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DECISION MAKING:
AN ANNOTATED BIBLIOGRAPHY OF SELECTED RECENT LITERATURE

Ellen S. Decker and Sharon L. Riedel
U.S. Army Research Institute

ARI Field Unit at Fort Leavenworth, Kansas
Stanley M. Halpin, Chief

SYSTEMS RESEARCH LABORATORY
Robin L. Keesee, Director

U. S. Army
Research Institute for the Behavioral and Social Sciences
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This annotated bibliography of selected readings in decision making is designed to serve as a guide for researchers and military personnel by providing them with a current bibliography on decision making/aiding in man/computer systems. Keywords:

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DECISION MAKING: AN ANNOTATED BIBLIOGRAPHY OF SELECTED LITERATURE

CONTENTS.

DECISION MAKING: AN ANNOTATED BIBLIOGRAPHY OF SELECTED LITERATURE

EXECUTIVE SUMMARY

Requirement:

To provide a guide for research and military personnel interested in current literature on decision making.

Procedure:

The literature collected was selective in nature, but has wide applicability in the area of decision making pertaining to basic research, decision aids, evaluation, and literature reviews/bibliographies.

The annotated bibliography consists of papers chosen from technical reports, published scientific studies, presented papers, and unpublished reports in progress. A categorical index is included.

Findings:

The literature is presented in the following manner:

a. According to categories as specified in the Table of Contents.

b. Indexed alphabetically by first author within each category.

c. Indexed alphabetically by author within year of publication.

The classification scheme is representative of the contents of the decision making material. The abstracts are designed to allow the reader an objective preview of each article. When a reference applies to more than one category, it is repeated.

Utilization of Findings:

This bibliography can be used by system analysts, system developers, and researchers doing work in decision making as an aid in identifying relevant issues and in locating related research findings. As such, it will facilitate the conduct of research, building on the past work of others, and contributing to the efficient use of resources.

DECISION MAKING: AN ANNOTATED BIBLIOGRAPHY OF SELECTED LITERATURE

INTRODUCTION

Decision aiding was identified by the 1983 Army Command and Control Master Plan as an area requiring increased attention. Interest in decision aiding and in the development of tactical decision aids has increased significantly over the past several years, and decision aiding is now a major concern in the research and development community. This research is critical to the design, evaluation, and implementation of decision support systems. Those from the many disciplines working in the area of decision making need to make efficient use of past research findings. Using this bibliography researchers can survey potentially relevant topics and identify articles for more detailed examination.

The body of literature relating to decision making is enormous, totaling in the thousands of articles. This bibliography contains articles that have been collected in the course of the ARI Fort Leavenworth Field Unit's continuing research program in decision aiding. Literature selection was neither comprehensive nor completely representative, however, it did include a wide variety of articles relating to the most important issues facing decision aid designers and evaluators.

The report has been divided into four main categories: basic research, decision aids, evaluation, and reviews and bibliographies. Subheadings are identified under each category except the fourth. In addition to the annotated entries, a topic and author index is included at the back of this report.

DECISION MAKING: AN ANNOTATED BIBLIOGRAPHY OF SELECTED LITERATURE

BASIC RESEARCH

General Decision Making

Alter, S. (1977, February). Why is man-computer interaction important for decision support systems? Interfaces, 7(2), 109-115.

Argues that interactive, conversational decision support systems do not represent their true identities in many cases. The author believes that better man-computer interfaces are needed, but not necessarily by managers themselves. Suggests that the focus should be on experts who understand the details underlying a support system; if managers do not learn the correct usage of decision support systems, then usage should be discouraged without the aid of an intermediary.

Arkes, H.R., Harkness, A.R. (1980). Effect of making a diagnosis on subsequent recognition of symptoms. Journal of Experimental Psychology: Human Learning and Memory, 6(5), 568-575.

A "false recognition effect" is described, whereby a subject incorrectly "remembers" items which remain consistent with his "schema" of something. The authors concur with previous research results that a diagnosis functions as a schema. Three experiments were conducted to observe the effect of the possession of a diagnosis on consequent recognition of symptoms that were conceptually related/unrelated to the diagnosis. Memory distortion may be attributed to overconfidence in the validity of one's hypothesis, false recognition of unpresented inferences or features of a schema, or a long retention interval.

Bandyopadhyay, R. (1977, January). Information for organizational decision-making - a literature review. IEEE Transactions on Systems, Man, and Cybernetics, SMC-7(1), 1-15.

Classifies literature pertaining to organizational decision making into three areas: management science, classical, and behavioral science. Stresses that there is a problem in measuring information value. The author aims to provide insight into the broad area cf organizational decisionmaking.

Beach, L.R. (1966, March). Accuracy and consistency in the revision of subjective probabilities. IEEE Transactions on Human Factors in Electronics, 7 (1), 29-36.

This report investigates the consistency with which subjective probabilities are revised. Four experiments were performed in which models of probabilistic concept formation studies and Bayesian subjective probability revision studies were combined. Results showed that subjects' revisions of their subjective probabilities can be accurately predicted with Bayes' theorem.

Bettenhausen, K., & Murnighan, J.K. (1985). The emergence of norms in competitive decisionmaking groups. Administrative Science Quarterly, 30, 350-372.

Interaction among group members in nineteen newly formed decision making groups (composed of five persons each) was studied to understand how social norms form. The behavior of these group members served as the foundation in constructing a model of norm development whereby uncertainty over appropriate behavior directs people to utilize their past experiences in similar social settings as scripts. By using these experiences they determine behaviors in their current situations. The results of gaining knowledge about how norms develop would grant the capability of "managing" this limitation in group decision making situations.

Blood, M.R. (1971). Short notes - the validity of importance. Journal of Applied Psychology, 55(5), 487-488.

Debates the utility of weighting by importance in measuring job satisfaction when combining measures of satisfaction relevant to job aspects into a measure of aggregate satisfaction. Doubts the validity of information which is applied in importance weighting.

Brown, R.V. (1974, October). Modeling subsequent acts for decision analysis: a heretical view. Paper presented at International Conference of ORSA/TIMS, Puerto Rico.

Addresses problems in the technology of decision analysis, namely structuring of the model itself. The conventional decision theory model in the form of a decision tree is referred to as "preposterior" analysis, which is faulted by the author as rarely meeting "real world" decision analyses requirements. This could possibly be a reason for the lack of success with decision analysis in information decisions as opposed to successful operating decisions which are all based on prior information. An acts-as-events model is proposed which supposedly provides an adequate framework for assessment (and involves a smaller number of total assessments) and allows events to be more readily visualized.

Chu, Y., & Rouse, W.B. (1979, December). Adaptive allocation of decisionmaking responsibility between human and computer in multitask situations. IEEE Transactions on Systems, Man, and Cybernetics, SMC-9(12), 769-778.

Addresses the question of how decisionmaking responsibilities should be allocated between humans and increasingly intelligent computers as systems become more automated. The authors maintain that with "adaptive allocation" the allocation of responsibility is contingent upon the state of the system and decisionmakers. The decisionmaker most capable of performing a task at a particular time will be subject to complete it. An experimental study involving a flight management task illustrates this general strategy.

Connelly, D.P., & Johnson, P.E. (1980, September). The medical problem solving process. Human Pathology, 11(5), 412-419.

Addresses the medical problem solving process. The two major decision making phases which characterize this process are: specification of the correct diagnosis to a level adequate for therapeutic considerations, and choice

of a therapy that positively influences the patient's problem. For effective decision making, appropriate selectivity must be engaged in to limit the amount of information worthy of examination or generated from the thought process.

Connolly, T., & Miklausich, V.M. (1978). Some effects of feedback error in diagnostic decision tasks. Academy of Management Journal, 21(2), 301-307.

A laboratory study was conducted to examine the effects of varying the levels of feedback error on performance in diagnostic tasks. Results suggest that the comprehensive decision quality is contingent on both the quality of information available when the decision is made and the quality of subsequent feedback.

Cyert, R.M., & DeGroot, M.H. (1974, May/June). Rational expectations and Bayesian analysis. Journal of Political Economy, 82, 521-536.

Models that delineate the means by which rational expectations may be developed within a market are the focus of this article. Three distinct models are unfolded which explain the interaction of Bayesian learning and the expectations in achieving a market equilibrium. These dynamic models depict the transition process toward equilibrium.

Dino, G.A., & Shanteau, J. (1984, November). What skills do managers consider important for effective decision making? Paper presented at the Psychonomics Meeting, San Antonio, Texas.

This study was conducted with the purpose of analyzing how decision makers themselves define decision making competence. Thirty-five bottom-level and twenty-four top-level managers participated in the following: (1) Rated skills that they believed important for effective decision makers; (2) Rated the importance of these skills in upper-level and lower-level decision makers; and, (3) Were evaluated in regards to the effects of gender, their types of organizations, and their levels within their organizations.

Edwards, W. (1975, August). Research on the technology of inference and decision (Report No. 001597-F). Los Angeles, California: Advanced Research Projects Agency.

The technology of inference and decision is the topic of this research report. The focus is on the elicitation of subjective probabilities, multi-attribute utility theory, and error in decision analysis. Stressed is the necessity of prioritizing the structuring of the problem along with processing information and the elicitation of probabilities/utilities, respectively.

Edwards, W. (1977, May). How to use multiattribute utility measurement for social decisionmaking. IEEE Transactions on Systems, Man, and Cybernetics, SMC-7(5), 326-339.

Contends that arguments over public policy often result from dissension over values. These disagreements are repeatedly contested in the context of specific decisions, at tremendous social cost for each decision which must be made. The author utilizes Multivariate Utility Measurement (MAUM) for social decision making through three examples in applied settings, in which he illustrates this ten-step process to elucidate the values of each participant in the decision making process. The fundamental idea is that every outcome of an

action may have value on a number of various dimensions. It is strongly emphasized that simplicity in elicitation procedures enable social policies to be efficiently and more easily implemented. MAUM is also flexible in response to ever-changing value systems.

Einhorn, H.J. & Hogarth, R.M. (1981). Behavioral decision theory: processes of judgment and choice. Ann. Rev. Psychol., 32, 53-88.

This review of behavioral decision theory literature argues that the judgmental biases exhibited in laboratory situations may be functional in natural settings. Areas reviewed include attention, memory, learning, feedback, cognitive representation, and conflict. Assuming a broad perspective in the research of decision making may yield the most insightful and generalized results.

Einhorn, H.J., Hogarth, R.M., & Klempner, E. (1977). Quality of group judgment. Psychological Bulletin, 84, 158-172.

Deals with the accuracy of group judgment within and between different populations of groups. The quality of group judgment is defined. Results as well as constraints affecting judgmental quality of various strategies for merging opinions under a diversity of circumstances are discussed. A statistical procedure is introduced that considers which baselines are suitable in the evaluation of the quality of group judgment.

Farquhar, P.H. (1982). Utility assessment methods (Working Paper 81-5). Davis, California: University of California.

Attempts to integrate current methods for evaluating single-attribute utility functions. Presents various new methods of evaluation which may be beneficial in furthering the research in this area, emphasizing the varied steps in the utility assessment process, and contrasting methods of comparative risk. Reviews approximately twenty-four utility assessment methods.

Fischer, G.W. (1979, July). Utility models for multiple objective decisions: do they accurately represent human preferences? The Journal for the American Institute for Decision Sciences, 10(3), 451-479.

This paper is written for those decision scientists who do not utilize Multivariate Utility (MAU) modeling procedures because they doubt that these procedures are reliable in providing a true representation of human preferences. The author's goal is to persuade many that the MAU approach has many useful applications. Two approaches to MAU modeling as well as relevant psychological research are examined. Covered in this article are the following topics: assigning utility values to decision outcomes, holistic utility assessment methods, an overview of MAU theory, methods for assessing decomposed MAU functions, common objections to MAU models, and validating MAU models and assessment procedures.

Fischhoff, B. (1977, May). Decision analysis: clinical art or clinical science? (Technical Report PTR-1042-77-5). Eugene, Oregon: Decision Research, A Branch of Perceptronics.

Draws an analogy between decision analysis and psychotherapy. Areas discussed include evaluating the validity, effectiveness, and underlying assumptions of decision analysis, improving analysts' skills, and social, ethical, and political issues. The comparison with psychotherapy serves to delineate the important issues that should be addressed in a research program.

Fischhoff, B. (1985, Winter). Environmental reporting: what to ask the experts. The Journalist, 11-15.

This study of environmental reporting focuses on the difficulty in obtaining complete, relevant, and valid environmental stories. The author cites the major problem as one of overconfidence displayed by specialists who do not realize the limits to their own understanding.

Fischhoff, B., Slovic, P., & Lichtenstein, S. (1978). Fault trees: sensitivity of estimated failure probabilities to problem representation. Journal of Experimental Psychology: Human Perception and Performance, 4(2), 330-344.

This study analyzes the effects of varying three aspects of fault tree structure on the assessment of a fault tree for the event of "a car failing to start." Results confirmed that: (a) People were insensitive to what had been omitted from the fault tree; (b) When the amount of detail was increased this did not significantly affect perceptions; and, (c) The perceived importance of a certain branch was increased by presenting it as two separate component branches.

Gaeth, G.J., & Shanteau, J. (1984). Reducing the influence of irrelevant information on experienced decision makers. Organizational Behavior and Human Performance, 33, 263-282.

Two training procedures were applied to assess the impact on reducing the influence of irrelevant information on agricultural expert judges. The training consisted of either a lecture or an involved interaction session with practice. The interactive training significantly lessened the incorporation of irrelevant information into the decision made by the expert decision makers. Not only did it also improve the accuracy of the judgments, it had long term effects. Application to areas other than those which are perceptually based is advocated.

Goitein, B. (1984). The danger of disappearing postdecision surprise: comment on Harrison and March, "decision making and postdecision surprises." Administrative Science Quarterly, 29, 410-413.

Comments on paper written by Harrison and March on "Decisionmaking and Postdecision surprises" (1984). The author examines the issue and explains why there is a problem with the disappearance of post decision surprise. Believes that "hindsight bias," where an outcome of a decision may be seen by one in

hindsight as having been expected to a greater extent than it actually was, is detrimental because it prevents individual and organizational learning about faults in the decision system. Further research is needed on how to reduce hindsight bias.

