maintainability Symposium, 1975, 110-115.

Silver, B.W. Statistical analysis of general aviation stall spin accidents (SAE Technical Report No. 760480 for meeting April 6-9, 1976). Warren, PA: Society of Automotive Engineers, 1976.

Simmonds, D.C., and Poulton, E C. Camera shake under stress: moving targets viewed briefly in poor light. Ergonomics, 1971, 14(6), 695-701.

Simonov, P.V., Frolov, M.V., and Ivanov, E.A. Psychophysiological monitoring of operator's emotional stress in aviation and astronautics. Aviation, Space and Environmental Medicine, 1980, 51(1), 46-50.

Singleton, W.T. Techniques for determining the causes of error. Applied Ergonomics, 1972, 3(3), 126-131.

Singleton, W.T., Easterby, R.S., and Whitfield, D.C. (Eds.) The human operator in complex systems. London: Taylor and Francis, Ltd., 1967.

Sipos, I., and Kollarik T. Effect of long-term stress on employment stability. Studia Psychologica, 1970, 12(2), 162-164.

Sivak, M. Human factors and highway-accident causation: Some theoretical considerations. Accident Analysis Prevention, 1981, 13(2), 61-64.

Slovic, P., and Fischhoff, B. Targeting risks. Risk Analysis, 1982, 2, 227-234.

Smillie, R.J. and Ayoub, M.A. Accident causation theories: A simulation approach. Journal of Occupational Accidents, 1976, 1, 47-68.

Smith, D.B.D., and Small, A.M. Elderly as cause and victim of accidents. Proceedings of the Human Factors Society, 19th Annual Meeting. Santa Monica, CA: Human Factors Society, 1975, 14-17.

Smith, R.P. Boredom: A review. Human Factors, 1981, 23(3), 329-340.

Sobel, R., and Underhill, R. Family disorganization and teenage auto accidents. Journal of Safety Research, 1976, 8(1), 8-18.

Stave, A.M. The influence of low frequency vibration on pilot performace (as measured in a fixed base simulator). Ergonomics, 1979, 22(7), 823-835.

Steinmetz, L. Managing the marginal and unsatisfactory performer. Reading, MA: Addison Wesley, 1969.

Stellman, J.M., and Daum, S.M. Work is dangerous to your health. New York: Pantheon Books, 1973.

Stewart, C. Human reliability and fault tree analysis. In Proceedings of the Human Factors Society, 26th Annual Meeting. Santa Monica, CA: Human Factors Society, 1982, 664-667.

Stranberg, L. On accident analysis and slip-resistance measurement. Ergonomics, 1983, 26(1), 11-32.

Sultan, S.E. The use of job performance, medical fitness, psychological measures, and selected nonwork factors to distinguish stress disabled police officers from physically disabled and currently active police officers. Dissertation Abstracts International, 1979, 40(4B), 1917-1918.

Swain, A.D. A method of performing a human-factors reliability analysis (Report No. SCR-685). Albuquerque, NM: Sandia Corporation, 1963.

Swain, A.D. Some problems in the measurement of human performance in man-machine systems. Human Factors, 1964, 6(6), 687-700.

Swain, A.D. Some limitations in using the simple multiplicative model in behavior quantification. In W.B. Askren (Ed.), Symposium on Reliability of Human Performance in Work (Report No. AMRL-TR-67-68). Wright-Patterson AFB, OH: Aerospace Medical Research Laboratories, May 1967.

Swain, A.D. Development of a human error rate data bank (Report No. SC-R-70 4286). Albuquerque, NM: Sandia Laboratories, 1970.

Swain, A.D. Design techniques for improving human performance in production. London: Industrial and Commercial Techniques, Ltd., 1973.

Swain, A.D., and Guttman, H.E. Handbook of human reliability with emphasis on nuclear power plant applications (Report No. NUREQ/CB 1278). Albuquerque, NM: Sandia National Laboratories, 1983.

Symonds, M. Emotional hazards of police work. American Journal of Psychoanalysis, 1970, 30(2), 155-160.

Tatsuoka, K. Detection of aberrant response patterns and their effect on dimensionality. Journal of Educational Statistics, 1982, 7(3), 215-231.

Taylor, D.H. Accidents, risks, and models of explanation. Human Factors, 1976, 18(4), 371-380.

Thackray, R.I., and Touchstone, R.M. Rate of initial recovery and subsequent radar monitoring performance following a simulated emergency involving startle. Washington, DC: Federal Aviation Administration, September 1983. (NTIS No. AD-A133 602/3)

Theologu, G.C., Wheaton, G.R., and Fleishman, E.A. Effects of intermittent, moderate intensity noise stress on human performance. Journal of Applied Psychology and Monograph, 1974, 95), 539-547.

Thomson, G.A. Role frontal motorcycle conspicuity has in road accidents. Accident Analysis Prevention, 1980, 12(3), 165-178.

Tinning, R.J., and Spry, W.B. The extent and significance of stress symptoms in industry - with examples for the steel industry. In E.N. Corlett and J. Richardson (Eds.), Stress, work design and productivity. New York: John Wiley & Sons, Ltd., 1981, 129-148.

Triki, M. Perception of role strain by outside salesmen. Dissertation Abstracts International, 1973, 34(5A), 2106.