Goldstein, I.P. (1979). The genetic graph: a representation for the evolution of procedural knowledge. International Journal of Man-Machine Studies, 11, 51-77.

A model of the evolution of rule-structured knowledge which is considered a cornerstone of the development of computer-based coaches is illustrated. A graph structure depicting the concepts of generalization, correction, and refinement is displayed and defined. Various genetic graph formulations pertaining to reasoning skills used in playing an elementary mathematical game are examined.

Hart, S.L. (1985). Toward quality criteria for collective judgments. Organizational Behavior and Human Decision Processes, 36, 209-228.

Addresses the subject of group decision making by presenting evaluative criteria, which were derived from a review of prevailing literature, for judging when a "high-quality outcome" has been reached. A major goal which is hoped to be generated by this project is the construction of a set of empirically derived criteria against which outcome quality may be judged. The most effective procedures for the achievement of a high quality collective judgment are suggested as a result of six factual group problem-solving cases which were evaluated by use of a specially developed questionnaire.

Hogarth, R.M. (1975, September). Methods for aggregated opinions. Revised version of paper presented at the Fifth Research Conference on Subjective Probability, Utility, and Decision Making, Darmstadt, West Germany.

Contends that there is no "one best way" to aggregate opinions. Items discussed in this report include: (a) methods and models for aggregating opinions in the way of point estimates and probability distributions; and (b) causes of incompetency in interacting groups and how to enhance group processes.

Hogarth, R.M. (1982, March). On the surprise and delight of inconsistent responses. In R. Hogarth (Ed.), New Directions for Methodology of Social and Behavioral Science: Questions Framing and Response Consistency (pp. 91-103). San Francisco: Josey Bass.

The author begins by providing the reader with various definitions of the word inconsistency, and relates inconsistency to the concept of variability. The goals and steps of practical inference are discussed, and sources of consistency and inconsistency in the process of formulating hypotheses are cited.

Hogarth, R.M., & Makridakis, S. (1981). The value of decision making in a complex environment: an experimental approach. Management Science, 27, 93-107.

An experiment was conducted in which a competitive game was played to assess whether or not the costs of time and effort used to analyze a decision outweighed the benefits. Another objective was to discover strategies to

improve decision performance. There were two kinds of uncomplicated decision rules: (1) rules were applied consistently (arbitrary-consistent), and (2) rules were subject to a random component (arbitrary-random).

Howard, R.A. (1979, October). An assessment of decision analysis. Stanford, California: Stanford University.

Presents an assessment of decision analysis by discussing human decision making, decision analysis, the usefulness of decision analysis, ethical concerns, and the challenge that must be faced if the field is to continue its growth. The author explains that "decision making is what you do when you don't know what to do", and cites evidence that people are not good natural decision makers. It is emphasized that decision analysis is not simply a logical procedure, but also an "artistic" process.

Jin, V.Y. (1985, May). Delays for distributed decisionmaking organizations. Unpublished thesis, Massachusetts Institute of Technology, Cambridge, Massachusetts.

In this thesis an algorithm for computing time delay in the operation of distributed decision making systems (DDM) is produced. Interactors in DDM organizations are investigated and asynchronous protocols that enrich performance are constructed.

Johnson, L.C., & Mai, N. (1979). Decomposition techniques: linear vs. nonlinear models. Organizational Behavior and Human Performance, 24, 60-66.

Discriminates between the scale quality in a simple linear model and the scale quality of a nonlinear model through use of a distortion index. This index is tested in a simulation study, indicating that in some cases the linear model can misleadingly disconnect alternatives. The correlation approach does not take into account the changes which may occur in the scale upon which alternatives are examined, which is why the simple linear model is proposed.

Johnson, P.E. (1980, June, in press). Cognitive models of medical problem solvers. In D. Connelly, E. Benson, & D. Burke (Eds.), Clinical Decision Making and Laboratory Use. Minneapolis, Minnesota: University of Minnesota Press.

In this discussion of cognitive models of medical problem solvers the principal theme is that similarities outweigh differences when comparing individual problem solvers. A diagnostic reasoning model of physician knowledge is proposed which depicts what patients with certain diseases or conditions should "look like".

Johnson-Laird, P.N. (1983). Mental models, towards a cognitive science of language, inference, and consciousness. Cambridge, Massachusetts: Harvard University Press.

This chapter from Johnson-Laird's book defines "mental models", explains how they are constructed, and interprets them. The theory itself is designed to explain the higher processes of cognition, particularly comprehension and inference.

Jungermann, H. (1980a). Speculations about decision-theoretic aids for personal decisionmaking. Acta Psychologica, 45, 7-34.

Deals with techniques which assist people in making personal decisions. Personal decisions are defined as those where the person making the decision must face the ramifications of his actions. Even though this distinction may seem blurred between those persons making decisions for themselves versus others, the author holds the opinion that not enough attention in applied decision research is given to personal decisionmaking. Structuring the problem, assessing ones value system, and examining alternative options are addressed in helping one to arrive at a decision.

Jungermann, H. (1980b, September). Structural modeling of decision problems. Paper presented at the 88th Annual Convention of the American Psychological Association (APA), Montreal.

The author's interest lies with the first stage in the process of decision making, in which the problem is represented (translated cognitively into a structure that represents the situation). It is proposed that the questions one asks influence the answers one gets, i.e., various methods of posing a decision problem to a person stimulates him to "reference structure" different sets of knowledge. Examples are given of the phases of the decision making process, the structuring of knowledge, and fault trees.

Kassirer, J.P., & Gorry, G.A. (1978). Clinical problem solving: a behavioral analysis. Annals of Internal Medicine, 89, 245-255.

Reports on some of the specific tactics and overall strategies composing the problem-solving behavior of trained clinicians as they were "taking the history of the present illness." The tape recorded behavior of this interchange between a clinician and simulated patient was analyzed. The authors suggest that the information has potential value in the field of medical education and in devising computer programs to assume the process of diagnosis.

Klayman, J. (1982). Simulations of six decision strategies: comparisons of search patterns, processing characteristics, and response to task complexity (Working paper #100). Chicago, Illinois: University of Chicago.

This paper addresses questions pertaining to the modifications made in strategies in response to task complexity by decision makers. A primary goal of these simulation studies entails identifying different decision strategies on the basis of information search patterns. It is reasoned that simulation can be very useful in generating, testing, and modifying hypotheses about human decision strategies but care must be taken to insure that the design is representative of the impending specific decision task.

Klein, G.A. (1980, October). Automated aids for the proficient decision maker. Proceedings of the Smith Conference on Cybernetics and Society.

Proposes a comparison-guided model of decision-making, maintaining that proficient decision makers are able to recognize and subsequently place new situations parallel to ones previously experienced. The types of decisions discussed are complex, those with unusual conditions. It is asserted that a

redefinition of the problem by the expert will allow utilization of all resources which may yield a solution to the problem, rather than using a decision aid requiring "rule-following". The author believes that proficiency is not just following rules and procedures.

Klein, G.A. (1981, March). A perceptual/recognitional model of decision making. Yellow Springs, Ohio: Klein Associates.

Defends the view that skilled decision making depends on perceptual learning and recognitional capacities, known as the perceptual/recognitional model. Argues that the procedural model, whereby one follows rules and procedures, is not adequate for use in making complex decisions. The author contends that decision making can be treated as a skill. The perceptual/recognitional model proposes the use of analogous experiences to form judgments and requires the evaluation of the intangible differences between experts and novices. Suggests that future decision aids should include a method by which relevant analogues may be identified.

Kunreuther, H.C., & Schoemaker, P.J.H. (1979). Decision analysis for complex systems, integrating descriptive and prescriptive components. Knowledge: Creation, Diffusion, and Utilization, 2(3), 389-412.

A framework for decision analysis in complex social systems is presented. Of major concern in this article are three components: (a) descriptive analyses of organizational environments and decision models; (b) prescriptive analysis, including decision methodology and decision theory; and, (c) the relationship between descriptive and prescriptive analyses. The importance of descriptive analyses is emphasized in organizational decision making.

Lichtenstein, S., Earle, T.C., & Slovic, P. (1975). Cue utilization in a numerical prediction task. Journal of Experimental Psychology: Human Perceptions and Performance, 104(1), 77-85.

Research results in this study were obtained from an experiment in which forty subjects were trained to make numerical predictions of a criterion from a cue. It was found that subjects regressed each cue and subsequently averaged the regressed values. It is suggested that by analyzing the heuristics utilized by subjects, we can further our knowledge of human decision making.

Morris, P.A. (1975, February). Modeling experts. Manuscript submitted for publication.

Addresses the problem of expert resolution. A model is presented which allows the decision maker to arrive at a solution, whether it is from a single expert or a group of experts. The term "surrogate prior" is defined and shown to play a role in measuring the joint information contained in the probability assessments generated by a panel of experts within the case of the multi-expert. This modeling approach forms the basis for analytical thinking about the interaction between experts and the manner in which probabilities should be derived from experts.

Newman, J.R. (1977, August). Differential weighting for prediction and decision making studies: a study of ridge regression (SSRI Research Report 77-1). University of Southern California: Social Science Research Institute.

This study describes the conditions which are appropriate for differential or simple unit weighting of predictor variables in prediction and/or decision studies. A regression model, ridge analysis (RIDGE), is proposed as a substitution for the ordinary least squares (OLS) regression analysis because of potential difficulties with OLS analysis. The RIDGE method of estimation may also be used as a substitute for cross validation.

Norman, D.A. (1981a, January). Categorization of action slips. Psychological Review, 88(1), 1-15.

The author outlines a system of activated schemas with a triggering mechanism which determines appropriate time for activation, which is a satisfactory framework for categorization and analysis of action slips. This theory permits slips to be categorized into three areas: (a) errors in the formation of the intention; (b) faulty activation of schemas; and, (c) faulty triggering of slips.

Norman, D.A. (1981b). A psychologist views human processing: human errors and other phenomena suggest processing mechanisms. Paper presented at: IJCAI, Vancouver, British Columbia.

Discusses human processing structures by arguing for a different kind of processing mechanism than that which is most commonly referred to in Artificial Intelligence. The form of human error is of major importance in this study. A distinction is made between two major classes of errors, mistakes versus slips, and these two types are examined.

Pitz, G.F. (1970). On the processing of information: probabilistic and otherwise. In G. de Zeeuw et al. (Eds.), Acta Psychologica 34 Subjective Probability (pp. 201-213). Amsterdam: North-Holland Publishing Company.

Advocated is the study of processes such as attention, encoding, and short-term memory in relation to probabilistic information processing (PIP) in order to expand our knowledge of decision making behavior. It is stressed that the information, not the processing itself, is probabilistic in nature. Two models of opinion revision are reviewed which incorporate the use of Bayes' theorem in their models, but recognize human error. Outlined is a PIP model computer program.

Rouse, W.B. (1983). Models of human problem solving: detection, diagnosis, and compensation for system failures. Automatica, 19(6), 613-625.

Covers models of human problem solving with an emphasis on those models which predict human behavior and performance to support design and evaluation. Areas which are of particular concern in this article are detection, diagnosis, and compensation of system failures. Proposed is an outline of a model which may influence the integration and progress of understanding human problem solving.

Saleh, J., Leal, A., Kim, J., & Pearl, J. (1979, October). Progress toward a goal-directed decision support system (Technical Report UCLA-ENG-CSL-7973). University of California, Los Angeles: School of Engineering and Applied Science.

A computerized decision-support system is described which was developed by the authors as an effective replacement for decision-tree representation. They state that the approach is preferable because of the clarity and purposefulness it provides. This goal-directed method focuses on a single objective at any given time and instructs the user to ignore all side effects. An extensive amount of graphs, structures, and representations are provided.

Schoemaker, P.J.H. (1981). Behavioral issues in multiattribute utility modeling and decision analysis. From J.N. Morse (Ed.), Organizations: Multiple Agents with Multiple Criteria. Heidelberg, Germany: Springer-Verlag.

Various empirical issues pertaining to decision analysis, specifically multiattribute utility (MAU) modeling, are investigated. The issues primarily concern the following issues: (a) the need for empirical validations in normative decision theory; (b) the examination of the intrinsic characteristics of MAU preference functions, expressly mathematical complexity; (c) the review of method bias; and, (d) analysis of the meanings of relative importance judgments.

Schonemann, P.H., Cafferty, T., & Rotton, J. (1973). A note on additive functional measurement. Psychological Review, 80(1), 85-87.

In this report it is demonstrated that the additive functional measurement model reduces to a distinct case of additive conjoint measurement. Disputes N. Anderson's (1970) functional measurement theory.

Shanteau, J. (1975). Averaging versus multiplying combination rules of inference judgment. Acta Psychologica, 39, 83-89.

Two combination rules, averaging and multiplying, which describe sequential inference judgments, were compared through three experiments in this study. Both of these rules depict how successive pieces of evidence are combined with previous judgments to form new judgments. Usage of the averaging rule was supported but the descriptive ability of the Bayesian approach (and other approaches which use the multiplying rule) was questioned. It may be inferred from the averaging result that judgments may incorporate processing rules differently than previously speculated.

Shanteau, J. (1985b, September). Psychological characteristics of expert decision makers (Psychology Report #85-2). Manhattan, Kansas: Kansas State University.

This study investigates personal characteristics in expert decision makers, the psychological properties which the author feels are neglected in expert judgment research. Observations are made concerning these characteristics and some unexplored questions about expert decision makers are asked.

Shanteau, J., & Gaeth, G.J. (1983, January). Training expert decision makers to ignore irrelevant information (Human Information Processing Report No. 82-5). Manhattan, Kansas: Kansas State University.

A series of research projects were performed with the goal of revealing the influence of irrelevant information on expert decision makers. Training programs to overcome this effect were discussed and the long-term effects of the training were evaluated.

Shanteau, J., & Nagy, G.F. (1984). Information integration in person perception: theory and application. In M. Cook (Ed.), Issues in person perception (pp. 48-86). London: Methuen.

This selected chapter covers some of the principal findings from research conducted on the person perception model with the information integration theory (ITT). Five research studies are alluded to which exemplify the early development and basic assumptions of ITT, which is traced to impression formation. Cases are cited which show how ITT can be utilized in the analysis of socially relevant interpersonal decisions, and also in real-world concerns.

Simon, H.A. (1979, Autumn). On how to decide what to do. Reprinted from The Bell Journal of Economics, 9(2), 494-507.

This article provides support for the idea that economic analysis should not simply be concerned with substantive rationality, but also with the procedural aspects of decision making. The author discusses approaches to procedural rationality within the fields of operations research and management science, artificial intelligence, computational complexity, and cognitive simulation.

Slovic, P., Fischhoff, B., & Lichtenstein, S. (1977). Behavioral decision theory. Ann. Rev. Psychol., 1-39.

The author focuses on the psychological aspects of individual judgment and decision making by reviewing descriptive research and examining decision aids. A survey of publications (the majority of them dated 1971-75) on the subject of behavioral decision theory is provided and descriptive studies of judgment are evaluated. An attempt is made to enumerate the errors in decision-making that may arise from judgment biases. Some areas mentioned under the topic of descriptive research include probabilistic judgment, choice, models of risky choice, and regression approaches. An insightful discussion of decision aids, MAUT research, decision analysis, man/machine systems, and use of decision aids clarifies: (a) issues which a decision maker may face, and (b) the systems used to solve problems.

Slovic, P., & Tversky, A. (1974, February). Who accepts Savage's Axiom? (ONR Technical Report NR 197-026). Eugene, Oregon: Oregon Research Institute.

Argues that the established principle: "rational choice is comparable to logic in that a reasonable person who understands the postulates would not want to violate them" is open to doubt. An experiment is conducted which examines Savage's independence principle, a key axiom inherent in expected utility theory. Discussed is the difficulty in discriminating between rejection of a decision principle and unsuccessful "understanding" of it.

Stevens, A., Collins, A., & Goldin, S.E. (1979). Misconceptions in student's understanding. Int. J. Man-Machine Studies, 11, 145-156.

Proposed in this research report is a system which tutors students with intelligent computer aided instruction (ICAI) by diagnosing and rectifying conceptual misunderstandings. A theory based on examination of tutoring dialogs is the basis for this system. The goal structure of a tutor and types of conceptual bugs are specified.

Taylor, E.N. (1983, September). A review of literature relevant to unaided tactical decision making (ARI Research Note 83-35). Alexandria, Virginia: Human Resources Research Organization (HumRRO).

Provides a summary of literature which may be useful in developing and implementing training programs pertaining to tactical decision making. The authors contend that a cause for concern in the military is the question of whether or not decision makers are deciding upon the best courses of action in rapidly changing situations based on the techniques utilized by them to organize, analyze, and present information. Various models of decision making, along with problems in training, are examined with the purpose of developing a methodology for preparing military leaders to make tactical decisions.

v. Winterfeldt, D. (1975, August). An overview, integration, and evaluation of utility theory for decision analysis (SSRI Research Report 75-9). Los Angeles, California: Social Science Research Institute.

Reviews current measurement theories on utility modeling and assessment. Written particularly for decision analysts who are interested in these theories for deciphering and solving real world decision problems which are complex in nature. This paper aims to relate the present utility measurement theory with decision analytic practice. The paper tries to lessen the gap between the theory and practice of utility measurement, which may be attributed in part to the difficulty in comprehension of the mathematical language inherent in the utility theories. It is concluded that even though utility theories can be beneficial in the structuring process of evaluation, they are usually too complex for usage in real world preference assessment.

Uncertainty

Beach, L.R. (1966, March). Accuracy and consistency in the revision of subjective probabilities. IEEE Transactions on Human Factors in Electronics, 7 (1), 29-36.

This report investigates the consistency with which subjective probabilities are revised. Four experiments were performed in which models of probabilistic concept formation studies and Bayesian subjective probability revision studies were combined. Results showed that subjects' revisions of their subjective probabilities can be accurately predicted with Bayes' theorem.

Beach, L.R., Townes, B.D., Campbell, F.L., & Keating, G.W. (1976). Developing and testing a decision aid for birth planning decisions. Organizational Behavior and Human Performance, 15, 99-116.

A decision aid is promoted which allows one to calculate subjective expected utilities (SEUs) for having a (another) child; a value hierarchy is used. The method is intended to assist people with their birth planning decisions so that they may logically and sensibly weigh the pros and cons. Decisions are divided into "manageable chunks" and the relative utility of each chunk is evaluated. The authors affirm that through the development of this aid they developed a method applicable to other areas besides birth planning.

Benbasat, I. & Taylor, R.N. (1982, July/August). Behavioral aspects of information processing for the design of management information systems. IEEE Transactions on Systems, Man, and Cybernetics, SMC-12(4), 439-450.

Cites various models of information processing which account for human thinking and attempts to cover the capabilities, as well as the inadequacies, in information processing present in the literature. The authors believe that management information systems (MIS) can be radically improved by understanding the behavioral processes by which humans process information and make choices. This will aid in eliminating the problem of "overloading" the human user.

Brown, R.V. (1974, October). Modeling subsequent acts for decision analysis: a heretical view. Paper presented at International Conference of ORSA/TIMS, Puerto Rico.

Addresses problems in the technology of decision analysis, namely structuring of the model itself. The conventional decision theory model in the form of a decision tree is referred to as "preposterior" analysis, which is faulted by the author as rarely meeting "real world" decision analyses requirements. This could possibly be a reason for the lack of success with decision analysis in information decisions as opposed to successful operating decisions which are all based on prior information. An acts-as-events model is proposed which supposedly provides an adequate framework for assessment (and involves a smaller number of total assessments) and allows events to be more readily visualized.

Edwards, W. (1975, August). Research on the technology of inference and decision (Report No. 001597-F). Los Angeles, California: Advanced Research Projects Agency.

The technology of inference and decision is the topic of this research report. The focus is on the elicitation of subjective probabilities, multi-attribute utility theory, and error in decision analysis. Stressed is the necessity of prioritizing the structuring of the problem along with processing information and the elicitation of probabilities/utilities, respectively.

Einhorn, H.J. (1980). Overconfidence in judgment. New Directions for Methodology of Social and Behavioral Science, 4, 1-16.

Argues that the methods we practice to fulfill our goals depend upon unaided judgment rather than scientific methodology. The author believes that we

continually "judge our own judgment," and overconfidence in judgment is a result of the manner in which outcome feedback is utilized to evaluate and learn about judgmental accuracy. The idea of outcome irrelevant learning structures (OILS) is presented. Discusses how our ability to learn about judgment can be enhanced.

Einhorn, H.J. & Hogarth, R.M. (1978). Confidence in judgment: persistence of the illusion of validity. Psychological Review, 85(5), 395-416.

Responds to the question "Why is there a substantial difference between a person's confidence in his own judgment and research findings on the fallibility of human judgment?" by exploring the structure of judgmental tasks as it affects outcomes. The manner in which outcomes are interpreted and used is discussed, as well as the relationship between learning and experience. Presents a model in which learning and maintaining confidence in one's own judgment is developed.

Einhorn, H.J. & Hogarth, R.M. (1981). Behavioral decision theory: processes of judgment and choice. Ann. Rev. Psychol., 32, 53-88.

This review of behavioral decision theory literature argues that the judgmental biases exhibited in laboratory situations may be functional in natural settings. Areas reviewed include attention, memory, learning, feedback, cognitive representation, and conflict. Assuming a broad perspective in the research of decision making may yield the most insightful and generalized results.

Einhorn, H.J., & Hogarth, R.M. (1985, January). Ambiguity and uncertainty in probabilistic inference. Psychological Review, in press.

Presents a model in reference to the role of ambiguity and uncertainty in inferential judgments. The authors show how this model may be associated with Keynes' concept of the weight of evidence, the non-additivity of complementary probabilities, risky choice, and current work on cognitive heuristics. It is proposed that reaching a compromise between "what is" and "what might have been" or "what might be" is focal to inferences under ambiguity and uncertainty.

Einhorn, H.J., & Schacht, S. (1977). Decisions based on fallible clinical judgment. To appear in Kaplan, M., & Schwartz, S. (Eds.), Human Judgment and Decision Processes: Applications in Problem Settings: Academic Press.

Addresses the problem of a low accuracy rate in clinical judgment. An analytical framework for dealing with questions pertaining to the validity of clinical judgment is illustrated. Some of the effects of clinical judgment on decisions that resulted because of a lack of correlation between some criterion and the judgment is also reviewed. The authors assert that their results are applicable to all situations where judgments lead to making decisions.

Fischhoff, B. (1985, Winter). Environmental reporting: what to ask the experts. The Journalist, 11-15.

This study of environmental reporting focuses on the difficulty in obtaining complete, relevant, and valid environmental stories. The author cites the major problem as one of overconfidence displayed by specialists who do not realize the limits to their own understanding.

Fischhoff, B., Slovic, P., & Lichtenstein, S. (1978). Fault trees: sensitivity of estimated failure probabilities to problem representation. Journal of Experimental Psychology: Human Perception and Performance, 4(2), 330-344.

This study analyzes the effects of varying three aspects of fault tree structure on the assessment of a fault tree for the event of "a car failing to start." Results confirmed that: (a) People were insensitive to what had been omitted from the fault tree; (b) When the amount of detail was increased this did not significantly affect perceptions; and, (c) The perceived importance of a certain branch was increased by presenting it as two separate component branches.

Fryback, D.G., Goodman, B.C., & Edwards, W. (1973). Choices among bets by Las Vegas gamblers: absolute and contextual effects. Journal of Experimental Psychology, 98(2), 271-278.

In this study, two experiments conducted at the Four Queens Casino in Las Vegas refute prior research evidence that accounted for choices among gambles. The Expected Value (EV) normally is highly correlated with preferences among gamblers. It may be inferred that the attraction of a gamble is not totally dependent upon the characteristics of that gamble. The results suggest that certain concepts can not be overlooked in the construction of theories that endeavor to depict human decision making; these are: anchoring, adaptation, assimilation, and contrast.

Hogarth, R.M. (1982, March). On the surprise and delight of inconsistent responses. In R. Hogarth (Ed.), New Directions for Methodology of Social and Behavioral Science: Questions Framing and Response Consistency (pp. 91-103). San Francisco: Josey Bass.

The author begins by providing the reader with various definitions of the word inconsistency and relates inconsistency to the concept of variability. The goals and steps of practical inference are discussed, and sources of consistency and inconsistency in the process of formulating hypotheses are cited.

Hudgens, G.A., & Fatkin, L.T. (1986, February). Sex differences in risk taking: repeated sessions on a computer-simulated task (Technical Memorandum 2-86). Aberdeen Proving Ground, Maryland: U.S. Army Human Engineering Laboratory.

A computer-generated task and a controlled task were used in two experiments to examine sex differences in risk-taking behavior. Male and female participants were shown a video display of simulated probabilities and took risks. The results concur with the current research that states men are more inclined to take risks than women in a diversity of situations.

Lichtenstein, S., Earle, T.C., & Slovic, P. (1975). Cue utilization in a numerical prediction task. Journal of Experimental Psychology: Human Perceptions and Performance, 104(1), 77-85.

Research results in this study were obtained from an experiment in which forty subjects were trained to make numerical predictions of a criterion from a cue. It was found that subjects regressed each cue and subsequently averaged the regressed values. It is suggested that by analyzing the heuristics utilized by subjects, we can further our knowledge of human decision making.

Lichtenstein, S., & Slovic, P. (1973). Response-induced reversals of preference in gambling: an extended replication in Las Vegas. Journal of Experimental Psychology, 101(1), 16-20.

An experiment was conducted at the Four Queens Casino in Las Vegas to determine the effects of response mode upon information-processing strategies applied by subjects in gambling decisions. Different strategies were used for choosing among pairs of bets as opposed to assigning monetary values to single bets. Bias was found to occur in favorable and unfavorable gambles as a result of cue-response compatibility.

Lopes, L.L. (1981). Notes, comments, and new findings: decision making in the short run. Journal of Experimental Psychology: Human Learning and Memory, 7(5), 377-385.

Addresses the question "Why do psychologists in general and decision experts treat gambling so differently from other probability distributions?". The author analyzes and questions the role that mathematical expectation has in affecting theories of rational choice and decision making.

MacGregor, D., & Slovic, P. (1985, March). Perceived acceptability of risk analysis as a decision-making approach. Eugene, Oregon: Decision Research, A Branch of Perceptronics.

Investigates a methodology for understanding how people evaluate decision making approaches involving health and safety risk factors. Three methods for making a consumer product safety decision were appraised on scales relating to their perceived acceptability, logical soundness, completeness, and sensitivity to moral and ethical concerns. An effect on judgments was not shown from having knowledge of the consequences. An implication made is that people's acceptance of risk may be greatly determined by the manner in which decision risks are made.

Morris, P.A. (1975, February). Modeling experts. Manuscript submitted for publication.

Addresses the problem of expert resolution. A model is presented which allows the decision maker to arrive at a solution, whether it is from a single expert or a group of experts. The term "surrogate prior" is defined and shown to play a role in measuring the joint information contained in the probability assessments generated by a panel of experts within the case of the multi-expert. This modeling approach forms the basis for analytical thinking about the interaction between experts and the manner in which probabilities should be derived from experts.

Newman, J.R. (1977, August). Differential weighting for prediction and decision making studies: a study of ridge regression (SSRI Research Report 77-1). University of Southern California: Social Science Research Institute.

This study describes the conditions which are appropriate for differential or simple unit weighting of predictor variables in prediction and/or decision studies. A regression model, ridge analysis (RIDGE), is proposed as a substitution for the ordinary least squares (OLS) regression analysis because of potential difficulties with OLS analysis. The RIDGE method of estimation may also be used as a substitute for cross validation.

Pitz, G.F. (1970). On the processing of information: probabilistic and otherwise. In G. de Zeeuw et al. (Eds.), Acta Psychologica 34 Subjective Probability (pp. 201-213). Amsterdam: North-Holland Publishing Company.