Trump, T., Etherton, J., and Jensen, R. Machine guards can protect workers! I. Ergonomics and lathe safety. National Safety News, 1983, 128(3), 33-37.

Tsuchiya, F. A study of human-error caused by drug naming. Ergonomics, 1982, 25(6), 540-541.

Vaernes, R.J. The defense mechanism test predicts in adequate performance under stress. Scandinavian Journal of Psychology, 1982, 23(1), 37-43.

VanCott, H.P., and Kinkade, R.G. (Eds.) Human engineering guide to equipment design, New York: McGraw-Hill, 1972.

Verdier, P.A. Basic human factors for engineers. New York: Exposition Press, Inc., 1960.

Verhaegen, P., Vanhalst, B., Derijcke, H., and VanHoecke, M. Value of some psychological theories on industrial accidents. Journal of Occupational Accidents, 1976, 1(1), 39-45.

Wallis, C. Stress: Can we cope? Time, 1983, 121(23), 48-54.

Ward, S.L. and Poturalski, R.J. Maze-solving as a performance measurement tool for human operations under time-stress. (Report No. AFAMRL-TR-83-052). Wright-Patterson, OH: Air Force Aerospace Medical Research Laboratories, August 1983. (NTIS No. AD A133 394 7)

Weisz, A.Z., and McElroy, L.S. Information processing in a complex task under speed stress. Cambridge, MA: Bolt, Beranek, and Newman, Inc., 1964. (NTIS No. AD 601 377)

Weitz, J. Psychological research needs on the problems of human stress. In J.E. McGrath (Ed.) Social and psychological factors in stress. New York: Holt, Rinehart and Winston, 1970.

Weitzel, W.D. A psychiatrist in a bureaucracy: The unsettling compromises. Hospital and Community Psychiatry, 1976, 27(9), 644-647.

Welford, A.T. Fundamentals of skill. London: Methune, 1968.

Welford, A.T. (Ed.), Man under stress. London: Taylor and Francis, Ltd., 1974.

Welford, A.T. Stress and performance. In A.T. Welford (Ed.), Man under stress, London: Taylor and Francis, Ltd., 1974, 1-14.

Wenzel, H.G., and Ilmarinen, R. Effects of environmental heat on performance and some physiological responses of a man during a psychomotor task. Journal of Human Ergology, 1977, 6(2), 139-152.

West, C.W. Coercive motivation, management pressure and worker effort. Dissertation Abstracts International, 1978, 39(5B), 2554.

Wheale, J.L., and O'Shea, N.M. Noise and the performance of a four-choice psychomotor task. Ergonomics, 1982, 25(11), 1053-1064.

Wickens, C.D. Engineering psychology and human performance. Columbus, OH: Charles E. Merrill Publishing Co., 1984.

Wiener, E.L. Midair collisions: The accidents, the systems, and the realpolitik. Human Factors, 1980, 22(5), 521-533.

Wiener, E.L., and Curry, R.E. Flight-deck automation: Promises and problems. Ergonomics, 1980, 23(10), 995-1011.

Wilcox, R.R. Bounds on the k out of n reliability of a test. Applied Psychological Measurement, 1982, 6(3), 327-336.

Wilde, G.J.S. Critical issues in risk homeostasis theory. Risk Analysis, 1982, 2(4), 249-258.

Wilde, G.J.S. Theory of risk homeostasis. Implications for safety and health. Risk Analysis, 1982, 2(4), 209-225.

Wilensk, R. Planning and understanding: A computational approach to human reasoning. Reading, MA: Addison Wesley Pub., 1983.

Wilkins, W.L. Psychophysiological correlates of stress and human performance. In E.A. Alluisi and E.A. Fleishman (Eds.), Human performance and productivity volume 3: Stress and performance effectiveness. Hillsdale, NJ: Lawrence Erlbaum Association, Inc., 1982, 57-90.

Williams, J.M., Decker, T.W., and Libassi, A. The impact of stress management-training on the academic performance of low-achieving college students. Journal of College Student Personnel, 1983, 24(6), 491-494.

Williams, J.R. Follow-up study of relationships between perceptual style measures and telephone company vehicle accidents. Journal of Applied Psychology, 1977, 62(6), 751-754.

Williams, M.J. Validity of the traffic conflicts technique. Accident Analysis Prevention, 1981, 13(2), 133-145.

Williams, R.H. and Zimmerman, D.W. Reconsideration of the attenuation paradox. Journal of Experimental Education, 1982, 50(3), 164-171.

Wolcott, J.H., McMeekin, R.R., Burgun, R.E., and Yanowitch, R.E. Correlation of general aviation accidents with the biorhythm theory. Human Factors, 1977, 19(3), 283-293.

Wolfe., J.W., and Cramer, R.L. Illusions of pitch induced by centripetal acceleration. Brooks AFB, TX: School of Aerospace Medicine, 1967. (NTIS NO. AD 715 158)

Woodson, W.E. Human factors design handbook. New York: Mcgraw-Hill, 1981, 988-992.

Woodson, W.E., and Conover, D. Human engineering guide for equipment designers. Los Angeles: University of California Press, 1964, 1-24,26.

Zuscar, A.B. The test of attentional and interpersonal style and physiological stress patterns among working men and women as predictors of performance of the Stroop Color Word Test. Dissertation Abstracts International, 1983, 44(4B), 1273-1274.