Advocated is the study of processes such as attention, encoding, and short-term memory in relation to probabilistic information processing (PIP) in order to expand our knowledge of decision making behavior. It is stressed that the information, not the processing itself, is probabilistic in nature. Two models of opinion revision are reviewed which incorporate the use of Bayes' theorem in their models, but recognize human error. Outlined is a PIP model computer program.

Shanteau, P. (1974). Component processes in risky decision making. Journal of Experimental Psychology, 103(4), 680-691.

The goal of this research study was to utilize the theory of information integration by applying an information processing approach to risky decision judgments. The study challenges the utility theory as used in risky decision making. The multiplying model is advocated, which is supported by data resulting from two experiments.

Slovic, P. Judgment, choice, and societal risk taking. In K.R. Hammond (Ed.), Judgment and Choice in Public Policy Decisions. AAAS Symposium Volume: in press.

The author senses that people are inadequately equipped to make societal decisions in our state of rapid technological development. This article deals with the determinants of perceived and acceptable risk within the context of risk assessment, which was developed as a result of society attempting to confront problems of risk.

Slovic, P. (1971, April). Information processing, situation specificity, and the generality of risk-taking behavior. ORI Research Bulletin, 11(3), 1-22.

Inter-task consistency of individual differences was ascertained in two structurally comparable risk-taking tasks. A relationship was shown between information processing and situational specificity. As a result of the experiment, it was determined that the two response modes triggered different methods of processing information pertaining to probabilities and payoffs in a way that influenced individual differences and reduced inter-task consistencies. The implication is that it is improbable to find significant correlations between risk-taking measures in structurally different settings or between risk-taking and different behaviors.

Slovic, P., Fischhoff, B., & Lichtenstein, S. (1977). Behavioral decision theory. Ann. Rev. Psychol., 1-39.

The author focuses on the psychological aspects of individual judgment and decision making by reviewing descriptive research and examining decision aids. A survey of publications (the majority of them dated 1971-75) on the subject of Behavioral Decision Theory is provided and descriptive studies of judgment are evaluated. An attempt is made to enumerate the errors in decision-making that may arise from judgment biases. Some areas mentioned under the topic of descriptive research include probabilistic judgment, choice, models of risky choice, and regression approaches. An insightful discussion of decision aids, MAUT research, decision analysis, man/machine systems, and use of decision aids clarifies: (a) issues which a decision maker may face, and (b) the systems used to solve problems.

Slovic, P., Fischhoff, B., & Lichtenstein, S. (1983, December). The psychometric study of risk perception. Eugene, Oregon: Decision Research, A Branch of Perceptronics.

Deals with the attempt by researchers to determine what the term "risky" means to people. Factors which affect the response to perceived risk are examined, with the goal of providing more effective communication risk information, altering people's perceptions, and enhancing management strategy. Reveiwed are some results obtained from psychometric studies of risk perception.

Slovic, P., & Lichtenstein, S. (1968, November). Relative importance of probabilities and payoffs in risk taking. Journal of Experimental Psychology Monograph, 78(3), 1-18.

This report examines the beliefs held by people about the relevant importance of probabilities and payoffs and their capability to act on the premise of these beliefs when processing information included in the description of a gamble. Two experiments are described which suggest that there is utility in recognizing decisions about gambling within the context of information processing.

Slovic, P., & Tversky, A. (1974, February). Who accepts Savage's Axiom? (ONR Technical Report NR 197-026). Eugene, Oregon: Oregon Research Institute.

Argues that the established principle: "rational choice is comparable to logic in that a reasonable person who understands the postulates would not want to violate them" is open to doubt. An experiment is conducted which examines Savage's independence principle, a key axiom inherent in expected utility theory. Discussed is the difficulty in discriminating between rejection of a decision principle and unsuccessful "understanding" of it.

Tversky, A., & Kahneman, D. (1973). Availability: a heuristic for judging frequency and probability. Cognitive Psychology, 5, 207-232.

How do people evaluate the frequency of classes or the likelihood of events? According to this article, people engage in using a limited number of heuristics, thus diminishing judgments into easier ones. A judgmental heuristic in which one assesses the frequency of classes or probability of events by availability (the quickness with which relevant instances come to mind) is

investigated. It is believed that reliance on the availability or representative heuristic leads to systematic biases. By analyzing the heuristics that one uses in judging the probability of an event, it is asserted that the occurrence of errors in human judgment under uncertainty may be decreased.

Heuristics, Biases, and Errors

Beach, L.R. (1966, March). Accuracy and consistency in the revision of subjective probabilities. IEEE Transactions on Human Factors in Electronics, 7 (1), 29-36.

This report investigates the consistency with which subjective probabilities are revised. Four experiments were performed in which models of probabilistic concept formation studies and Bayesian subjective probability revision studies were combined. Results showed that subjects' revisions of their subjective probabilities can be accurately predicted with Bayes' theorem.

Einhorn, H.J., & Hogarth, R.M. (1978). Confidence in judgment: persistence of the illusion of validity. Psychological Review, 85(5), 395-416.

Responds to the question "Why is there a substantial difference between a person's confidence in his own judgment and research findings on the fallibility of human judgment?" by exploring the structure of judgmental tasks as it affects outcomes. The manner in which outcomes are interpreted and used is discussed, as well as the relationship between learning and experience. Presents a model in which learning and maintaining confidence in one's own judgment is developed.

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This review of behavioral decision theory literature argues that the judgmental biases exhibited in laboratory situations may be functional in natural settings. Areas reviewed include attention, memory, learning, feedback, cognitive representation, and conflict. Assuming a broad perspective in the research of decision making may yield the most insightful and generalized results.

Einhorn, H.J., & Hogarth, R.M. (1985, January). Ambiguity and uncertainty in probabilistic inference. Psychological Review, in press.

Presents a model in reference to the role of ambiguity and uncertainty in inferential judgments. The authors show how this model may be associated with Keynes' concept of the weight of evidence, the non-additivity of complementary probabilities, risky choice, and current work on cognitive heuristics. It is proposed that reaching a compromise between "what is" and "what might have been" or "what might be" is focal to inferences under ambiguity and uncertainty.

Farquhar, P.H. (1982). Utility assessment methods (Working Paper 81-5). Davis, California: University of California.

Attempts to integrate current methods for evaluating single-attribute utility functions. Presents various new methods of evaluation which may be beneficial in furthering the research in this area, emphasizing the varied steps in the utility assessment process, and contrasting methods of comparative risk. Reviews approximately twenty-four utility assessment methods.

Fischhoff, B., & Johnson, S. (1985, March). The possibility of distributed decision making. Prepared for Workshop on Political-Military Decision Making, The Hoover Institution, Stanford University.

Reviews existing problems of decision making distribution when dealing with several individuals or groups. The authors propose solutions for complications which may arise as a result of using these systems, and discuss design and management of distributed decision making. Outlined are possible limitations which could affect an organization.

Fryback, D.G., Goodman, B.C., & Edwards, W. (1973). Choices among bets by Las Vegas gamblers: absolute and contextual effects. Journal of Experimental Psychology, 98(2), 271-278.

In this study, two experiments conducted at the Four Queens Casino in Las Vegas refute prior research evidence that accounted for choices among gambles. The Expected Value (EV) normally is highly correlated with preferences among gamblers. It may be inferred that the attraction of a gamble is not totally dependent upon the characteristics of that gamble. The results suggest that certain concepts can not be overlooked in the construction of theories that endeavor to depict human decision making; these are: anchoring, adaptation, assimilation, and contrast.

Goitein, B. (1984). The danger of disappearing postdecision surprise: comment on Harrison and March, "decision making and postdecision surprises." Administrative Science Quarterly, 29, 410-413.

Comments on paper written by Harrison and March on "Decisionmaking and Postdecision surprises" (1984). The author examines the issue and explains why there is a problem with the disappearance of post decision surprise. Believes that "hindsight bias," where an outcome of a decision may be seen by one in hindsight as having been expected to a greater extent than it actually was, is detrimental because it prevents individual and organizational learning about faults in the decision system. Further research is needed on how to reduce hindsight bias.

Halpin, S.M., Johnson, E.M., & Thornberry, J.A. (1973, August). Cognitive reliability in manned systems. IEEE Transactions on Reliability, R-22(3), 165-170.

Analyzes cognitive reliability in manned systems, which the authors state is an intricate function of attitudinal and structural factors, along with their interaction. Cites the types of human errors which may transpire, and discusses factors which influence the chance of these errors. Due to the changing role of man in complex systems, a broadening of prevalent approaches

to human performance reliability must be sought. In addition to describing the tasks which are becoming progressively more important in man-machine systems, the term "cognitive reliability" is defined, methods of classifying cognitive errors are identified, and an example is given which exemplifies the factors likely to affect cognitive errors.

Klayman, J. (1982). Simulations of six decision strategies: comparisons of search patterns, processing characteristics, and response to task complexity. (Working paper #100). Chicago, Illinois: University of Chicago.

This paper addresses questions pertaining to the modifications made in strategies in response to task complexity by decision makers. A primary goal of these simulation studies entails identifying different decision strategies on the basis of information search patterns. It is reasoned that simulation can be very useful in generating, testing, and modifying hypotheses about human decision strategies but care must be taken to insure that the design is representative of the impending specific decision task.

Klayman, J. (1983). Analysis of predecisional information search patterns. In P. Humphreys, O. Svenson, & A. Vari (Eds.), Analyzing and Aiding Decision Processes. Amsterdam: North-Holland.

The present paper discusses the analysis of information gathering patterns as a tool for process tracing. Attention to complex and diverse decision approaches has underscored the necessity of developing more refined process tracing analyses (analyzing information gathering patterns). Two major methods of improving search analysis are examined. An experimental example using these techniques is given, and applications are submitted in three areas.

Lichtenstein, S., Earle, T.C., & Slovic, P. (1975). Cue utilization in a numerical prediction task. Journal of Experimental Psychology: Human Perceptions and Performance, 104(1), 77-85.

Research results in this study were obtained from an experiment in which forty subjects were trained to make numerical predictions of a criterion from a cue. It was found that subjects regressed each cue and subsequently averaged the regressed values. It is suggested that by analyzing the heuristics utilized by subjects, we can further our knowledge of human decision making.

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Lopes, L.L. (1981). Notes, comments, and new findings: decision making in the short run. Journal of Experimental Psychology: Human Learning and Memory, 7(5), 377-385.

Addresses the question "Why do psychologists in general and decision experts treat gambling so differently from other probability distributions?". The author analyzes and questions the role that mathematical expectation has in affecting theories of rational choice and decision making.

Morier, D.M, & Borgida, E. (1984, June). The conjunction fallacy: a task specific phenomenon? Personality and Social Psychology Bulletin, 10(2) 243-252.

The goal of this study was to ascertain the extent to which the conjunction fallacy, a type of judgmental error, reflects task specific misunderstanding of specific judgment problems. Results show that: (a) Task specificity is a factor in the subjects' misunderstanding of conjunction problems, and (b) an unprejudiced approach to conjunction fallacy may lower but not eradicate the conjunctive error rate for problems which are not depictive of representative thinking.

Norman, D.A. (1980, August). Errors in human performance (Report No. 8004). La Jolla, California: Center for Human Information Processing.

This report's area of concentration lies in human error, particularly error made by skilled operators in complex, demanding systems. Through this analysis of human error, various applications of human information processing are delineated and a classification scheme for errors is outlined. Short-term memory and human attentional limitations are examined in the design of human-machine interfaces.

Norman, D.A. (1981a, January). Categorization of action slips. Psychological Review, 88(1), 1-15.

The author outlines a system of activated schemas with a triggering mechanism which determines appropriate time for activation, which is a satisfactory framework for categorization and analysis of action slips. This theory permits slips to be categorized into three areas: (a) errors in the formation of the intention; (b) faulty activation of schemas; and, (c) faulty triggering of slips.

Norman, D.A. (1981b). A psychologist views human processing: human errors and other phenomena suggest processing mechanisms. Paper presented at: IJCAI, Vancouver, British Columbia.

Discusses human processing structures by arguing for a different kind of processing mechanism than that which is most commonly referred to in Artificial Intelligence. The form of human error is of major importance in this study. A distinction is made between two major classes of errors, mistakes versus slips, and these two types are examined.

Norman, D.A. (1981c, August). Steps toward a cognitive engineering: system images, system friendliness, mental models. Paper presented at Symposium on Models of Human Performance, ONR Contractor's meeting, La Jolla, California.

Contends that current inappropriate system design does not allow optimum efficacy between the users and machines. Through the study of human error, it is discovered that human usage should be a factor warranting primary consideration by designers. The author proposes a cohesive system, a "friendly system", composed of the principles underlying both cognitive science and human factors.

Pitz, G.F. (1970). On the processing of information: probabilistic and otherwise. In G. de Zeeuw et al. (Eds.), Acta Psychologica 34 Subjective Probability (pp. 201-213). Amsterdam: North-Holland Publishing Company.

Advocated is the study of processes such as attention, encoding, and short-term memory in relation to probabilistic information processing (PIP) in order to expand our knowledge of decision making behavior. It is stressed that the information, not the processing itself, is probabilistic in nature. Two models of opinion revision are reviewed which incorporate the use of Bayes' theorem in their models, but recognize human error. Outlined is a PIP model computer program.

Rouse, W.B. & Rouse, S.H. (1983, July/August). Analysis and classification of human error. IEEE Transactions on Systems, Man, and Cybernetics, SMC-13(4), 539-549.

This issue is devoted to understanding human error. It is defined through the causal approach as error that is seldom random and traceable to causes, which once identified, can be obliterated or lessened. A methodology is presented which allows one to analyze and classify human error; this is exemplified by comparing the use of checklists in aviation. The goal is to examine human error and its causes, contributing factors, and contributing events.

Schoemaker, P.J.H. (1981). Behavioral issues in multiattribute utility and modeling and decision analysis. From J.N. Morse (Ed.), Organizations: Multiple Agents with Multiple Criteria. Heidelberg, German: Springer-Verlag.

Various empirical issues pertaining to decision analysis, specifically multiattribute utility (MAU) modeling, are investigated. The issues primarily concern the following issues: (a) the need for empirical validations in normative decision theory; (b) the examination of the intrinsic characteristics of MAU preference functions, expressly mathematical complexity; (c) the review of method bias; and, (d) analysis of the meanings of relative importance judgments.

Shanteau, J. (1975). Averaging versus multiplying combination rules of inference judgment. Acta Psychologica, 39, 83-89.

Two combination rules, averaging and multiplying, which describe sequential inference judgments, were compared through three experiments in this study. Both of these rules depict how successive pieces of evidence are combined with previous judgments to form new judgments. Usage of the averaging rule was supported but the descriptive ability of the Bayesian approach (and other

approaches which use the multiplying rule) was questioned. It may be inferred from the averaging result that judgments may incorporate processing rules differently than previously speculated.

Slovic, P. Judgment, choice, and societal risk taking. In K.R. Hammond (Ed.), Judgment and Choice in Public Policy Decisions. AAAS Symposium Volume: in press.

The author senses that people are inadequately equipped to make societal decisions in our state of rapid technological development. This article deals with the determinants of perceived and acceptable risk within the context of risk assessment, which was developed as a result of society attempting to confront problems of risk.

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The author focuses on the psychological aspects of individual judgment and decision making by reviewing descriptive research and examining decision aids. A survey of publications (the majority of them dated 1971-75) on the subject of Behavioral Decision Theory is provided and descriptive studies of judgment are evaluated. An attempt is made to enumerate the errors in decision-making that may arise from judgment biases. Some areas mentioned under the topic of descriptive research include probabilistic judgment, choice, models of risky choice, and regression approaches. An insightful discussion of decision aids, MAUT research, decision analysis, man/machine systems, and use of decision aids clarifies: (a) issues which a decision maker may face, and (b) the systems used to solve problems.

Slovic, P., & Tversky, A. (1974, February). Who accepts Savage's Axiom? (ONR Technical Report NR 197-026). Eugene, Oregon: Oregon Research Institute.

Argues that the established principle: "rational choice is comparable to logic in that a reasonable person who understands the postulates would not want to violate them" is open to doubt. An experiment is conducted which examines Savage's independence principle, a key axiom inherent in expected utility theory. Discussed is the difficulty in discriminating between rejection of a decision principle and unsuccessful "understanding" of it.

Tversky, A., & Kahneman, D. (1973). Availability: a heuristic for judging frequency and probability. Cognitive Psychology, 5, 207-232.

How do people evaluate the frequency of classes or the likelihood of events? According to this article, people engage in using a limited number of heuristics, thus diminishing judgments into easier ones. A judgmental heuristic in which one assesses the frequency of classes or probability of events by availability (the quickness with which relevant instances come to mind) is investigated. It is believed that reliance on the availability or representative heuristic leads to systematic biases. By analyzing the heuristics that one uses in judging the probability of an event, it is asserted that the occurrence of errors in human judgment under uncertainty may be decreased.

Military Decision Making

Burke, J.T. (1986, March). The next step: managing battle with technology. ARMY, 56-60.

Discusses the concept of the Battlefield Management System (BMS) and advocates its role in improving the speed and effectiveness of combat operations and reducing battlefield stress. Col. (U.S. Army retired) Burke does not suggest replacing the human factor, but rather applying advanced technology to assist soldiers, leaders, and staff people in coping with the hectic movement of combat action. BMS is designed with the purpose of allowing humans to concentrate on creative decision making while it stores and processes data with great speed. BMS would be an immense asset to the battalion S2 and S3. It is argued that BMS can be used to train combat crews and entire units through battlefield simulation and will save millions of dollars, a substantial amount of time, and increase efficiency in field training.

Cohen, M.S., & Freeling, A.N.S. (1981, February). The impact of information on decisions: command and control system evaluation (Technical Report 81-1). Falls Church, Virginia: Decision Science Consortium, Inc.

This study applies decision analytic concepts to the problem of determining value of information in the design and evaluation of information systems. Although many current systems furnish an abundance of data, the decision maker is often unable to pick out the data essential to the problem. Necessary information is that which has a high probability of changing a decision and improving decision outcome. This study modifies standard VOI techniques in order to simplify them and encourage their usage.

Fischhoff, B., & Johnson, S. (1985, March). The possibility of distributed decision making. Prepared for Workshop on Political-Military Decision Making, The Hoover Institution, Stanford University.

Reviews existing problems of decision making distribution when dealing with several individuals or groups. The authors propose solutions for complications which may arise as a result of using these systems, and discuss design and management of distributed decision making. Outlined are possible limitations which could affect an organization.

Jacobs, T.O. (1976, September). Analysis and evaluation of tactical decision making. Paper presented at American Psychological Association Meeting, Washington, D.C.

Outlines a study in which an illustration of how incumbent generals, colonels, and lieutenant colonels define command and control performances. Five general categories which emerged were: getting and using information, planning, organizing, controlling/directing, and leadership/personnel. Reports on an experiment in which the usefulness of automating analysis and production tasks is analyzed and proves to be applicable to organizational decision making. Among the findings reported are: (a) The battalion level differs from division command level in that the descriptive model suggests a "process-oriented reactive orientation" for battalion level decision makers; (b) the time

perspective is very limited for the battalion commander in combat; and, (c) experiments in the area of tactical decision making may require the utilization of real incumbents in realistic situations.

Phelps, R.H., Halpin, S.M., & Johnson, E.M. (1981, January). A decision support framework for decision aid designers (ARI Technical Report 504). Alexandria, Virginia: U.S. Army Research Institute for the Behavioral and Social Sciences.

Describes a decision support framework to be utilized by developers of decision aids to assist them in the organization and categorization of decision aiding procedures. This framework succinctly distinguishes between two categories of aids and exemplifies the development and execution of the aid system. The authors suggest that utilization of this framework could result in maximum productivity of their systems. Army Intelligence decision making examples are cited which typify the components of the framework. This decision support framework is designed to represent the decision support components, not the decision process itself.

O'Connor, M.F. (1977, July). Procedures for assessing the value of command and control capabilities (Technical Report 77-4). McLean, Virginia: Decisions and Designs, Inc.

Addresses the question: How much command and control (C^2) capability is enough? In order for one to answer this question, the cost of achieving that capability must be weighed against the potential benefits of allocating funds elsewhere. A value is assigned to the action of deciding to deploy a certain C^2 system in a precarious future. The trade-offs which must be made in order to resolve this question are analyzed. The paper is divided into four sections; discussed are: (a) the theory of assessing value for multiple attributed alternatives; (b) the use of scenarios as a solution to the problem with decision trees; (c) the application of value assessment procedures; and, (d) a specific problem: the trade-offs between cost and multiple performance measures, which illustrates the use of utility assessment procedures with the C^2 problem.

Taylor, E.N. (1983, September). A review of literature relevant to unaided tactical decision making (ARI Research Note 83-35). Alexandria, Virginia: Human Resources Research Organization (HumRRO).

Provides a summary of literature which may be useful in developing and implementing training programs pertaining to tactical decision making. The authors contend that a cause for concern in the military is the question of whether or not decision makers are deciding upon the best courses of action in rapidly changing situations based on the techniques utilized by them to organize, analyze, and present information. Various models of decision making, along with problems in training, are examined with the purpose of developing a methodology for preparing military leaders to make tactical decisions.

Methodology

Klayman, J. (1982). Simulations of six decision strategies: comparisons of search patterns, processing characteristics, and response to task complexity. (Working paper #100). Chicago, Illinois: University of Chicago.

This paper addresses questions pertaining to the modifications made in strategies in response to task complexity by decision makers. A primary goal of these simulation studies entails identifying different decision strategies on the basis of information search patterns. It is reasoned that simulation can be very useful in generating, testing, and modifying hypotheses about human decision strategies but care must be taken to insure that the design is representative of the impending specific decision task.

Klayman, J. (1983). Analysis of predecisional information search patterns. In P. Humphreys, O. Svenson, & A. Vari (Eds.), Analyzing and Aiding Decision Processes. Amsterdam: North-Holland.

The present paper discusses the analysis of information gathering patterns as a tool for process tracing. Attention to complex and diverse decision approaches has underscored the necessity of developing more refined process tracing analyses (analyzing information gathering patterns). Two major methods of improving search analysis are examined. An experimental example using these techniques is given, and applications are submitted in three areas.

Schweiger, D.M., Anderson, C.R., & Locke, E.A. (1985). Complex decision making: a longitudinal study of process and performance. Organizational Behavior and Human Decision Processes, 36, 245-272.

Simultaneous verbal protocols were employed to study individual decision making processes. The authors describe the protocol analysis procedure used and present the coding scheme developed to analyze the data. Results of two experiments show that thought processes used in complex decision making are associated with subsequent performance: subjects using causal analysis performed more successfully than those who did not.

DECISION AIDS

Models

Adelman, L., Donnell, M.L., Patterson, J.F., & Weiss, J.J. (1981, February). Issues in the design and evaluation of decision-analytic aids (Technical Report 81-1-304). McLean, Virginia: Decisions and Designs, Inc.

Addresses three important issues which are relevant to the design and evaluation of decision analytic aids and presents a framework which illustrates the decision making organization. The three interfaces identified are: between the decision aid and the user, between the user and the extent to which the decision aid facilitates the decision making processes of the organization, and between the decision making organization and whether or not the quality of the organization's decision making has improved the environment. Without the

smooth functioning of the three interfaces, effective integration of decision aids into organizations can not be accomplished. The author covers some ways to attract the user to the aid and to simplify its overall operation.

Alter, S. (1977, February). Why is man-computer interaction important for decision support systems? Interfaces, 7(2), 109-115.

Argues that interactive, conversational decision support systems do not represent their true identities in many cases. The author believes that better man-computer interfaces are needed, but not necessarily by managers themselves. Suggests that the focus should be on experts who understand the details underlying a support system; if managers do not learn the correct usage of decision support systems, then usage should be discouraged without the aid of an intermediary.

Andriole, S.J. (1982, July/August). The design of microcomputer-based personal decision aiding systems. IEEE Transactions on Systems, Man, and Cybernetics, SMC-12(4), 463-469.

Presents an approach to the design and development of personal computer-based decision aiding systems which views the human problem-solver as an active user who must be able to use the computer without the aid of a problem-solving intermediary. In order to successfully utilize a system, the author states that the design of the system should encompass the measurement and integration of cognitive, situational, and physiological variables which should inform and alter the decision-aiding process. It is suggested that without explicit user requirements, interactive systems fulfill the needs of the designer and not the target user. Problem solvers are categorized according to their experience with computer-based systems and grouped according to their "cognitive styles" in order to formulate computer-generated information and strengthen man's interaction with the computer. The user's physiological state and situational characteristics are examined as well.

Baker, J.D. (1970). Quantitative modelling of human performance in information systems. Ergonomics, 13(6), 645-664.

Describes a general information system model, MAN, which emphasizes the importance of the user in man-machine systems. The ultimate goal is to acquire the ability to utilize the results of human information processing studies to predict the impact on system performance. The framework structure is based on the supposition that there are five central operations in the performance of an information system: screen, transform, input, assimilate, and decide.

Benbasat, I. & Taylor, R.N. (1982, July/August). Behavioral aspects of information processing for the design of management information systems. IEEE Transactions on Systems, Man, and Cybernetics, SMC-12(4), 439-450.

Cites various models of information processing which account for human thinking and attempts to cover the capabilities, as well as the inadequacies, in information processing present in the literature. The authors believe that management information systems (MIS) can be radically improved by understanding the behavioral processes by which humans process information and make choices. This will aid in eliminating the problem of "overloading" the human user.

Benel, D.C.R., & Pain, R.F. (1985). The human factors usability laboratory in product evaluation. Proceedings of the Human Factors Society - 29th Annual Meeting.

Human factors engineering is a discipline which has not had widespread application in commercial product development, but through the proposed usability laboratory, experts may incorporate this approach into their product evaluation. Describes the structure of a usability laboratory.

Bettenhausen, K., & Murnighan, J.K. (1985). The emergence of norms in competitive decisionmaking groups. Administrative Science Quarterly, 30, 350-372.

Interaction among group members in nineteen newly formed decision making groups (composed of five persons each) was studied to understand how social norms form. The behavior of these group members served as the foundation in constructing a model of norm development whereby uncertainty over appropriate behavior directs people to utilize their past experiences in similar social settings as scripts. By using these experiences they determine behaviors in their current situations. The results of gaining knowledge about how norms develop would grant the capability of "managing" this limitation in group decision making situations.

Chu, Y., & Rouse, W.B. (1979, December). Adaptive allocation of decisionmaking responsibility between human and computer in multitask situations. IEEE Transactions on Systems, Man, and Cybernetics, SMC-9(12), 769-778.

Addresses the question of how decisionmaking responsibilities should be allocated between humans and increasingly intelligent computers as systems become more automated. The authors maintain that with "adaptive allocation" the allocation of responsibility is contingent upon the state of the system and decisionmakers. The decisionmaker most capable of performing a task at a particular time will be subject to complete it. An experimental study involving a flight management task illustrates this general strategy.

Cohen, M.S., & Freeling, A.N.S. (1981, February). The impact of information on decisions: command and control system evaluation (Technical Report 81-1). Falls Church, Virginia: Decision Science Consortium, Inc.

This study applies decision analytic concepts to the problem of determining value of information in the design and evaluation of information systems. Although many current systems furnish an abundance of data, the decision maker is often unable to pick out the data essential to the problem. Necessary information is that which has a high probability of changing a decision and improving decision outcome. This study modifies standard VOI techniques in order to simplify them and encourage their usage.

Collins, A. (1978). Fragments of a theory of human plausible reasoning. In D.L. Waltz (Ed.), Theoretical Issues in Natural Language Processing - 2, Urbana Champaign: University of Illinois, 194-201.

Discusses a theory of human plausible reasoning which purports to exemplify how various configurations of information affect the surety of drawn conclusions. The theory is computational in nature and was constructed from an experiment in which an analysis was made of the answers people gave to routine questions.

Collins, A., & Stevens, A.L. (1981). A cognitive theory of interactive teaching. To appear in C.M. Reigeluth (Ed.), Instructional Design Theories and Models: An Overview, New York: Academic Press.

The authors propose a theory of inquiry teaching whereby students construct theories by dealing with specifications and subsequently apply these theories to new cases. The authors feel that as a result of this teaching, reasoning skills, such as forming and testing hypotheses, making predictions, and knowing which questions to ask, to name a few, are learned and applied. It is recommended that these techniques be applied within other fields of study.

Einhorn, H.J., Hogarth, R.M., & Klempner, E. (1977). Quality of group judgment. Psychological Bulletin, 84, 158-172.

Deals with the accuracy of group judgment within and between different populations of groups. The quality of group judgment is defined. Results as well as constraints affecting judgmental quality of various strategies for merging opinions under a diversity of circumstances are discussed. A statistical procedure is introduced that considers which baselines are suitable in the evaluation of the quality of group judgment.

Fischer, G.W. (1979, July). Utility models for multiple objective decisions: do they accurately represent human preferences? The Journal for the American Institute for Decision Sciences, 10(3), 451-479.

This paper is written for those decision scientists who do not utilize Multivariate Utility (MAU) modeling procedures because they doubt that these procedures are reliable in providing a true representation of human preferences. The author's goal is to persuade many that the MAU approach has many useful applications. Two approaches to MAU modeling as well as relevant psychological research are examined. Covered in this article are the following topics: assigning utility values to decision outcomes, holistic utility assessment methods, an overview of MAU theory, methods for assessing decomposed MAU functions, common objections to MAU models, and validating MAU models and assessment procedures.

Fischhoff, B., & Johnson, S. (1985, March). The possibility of distributed decision making. Prepared for Workshop on Political-Military Decision Making, The Hoover Institution, Stanford University.

Reviews existing problems of decision making distribution when dealing with several individuals or groups. The authors propose solutions for complications which may arise as a result of using these systems, and discuss design and management of distributed decision making. Outlined are possible limitations which could affect an organization.

Goldstein, I. (1978, October). Developing a computational representation for problem solving skills (Artificial Intelligence Memo 495). Paper to appear in Proceedings of the Carnegie Mellon Conference on Problem Solving and Education: Issues in Teaching and Research.

Presents a problem solving model which originated from the study of computer coaches (advanced computer assisted instruction). This model depicts problem solving skills as an evolving set of rules for a domain influencing growing representation of the problem and administered by a resource-limited problem solver.

Goldstein, I.P. (1979). The genetic graph: a representation for the evolution of procedural knowledge. International Journal of Man-Machine Studies, 11, 51-77.

A model of the evolution of rule-structured knowledge which is considered a cornerstone of the development of computer-based coaches is illustrated. A graph structure depicting the concepts of generalization, correction, and refinement is displayed and defined. Various genetic graph formulations pertaining to reasoning skills used in playing an elementary mathematical game are examined.

Hart, S.L. (1985). Toward quality criteria for collective judgments. Organizational Behavior and Human Decision Processes, 36, 209-228.

Addresses the subject of group decision making by presenting evaluative criteria, which were derived from a review of prevailing literature, for judging when a "high-quality outcome" has been reached. A major goal which is hoped to be generated by this project is the construction of a set of empirically derived criteria against which outcome quality may be judged. The most effective procedures for the achievement of a high quality collective judgment are suggested as a result of six factual group problem-solving cases which were evaluated by use of a specially developed questionnaire.

Hogarth, R.M. (1975). Decision time as a function of task complexity. In Wendt/Velk (Eds.). Utility, Probability, and Human Decision Making (pp. 321-338). Dordrecht-Holland: D. Riedel Publishing Company.

Discusses the association between decision time and task complexity. A mathematical model is thoroughly explained which examines this association. The model is described as having several observable variables linked to an unobservable variable of the psychological function, i.e., cognitive strain. It is suggested that when a decision maker is faced with different alternatives, he considers two kinds of cost: the time involved in the decision procedure, and the cost of making errors.

Hogarth, R.M., & Einhorn, H.J. (1976, January, in press). Optimal strategies for personnel selection when candidates can reject offers. Journal of Business.

Discusses personnel decision making with the inclusion of the possibility of rejection of job offers by candidates, which the authors recognize as an overlooked factor in formal models of decision making. Perfect Expected Acceptance Gain and Expected Acceptance Gain are promoted and demonstrate significant value for assessing the effects of various selection strategies. An interactive computer program is described. It is capable of being utilized for sensitivity analysis as a tool in the evaluation of important variations in subjective inputs, which affect changes in decision variables and their possible economic results.

Jin, V.Y. (1985, May). Delays for distributed decisionmaking organizations. Unpublished thesis, Massachusetts Institute of Technology, Cambridge, Massachustetts.

In this thesis an algorithm for computing time delay in the operation of distributed decision making systems (DDM) is produced. Interactors in DDM organizations are investigated and asynchronous protocols that enrich performance are constructed.

Johnson, P.E. (1980, June, in press). Cognitive models of medical problem solvers. In D. Connelly, E. Benson, & D. Burke (Eds.), Clinical Decision Making and Laboratory Use. Minneapolis, Minnesota: University of Minnesota Press.

In this discussion of cognitive models of medical problem solvers the principal theme is that similarities outweigh differences when comparing individual problem solvers. A diagnostic reasoning model of physician knowledge is proposed which depicts what patients with certain diseases or conditions should "look like."

Johnson-Laird, P.N. (1983). Mental models, towards a cognitive science of language, inference, and consciousness. Cambridge, Massachusetts: Harvard University Press.

This chapter from Johnson-Laird's book defines "mental models," explains how they are constructed, and interprets them. The theory itself is designed to explain the higher processes of cognition, particularly comprehension and inference.

Jungermann, H. (1980a). Speculations about decision-theoretic aids for personal decisionmaking. Acta Psychologica, 45, 7-34.

Deals with techniques which assist people in making personal decisions. Personal decisions are defined as those where the person making the decision must face the ramifications of his actions. Even though this distinction may seem blurred between those persons making decisions for themselves versus others, the author holds the opinion that not enough attention in applied decision research is given to personal decisionmaking. Structuring the problem, assessing one's value system, and examining alternative options are addressed in helping one to arrive at a decision.

Jungermann, H. (1980b, September). Structural modeling of decision problems. Paper presented at the 88th Annual Convention of the American Psychological Association (APA), Montreal.

The author's interest lies with the first stage in the process of decision making, in which the problem is represented (translated cognitively into a structure that represents the situation). It is proposed that the questions one asks influence the answers one gets, i.e., various methods of posing a decision problem to a person stimulates him to "reference structure" different sets of knowledge. Examples are given of the phases of the decision making process, the structuring of knowledge, and fault trees.

Kassirer, J.P., & Gorry, G.A. (1978). Clinical problem solving: a behavioral analysis. Annals of Internal Medicine, 89, 245-255.

Reports on some of the specific tactics and overall strategies composing the problem-solving behavior of trained clinicians as they were "taking the history of the present illness." The tape recorded behavior of this interchange between a clinician and simulated patient was analyzed. The authors suggest that the information has potential value in the field of medical education and in devising computer programs to assume the process of diagnosis.

Klein, G.A. (1980, October). Automated aids for the proficient decision maker. Proceedings of the Smith Conference on Cybernetics and Society.

Proposes a comparison-guided model of decision-making, maintaining that proficient decision makers are able to recognize and subsequently place new situations parallel to ones previously experienced. The types of decisions discussed are complex, those with unusual conditions. It is asserted that a redefinition of the problem by the expert will allow utilization of all resources which may yield a solution to the problem, rather than using a decision aid requiring "rule-following." The author believes that proficiency is not simply following rules and procedures.

Morris, N.M., Rouse, W.B., & Frey, P.R. (1985, February). Adaptive aiding for symbiotic human-computer control: conceptual model and experimental approach (Air Force Aerospace Medical Research Laboratory Technical Report #84-072). Wright-Patterson Air Force Base, Ohio: Search Technology, Inc.

In this report, development of an experimental approach to be used in the investigation of the advantages of adaptive aiding is recapitulated. Implications for the design of adaptive aids are examined and a conceptual framework is outlined. The task environment consists of two competing tasks which must be performed concurrently: a target spotting task and a tracking task. Results indicate that the manipulation of spotting task difficulty affects performance.

Morris, P.A. (1975, February). Modeling experts. Manuscript submitted for publication.

Addresses the problem of expert resolution. A model is presented which allows the decision maker to arrive at a solution, whether it is from a single expert or a group of experts. The term "surrogate prior" is defined and shown to play a role in measuring the joint information contained in the probability assessments generated by a panel of experts within the case of the multi-

expert. This modeling approach forms the basis for analytical thinking about the interaction between experts and the manner in which probabilities should be derived from experts.

Newman, J.R. (1977, August). Differential weighting for prediction and decision making studies: a study of ridge regression (SSRI Research Report 77-1). University of Southern California: Social Science Research Institute.

This study describes the conditions which are appropriate for differential or simple unit weighting of predictor variables in prediction and/or decision studies. A regression model, ridge analysis (RIDGE), is proposed as a substitution for the ordinary least squares (OLS) regression analysis because of potential difficulties with OLS analysis. The RIDGE method of estimation may also be used as a substitute for cross validation.

Norman, D.A. (1981b). A psychologist views human processing: human errors and other phenomena suggest processing mechanisms. Paper presented at: IJCAI, Vancouver, British Columbia.

Discusses human processing structures by arguing for a different kind of processing mechanism than that which is most commonly referred to in Artificial Intelligence. The form of human error is of major importance in this study. A distinction is made between two major classes of errors, mistakes versus slips, and these two types are examined.

Norman, D.A. (1981c, August). Steps toward a cognitive engineering: system images, system friendliness, mental models. Paper presented at Symposium on Models of Human Performance, ONR Contractor's meeting, La Jolla, California.

Contends that current inappropriate system design does not allow optimum efficacy between the users and machines. Through the study of human error, it is discovered that human usage should be a factor warranting primary consideration by designers. The author proposes a cohesive system, a "friendly system", composed of the principles underlying both cognitive science and human factors.

Pangaro, P.A., & Nicoll, J.F. (1983, February). Deleting the knowledge engineer: the practical design of intelligent support software based on Pask's proto-logic Lp. Paper presented at the Seminar "The Application of Machine Intelligence to Defense Systems", Portland, UK.

Discusses the role of the knowledge engineer, a person who builds an expert system in conjunction with an expert in the subject field. Believes that the expert should communicate directly with the computer, thus eliminating the need for a knowledge engineer. An Intelligent Support System (ISS) is presented as an ideal solution to providing sophisticated support in expert systems in three different roles: the training of novices, tactical or operational support, and strategic planning. The philosopy is that there should be only a narrow gap between the creators and operators of an intelligent support system.

Pearl, J., Kim, J.H., & Fiske, R. (1981, December). An experimental evaluation of the effectiveness of two decision structuring methods. Prepared for Wayne Zachary (Ed.), Computer Augmentation of Human Decision Making. New York: Gordon and Breech.

An experimental evaluation is conducted on the effectiveness of decision-tree elicitation and goal-directed structuring. To analyze these two structuring procedures, a computer simulation of a hypothetical decision making environment, Goal-Directed Decision-Structuring System (GODDESS), was applied. This system promoted an objective evaluation of each decision instituted by the subjects. The main topics of discussion are the simulated model, the experimental approach, and the results. The results illuminate the strengths and weaknesses of the two decision structuring methods. The authors contend that the supremacy of the goal-directed approach would be recognized in a situation where the difference in performance between long-range and short-range planners is more strongly emphasized.

Phelps, R.H., Halpin, S.M., & Johnson, E.M. (1981, January). A decision support framework for decision aid designers (ARI Technical Report 504). Alexandria, Virginia: U.S. Army Research Institute for the Behavioral and Social Sciences.

Describes a decision support framework to be utilized by developers of decision aids to assist them in the organization and categorization of decision aiding procedures. This framework succinctly distinguishes between two categories of aids and exemplifies the development and execution of the aid system. The authors suggest that utilization of this framework could result in maximum productivity of their systems. Army Intelligence decision making examples are cited which typify the components of the framework. This decision support framework is designed to represent the decision support components, not the decision process itself.

Posa, T. (1985, October). Software helps busy executives analyze, make key decisions. Infoworld, 7(41), 43-44.

Decisionmap, published by Softstyle Inc., is decision support software (run on the Macintosh) through which one is able to design his/her own decision model. After choosing criteria on which the decision is to be based, factors are weighed according to importance and possible solutions are ranked. The author advocates its usage, emphasizing the ease of learning and minimal amount of time involved.

Rouse, S.H., Rouse, W.B., & Hammer, J.M. (1982, August). Design and evaluation of an onboard computer-based information system for aircraft. IEEE Transactions on Systems, Man, and Cybernetics, SMC-12(4), 451-463.

This report concerns computer-aided human information seeking. It is proposed that a computer-based information system can considerably reduce the frequency of human errors. Various types of information and styles of presentation are evaluated. Results are submitted which support the hypothesis that computer aiding is often more desirable than computerizing in that the goal

should be for computers to help humans overcome limitations and utilize their best skills, rather than replace human operators. The design of an onboard computer-based information system for aircraft is explained.

Rouse, W.B. (1983). Models of human problem solving: detection, diagnosis, and compensation for system failures. Automatica, 19(6), 613-625.

Covers models of human problem solving with an emphasis on those models which predict human behavior and performance to support design and evaluation. Areas which are of particular concern in this article are detection, diagnosis, and compensation of system failures. Proposed is an outline of a model which may influence the integration and progress of understanding human problem solving.

Rouse, W.B. (1984). Design and evaluation of computer-based decision support systems. To appear in S.J. Andriole (Ed.), Microcomputer Decision Support Systems. Wellesley, MA: QED Information Sciences.

Argues that by integrating design and evaluation in computer-based decision support systems, improvements in the efficiency and effectiveness of the process will be the result. Because systems are becoming increasingly complex, decision suport systems which aid humans in decision making and problem solving are essential.

Rouse, W.B., & Rouse, S.H. (1984). Human information seeking and design of information systems. Information Processing and Management, 20(1), 129-138.

Organizes current literature from various disciplines (i.e., psychology, management, systems engineering, computer science, and library science) to develop the topic of human information seeking and information systems. The nature of information seeking is defined, and through discussion, the contrast is made between information seeking and information processing. The difficulty in defining and measuring the value of information affects the progress which may be made in developing frameworks and formulating methods to evaluate this area of concern. Human information seeking is shown to be a integral part of decision making and problem solving.

Saleh, J., Leal, A., Kim, J., & Pearl, J. (1979, October). Progress toward a goal-directed decision support sytem (Technical Report UCLA-ENG-CSL-7973). University of California, Los Angeles: School of Engineering and Applied Science.

A computerized decision support system is described which was developed by the authors as an effective replacement for decision-tree representation. They state that the approach is preferable because of the clarity and purposefulness it provides. This goal-directed method focuses on a single objective at any given time and instructs the user to ignore all side effects. An extensive amount of graphs, structures, and representations are provided.

Schweiger, D.M., Anderson, C.R., & Locke, E.A. (1985). Complex decision making: a longitudinal study of process and performance. Organizational Behavior and Human Decision Processes, 36, 245-272.

Simultaneous verbal protocols were employed to study individual decision making processes. The authors describe the protocol analysis procedure used and present the coding scheme developed to analyze the data. Results of two experiments show that thought processes used in complex decision making are associated with subsequent performance: subjects using causal analysis performed more successfully than those who did not.

Shanteau, J. (1975). Averaging versus multiplying combination rules of inference judgment. Acta Psychologica, 39, 83-89.

Two combination rules, averaging and multiplying, which describe sequential inference judgments, were compared through three experiments in this study. Both of these rules depict how successive pieces of evidence are combined with previous judgments to form new judgments. Usage of the averaging rule was supported but the descriptive ability of the Bayesian approach (and other approaches which use the multiplying rule) was questioned. It may be inferred from the averaging result that judgments may incorporate processing rules differently than previously speculated.

Shanteau, J., & O'Reilly, M. (1981, November). Beyond linearity in decision making: the impact of synergisms with representative designs. Paper presented at the Psychonomic Society meeting, Philadelphia, Pennsylvania.

Evaluated are the effects of synergisms on nonorthogonal designs. It is determined that multiplicative synergisms have an influence on nonorthogonal designs. Methodology currently in use in the analysis of these designs is questioned. Incongruity is found in the stimulus cue sets; some reveal the presence of synergisms better than others.

Smillie, R.J., & Ayoub, M.A. (1980). Job performance aids: evaluation of design alternatives via network simulation. Ergonomics, 23(4), 319-339.

Discusses the utilization of job performance aids (JPAs), which are defined as plans that allow the human component of a system to perform some function he could not otherwise accomplish without extensive training or complex information processing. Through the employment of computer simulation (as opposed to laboratory experimentation) different combinations of job performance aid formats and the effect of stress on task performance with a JPA is analyzed. The use of computer simulation allows one to estimate and evaluate JPA combinations under varying conditions.

Smith, S.L., & Mosier, J.N. (1984, September). Design guidelines for user-system interface software (Technical Paper ESD-TR-84-190). Bedford, Massachusetts: The Mitre Corporation.

Provides guidelines for the design of user interface software to aid designers, system analysts, teachers, students, human factors practitioners, and researchers in making this process more efficient. The focus is on six functional areas: data entry, data display, sequence control, user guidance, data transmission, and data protection.

Stevens, A., Collins, A., & Goldin, S.E. (1979). Misconceptions in student's understanding. Int. J. Man-Machine Studies, 11, 145-156.

Proposed in this research report is a system which tutors students with intelligent computer-aided instruction (ICAI) by diagnosing and rectifying conceptual misunderstandings. A theory based on examination of tutoring dialogs is the basis for this system. The goal structure of a tutor and types of conceptual bugs are specified.

Waldrop, G.P., & Lane, N.E. (1985). Computer-based instruction (CBI): toward a user-oriented technology data base. Proceedings of the Human Factors Society - 29th Annual Meeting.

The focus of this paper is on two issues originating from computer-based instruction (CBI) research and development analysis in support of the CBI data base design. The two points of concern deal with: (a) the importance of specific attention to the characteristics and requirements of potential users (of CBI and of the data base), and (b) the necessity of having a well-formulated classification schema for description of the features of CBI systems in the form of data storage and retrieval cues. The goal of this technology analysis and synthesis is to describe current and near future capabilities of CBI in the Department of Defense (DOD) environment.

Weisbrod, R.L., Davis, K.B., & Freedy, A. (1975). Adaptive utility assessment in dynamic decision processes: an experimental evaluation of decision aiding. Proceedings of Conference on Systems, Man, and Cybernetics Society, San Francisco, California.

Supports usage of an Adaptive Dynamic Decision Aiding Mechanism (ADDAM) system to aid decision makers in their administration of dynamic decision tasks. The effectiveness of the decision aiding system was examined through an experimental study which used a realistic decision task. ADDAM allows the operator to organize his own in-context behavior into a methodical mathematical framework. The purpose of this strategy is not simply to present a model for decision making behavior, but also to furnish a foundation for decision aiding.

Zachary, W., & Hopson, J. (1981a). A methodology for decision augmentation system design (Report No. 81-2201). American Institute of Aeronautics and Astronautics, Inc.

Proposes steps and guidelines which will enable airborne decision makers to enhance their performance. This methodological approach is intended to allow designers to effectively convert system performance objectives into full system designs. Cites some difficulties with decision augmentation systems and outlines steps to design and organize these systems.

Zachary, W., & Hopson, J. (1981b, June). Scope and requirements of a framework for decision augmentation system design. Willow Grove, Pennsylvania: Analytics Inc.

Provides support for the notion that the implementation of Decision Augmentation Systems (DASs) is an additional requirement for properly assessing and developing situations in order to make optimal decisions. The introduction of computer-based systems which support managerial decision making (Decision

Support Systems, DSSs) are not sufficient in augmenting human decision making performance to its fullest degree. The overall structure of a functional and computational DAS is presented in six stages.

User/Computer Interface

Alter, S. (1977, February). Why is man-computer interaction important for decision support systems? Interfaces, 7(2), 109-115.

Argues that interactive, conversational decision support systems do not represent their true identities in many cases. The author believes that better man-computer interfaces are needed, but not necessarily by managers themselves. Suggests that the focus should be on experts who understand the details underlying a support system; if managers do not learn the correct usage of decision support systems, then usage should be discouraged without the aid of an intermediary.

Andriole, S.J. (1982, July/August). The design of microcomputer-based personal decision aiding systems. IEEE Transactions on Systems, Man, and Cybernetics, SMC-12(4), 463-469.

Presents an approach to the design and development of personal computer-based decision aiding systems which views the human problem-solver as an active user who must be able to use the computer without the aid of a problem-solving intermediary. In order to successfully utilize a system, the author states that the design of the system should encompass the measurement and integration of cognitive, situational, and physiological variables which should inform and alter the decision-aiding process. It is suggested that without explicit user requirements, interactive systems fulfill the needs of the designer and not the target user. Problem solvers are categorized according to their experience with computer-based systems and grouped according to their "cognitive styles" in order to formulate computer-generated information and strengthen man's interaction with the computer. The user's physiological state and situational characteristics are examined as well.

Baldwin, J.T., & Siklossy, L. (1977). An unobtrusive computer monitor for multi-step problem solving. Int. J. Man-Machine Studies, 9, 349-362.

A method is presented for designing computer-assisted instructional (CAI) systems, Unobtrusive Problem Solving Monitors (UPSM's). These systems are aimed at monitoring students solving multi-step problems and provide valuable guidance to students based on prior students' input history. Students may solve problems in an unguided fashion with easily accessible help if needed. A typical example of a UPSM system that has been employed in plane geometry instruction is summarized.

Benbasat, I. & Taylor, R.N. (1982, July/August). Behavioral aspects of information processing for the design of management information systems. IEEE Transactions on Systems, Man, and Cybernetics, SMC-12(4), 439-450.

Cites various models of information processing which account for human thinking and attempts to cover the capabilities, as well as the inadequacies, in information processing present in the literature. The authors believe that

management information systems (MIS) can be radically improved by understanding the behavioral processes by which humans process information and make choices. This will aid in eliminating the problem of "overloading" the human user.

Benel, D.C.R., & Pain, R.F. (1985). The human factors usability laboratory in product evaluation. Proceedings of the Human Factors Society - 29th Annual Meeting.

Human factors engineering is a discipline which has not had widespread application in commercial product development, but through the proposed usability laboratory, experts may incorporate this approach into their product evaluation. Describes the structure of a usability laboratory.

Brooke, J.B., Duncan, K.D., & Marshall, E.C. (1978). Interactive instruction in solving fault finding problems. Int. J. Man-Machine Studies, 10, 603-611.

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Burke, J.T. (1986, March). The next step: managing battle with technology. ARMY, 56-60.

Discusses the concept of the Battlefield Management System (BMS) and advocates its role in improving the speed and effectiveness of combat operations and reducing battlefield stress. Col. (U.S. Army retired) Burke does not suggest replacing the human factor, but rather applying advanced technology to assist soldiers, leaders, and staff people in coping with the hectic movement of combat action. BMS is designed with the purpose of allowing humans to concentrate on creative decision making while it stores and processes data with great speed. BMS would be an immense asset to the battalion S2 and S3. It is argued that BMS can be used to train combat crews and entire units through battlefield simulation and will save millions of dollars, a substantial amount of time, and increase efficiency in field training.

Burton, R R., & Brown, J.S. (1979). An investigation of computer coaching for informal learning activities. International Journal of Man-Machine Studies, 11, 5-24.

Addresses the problem of computer-based coaching by presenting a coaching system named WEST, structured upon the game "How the West was Won." Analyzes this system in order to discover possible limitations and to yield tutorial strategies which should be an integral part of a successful coaching system. As a result of the increase in use of personal computers, computer-based games are widely played and may provide a beneficial environment for learning which is informal. A limitation is that a certain amount of tutoring is necessary to facilitate proper learning.

Caruso, D.E. (1969, April). Tutorial programs for operation of on-line retrieval systems. Paper presented before the Division of Chemical Literature, 157th Meeting, ACS, Minneapolis, Minnesota.

Discusses the need for an increase of Computer-Aided Instruction (CAI) programs in on-line computer systems. Interactive on-line computer programs are shown to allow the user use of computer services, and facilitate meaningful contact with the computer. Three examples of this type of system are given which were developed by the author and have varying user-training characteristics. The author purports to show that self-teaching systems can create a skilled user population.

Chu, Y., & Rouse, W.B. (1979, December). Adaptive allocation of decisionmaking responsibility between human and computer in multitask situations. IEEE Transactions on Systems, Man, and Cybernetics, SMC-9(12), 769-778.

Addresses the question of how decisionmaking responsibilities should be allocated between humans and increasingly intelligent computers as systems become more automated. The authors maintain that with "adaptive allocation" the allocation of responsibility is contingent upon the state of the system and decisionmakers. The decisionmaker most capable of performing a task at a particular time will be subject to complete it. An experimental study involving a flight management task illustrates this general strategy.

Collins, A., & Adams, M.J. (1977). Comparison of two teaching strategies in computer assisted instruction. Contemporary Educational Psychology, 2, 133-148.

In three experiments comparing a method of teaching developed from analysis of human tutors (Tutorial Mode) versus a method developed from programmed instruction (Block-Test Mode) a SCHOLAR Computer Assisted Instruction (CAI) is employed. The goal was to determine which facets of teaching strategy affected student learning. The results yield the conclusion that the major factor affecting student learning is tutorial strategy. Because CAI has the capacity to provide a mode analoguous to human tutors, it is said to be beneficial in the evaluation and implementation of different teaching strategies.

Collins, A., & Stevens, A.L. (1981). A cognitive theory of interactive teaching. To appear in C.M. Reigeluth (Ed.), Instructional Design Theories and Models: An Overview, New York: Academic Press.

The authors propose a theory of inquiry teaching whereby students construct theories by dealing with specifications and subsequently apply these theories to new cases. The authors feel that as a result of this teaching, reasoning skills, such as forming and testing hypotheses, making predictions, and knowing which questions to ask, to name a few, are learned and applied. It is recommended that these techniques be applied within other fields of study.

Eklundh, K.S., Marmolin, H., & Hedin, C. (1985). Experimental evaluation of dialogue types for data entry. International Journal of Man-Machine Studies, 22, 651-661.

A definite interaction between type of dialogue and type of data is evident in an experiment which evaluated four fundamental types of data entry dialogue concerning speed. It was found that subjects in this experiment preferred an interaction mode which maximized speed at the cost of less feedback and less opportunity for error control in the command dialogues. There were no significant differences between the number of errors within each type of dialogue. Authors contend that an adaptable man-computer dialogue is necessary with an irregular data structure in performing data entry.

Farquhar, P.H. (1982). Utility assessment methods (Working Paper 81-5). Davis, California: University of California.

Attempts to integrate current methods for evaluating single-attribute utility functions. Presents various new methods of evaluation which may be beneficial in furthering the research in this area, emphasizing the varied steps in the utility assessment process, and contrasting methods of comparative risk. Reviews approximately twenty-four utility assessment methods.

Goldstein, I. (1978, October). Developing a computational representation for problem solving skills (Artificial Intelligence Memo 495). Paper to appear in Proceedings of the Carnegie Mellon Conference on Problem Solving and Education: Issues in Teaching and Research.

Presents a problem solving model which originated from the study of computer coaches (advanced computer assisted instruction). This model depicts problem solving skills as an evolving set of rules for a domain influencing growing representation of the problem and administered by a resource-limited problem solver.

Goldstein, I.P. (1979). The genetic graph: a representation for the evolution of procedural knowledge. International Journal of Man-Machine Studies, 11, 51-77.

A model of the evolution of rule-structured knowledge which is considered a cornerstone of the development of computer-based coaches is illustrated. A graph structure depicting the concepts of generalization, correction, and refinement is displayed and defined. Various genetic graph formulations pertaining to reasoning skills used in playing an elementary mathematical game are examined.

Halpin, S.M., Johnson, E.M., & Thornberry, J.A. (1973, August). Cognitive reliability in manned systems. IEEE Transactions on Reliability, R-22(3), 165-170.

Analyzes cognitive reliability in manned systems, which the authors state is an intricate function of attitudinal and structural factors, along with their interaction. Cites the types of human errors which may transpire, and discusses factors which influence the chance of these errors. Due to the changing role of man in complex systems, a broadening of prevalent approaches to human performance reliability must be sought. In addition to describing the

tasks which are becoming progressively more important in man-machine systems, the term "cognitive reliability" is defined, methods of classifying cognitive errors are identified, and an example is given which exemplifies the factors likely to affect cognitive errors.

Hogarth, R.M., & Einhorn, H.J. (1976, January, in press). Optimal strategies for personnel selection when candidates can reject offers. Journal of Business.

Discusses personnel decision making with the inclusion of the possibility of rejection of job offers by candidates, which the authors recognize as an overlooked factor in formal models of decision making. Perfect Expected Acceptance Gain and Expected Acceptance Gain are promoted and demonstrate significant value for assessing the effects of various selection strategies. An interactive computer program is described. It is capable of being utilized for sensitivity analysis as a tool in the evaluation of important variations in subjective inputs, which affect changes in decision variables and their possible economic results.

Huber, G.P. (1981, November). Cognitive style as a basis for designing MIS and DSS: much ado about nothing? (Wisconsin Working Paper 11-81-29). Wisconsin: University of Wisconsin-Madison.

Argues that the current literature on cognitive styles is inadequate for determining operational Management Information Systems and Decision Support Systems (DSS) guidelines. He further states that cognitive style research is unlikely to produce valuable guidelines.

MacGregor, D., & Slovic, P. (1985, March). Perceived acceptability of risk analysis as a decision-making approach. Eugene, Oregon: Decision Research, A Branch of Perceptronics.

Investigates a methodology for understanding how people evaluate decision making approaches involving health and safety risk factors. Three methods for making a consumer product safety decision were appraised on scales relating to their perceived acceptability, logical soundness, completeness, and sensitivity to moral and ethical concerns. An effect on judgments was not shown from having knowledge of the consequences. An implication made is that people's acceptance of risk may be greatly determined by the manner in which decision risks are made.

Morehead, D.R. & Rouse, W.B. (1983). Human-computer interaction in information seeking tasks. Information Processing and Management, 19(4), 243-253.

In this report, the authors utilize a simplified information seeking environment, DBASE (Data Base Access and Search Environment), in an experiment to study human machine interaction. Included in this topic are computer aiding, availability of citation lists, data base structure, and type of search tasks. It is indicated from the results of this experiment that data base structure and type of search task may be combined to create diversified search environments, which greatly influence the user's search performance.

Morris, N.M., Rouse, W.B., & Frey, P.R. (1985, February). Adaptive aiding for symbiotic human-computer control: conceptual model and experimental approach (Air Force Aerospace Medical Research Laboratory Technical Report #84-072). Wright-Patterson Air Force Base, Ohio: Search Technology, Inc.

In this report, development of an experimental approach to be used in the investigation of the advantages of adaptive aiding is recapitulated. Implications for the design of adaptive aids are examined and a conceptual framework is outlined. The task environment consists of two competing tasks which must be performed concurrently: a target spotting task and a tracking task. Results indicate that the manipulation of spotting task difficulty affects performance.

Newsted, P.R., & Wynne, B.E. (1976). Augmenting man's judgment with interactive computer systems. Int. J. Man-Machine Studies, 8, 29-59.

Presents a computer-based technique, An Interactive Decision System (AIDS), with the goal of assisting typical managers in making strategic decisions dealing with qualitative issues by allowing them optimal usage of their available information and resources. This system is based on Kepner and Tregoe's information processing techniques utilized in their decision training agendas. A thorough illustration of the nine steps in AIDS and a discussion of the program and its effectiveness describe this approach.

Norman, D.A. (1980, August). Errors in human performance (Report No. 8004). La Jolla, California: Center for Human Information Processing.

This report's area of concentration lies in human error, particularly error made by skilled operators in complex, demanding systems. Through this analysis of human error, various applications of human information processing are delineated and a classification scheme for errors is outlined. Short-term memory and human attentional limitations are examined in the design of human-machine interfaces.

Norman, D.A. (1981c, August). Steps toward a cognitive engineering: system images, system friendliness, mental models. Paper presented at Symposium on Models of Human Performance, ONR Contractor's meeting, La Jolla, California.

Contends that current inappropriate system design does not allow optimum efficacy between the users and machines. Through the study of human error, it is discovered that human usage should be a factor warranting primary consideration by designers. The author proposes a cohesive system, a "friendly system", composed of the principles underlying both cognitive science and human factors.

O'Shea, T. (1978). A self-improving quadratic tutor. Int. J. Man-Machine Studies, 11, 97-124.

The lack of learning capability in Computer Assisted Instruction (CAI) programs is the issue addressed in this research report. The author's goal is to present an alternative teaching strategy for instructing students on ways to solve quadratic equations. Introduced is a self-improving quadratic tutor which teaches the solution to quadratic equations through the discovery method. The two major components of the tutor are explained. One of the components is an adaptive teaching program where the teaching strategy is described as a set

of production rules, and the second component executes the self-improving function of the system by making experimental changes to the set of production rules.

Rouse, S.H., Rouse, W.B., & Hammer, J.M. (1982, August). Design and evaluation of an onboard computer-based information system for aircraft. IEEE Transactions on Systems, Man, and Cybernetics, SMC-12(4), 451-463.

This report concerns computer-aided human information seeking. It is proposed that a computer-based information system can considerably reduce the frequency of human errors. Various types of information and styles of presentation are evaluated. Results are submitted which support the hypothesis that computer aiding is often more desirable than computerizing in that the goal should be for computers to help humans overcome limitations and utilize their best skills, rather than replace human operators. The design of an onboard computer-based information system for aircraft is explained.

Rouse, W.B. (1984). Design and evaluation of computer-based decision support systems. To appear in S.J. Andriole (Ed.), Microcomputer Decision Support Systems. Wellesley, MA: QED Information Sciences.

Argues that by integrating design and evaluation in computer-based decision support systems, improvements in the efficiency and effectiveness of the process will be the result. Because systems are becoming increasingly complex, decision suport systems which aid humans in decision making and problem solving are essential.

Rouse, W.B., Rouse, S.H., Hunt, R.M., Johnson, W.B., & Pelligrino, S.J. (1980, January). Human decision-making in computer-aided fault diagnosis (Technical Report 434). University of Illinois: Coordinated Science Laboratory.

Six experiments evaluating the effects of computer aiding on performance are described. The practicality of utilizing context-free computer-based simulations to instruct troubleshooting skills is also examined. A goal of this research study is to increase understanding of human fault diagnosis abilities. Computer aiding significantly lessened the number of tests required to diagnose simple problems and improved consequent unaided performance.

Slovic, P. (1971, April). Information processing, situation specificity, and the generality of risk-taking behavior. ORI Research Bulletin, 11(3), 1-22.

Inter-task consistency of individual differences was ascertained in two structurally comparable risk-taking tasks. A relationship was shown between information processing and situational specificity. As a result of the experiment, it was determined that the two response modes triggered different methods of processing information pertaining to probabilities and payoffs in a way that influenced individual differences and reduced inter-task consistencies. The implication is that it is improbable to find significant correlations between risk-taking measures in structurally different settings or between risk-taking and different behaviors.

Slovic, P., Fischhoff, B., & Lichtenstein, S. (1977). Behavioral decision theory. Ann. Rev. Psychol., 1-39.

The author focuses on the psychological aspects of individual judgment and decision making by reviewing descriptive research and examining decision aids. A survey of publications (the majority of them dated 1971-75) on the subject of behavioral decision theory is provided and descriptive studies of judgment are evaluated. An attempt is made to enumerate the errors in decision-making that may arise from judgment biases. Some areas mentioned under the topic of descriptive research include probabilistic judgment, choice, models of risky choice, and regression approaches. An insightful discussion of decision aids, MAUT research, decision analysis, man/machine systems, and use of decision aids clarifies: (a) issues which a decision maker may face, and (b) the systems used to solve problems.

Smith, S.L., & Mosier, J.N. (1984, September). Design guidelines for user-system interface software (Technical Paper ESD-TR-84-190). Bedford, Massachusetts: The Mitre Corporation.

Provides guidelines for the design of user interface software to aid designers, system analysts, teachers, students, human factors practitioners, and researchers in making this process more efficient. The focus is on six functional areas: data entry, data display, sequence control, user guidance, data transmission, and data protection.

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Specific Aids

Beach, L.R., Townes, B.D., Campbell, F.L., & Keating, G.W. (1976). Developing and testing a decision aid for birth planning decisions. Organizational Behavior and Human Performance, 15, 99-116.

A decision aid is promoted which allows one to calculate subjective expected utilities (SEUs) for having a (another) child; a value hierarchy is used. The method is intended to assist people with their birth planning decisions so that they may logically and sensibly weigh the pros and cons. Decisions are divided into "manageable chunks" and the relative utility of each chunk is evaluated. The authors affirm that through the development of this aid they developed a method applicable to other areas besides birth planning.

Brooke, J.B., Duncan, K.D., & Marshall, E.C. (1978). Interactive instruction in solving fault finding problems. Int. J. Man-Machine Studies, 10, 603-611.

This study reviews a training program which furnishes supplementary information pertaining to the relationship between remaining faults and the realizable indicators during fault diagnosis. An interactive computer system provides problem solving process information to trainees as they learn to diagnose faults. A flow chart is given which displays the procedure followed by computer programmers in controlling a fault diagnosis problem.

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Pangaro, P.A. & Nicoll, J.F. (1983, February). Deleting the knowledge engineer: the practical design of intelligent support software based on Pask's proto-logic Lp. Paper presented at the Seminar "The Application of Machine Intelligence to Defense Systems", Portland, UK.

Discusses the role of the knowledge engineer, a person who builds an expert system in conjunction with an expert in the subject field. Believes that the expert should communicate directly with the computer, thus eliminating the need for a knowledge engineer. An Intelligent Support System (ISS) is presented as an ideal solution to providing sophisticated support in expert systems in three different roles: the training of novices, tactical or operational support, and strategic planning. The philosopy is that there should be only a narrow gap between the creators and operators of an intelligent support system.

Posa, T. (1985, October). Software helps busy executives analyze, make key decisions. Infoworld, 7(41), 43-44.

Decisionmap, published by Softstyle Inc., is decision support software (run on the Macintosh) through which one is able to design his/her own decision model. After choosing criteria on which the decision is to be based, factors are weighed according to importance and possible solutions are ranked. The author advocates its usage, emphasizing the ease of learning and minimal amount of time involved.

Rouse, S.H., Rouse, W.B., & Hammer, J.M. (1982, August). Design and evaluation of an onboard computer-based information system for aircraft. IEEE Transactions on Systems, Man, and Cybernetics, SMC-12(4), 451-463.

This report concerns computer-aided human information seeking. It is proposed that a computer-based information system can considerably reduce the frequency of human errors. Various types of information and styles of presentation are evaluated. Results are submitted which support the hypothesis that computer aiding is often more desirable than computerizing in that the goal should be for computers to help humans overcome limitations and utilize their best skills, rather than replace human operators. The design of an onboard computer-based information system for aircraft is explained.

Saleh, J., Leal, A., Kim, J., & Pearl, J. (1979, October). Progress toward a goal-directed decision support sytem (Technical Report UCLA-ENG-CSL-7973). University of California, Los Angeles: School of Engineering and Applied Science.

A computerized decision support system is described which was developed by the authors as an effective replacement for decision-tree representation. They state that the approach is preferable because of the clarity and purposefulness it provides. This goal-directed method focuses on a single objective at any given time and instructs the user to ignore all side effects. An extensive amount of graphs, structures, and representations are provided.

Weisbrod, R.L., Davis, K.B., & Freedy, A. (1975). Adaptive utility assessment in dynamic decision processes: an experimental evaluation of decision aiding. Proceedings of Conference on Systems, Man, and Cybernetics Society, San Francisco, California.

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EVALUATION

Human Factors

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A definite interaction between type of dialogue and type of data is evident in an experiment which evaluated four fundamental types of data entry dialogue concerning speed. It was found that subjects in this experiment preferred an interaction mode which maximized speed at the cost of less feedback and less opportunity for error control in the command dialogues. There were no significant differences between the number of errors within each type of dialogue. Authors contend that an adaptable man-computer dialogue is necessary with an irregular data structure in performing data entry.

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Information

Baker, J.D. (1970). Quantitative modelling of human performance in information systems. Ergonomics, 13(6), 645-664.

Describes a general information system model, MAN, which emphasizes the importance of the user in man-machine systems. The ultimate goal is to acquire the ability to utilize the results of human information processing studies to predict the impact on system performance. The framework structure is based on the supposition that there are five central operations in the performance of an information system: screen, transform, input, assimilate, and decide.

Bandyopadhyay, R. (1977, January). Information for organizational decision-making - a literature review. IEEE Transactions on Systems, Man, and Cybernetics, SMC-7(1), 1-15.

Classifies literature pertaining to organizational decision making into three areas: management science, classical, and behavioral science. Stresses that there is a problem in measuring information value. The author aims to provide insight into the broad area of organizational decisionmaking.

Benbasat, I. & Taylor, R.N. (1982, July/August). Behavioral aspects of information processing for the design of management information systems. IEEE Transactions on Systems, Man, and Cybernetics, SMC-12(4), 439-450.

Cites various models of information processing which account for human thinking and attempts to cover the capabilities, as well as the inadequacies, in information processing present in the literature. The authors believe that management information systems (MIS) can be radically improved by understanding the behavioral processes by which humans process information and make choices. This will aid in eliminating the problem of "overloading" the human user.

Cohen, M.S., & Freeling, A.N.S. (1981, February). The impact of information on decisions: command and control system evaluation (Technical Report 81-1). Falls Church, Virginia: Decision Science Consortium, Inc.

This study applies decision analytic concepts to the problem of determining value of information in the design and evaluation of information systems. Although many current systems furnish an abundance of data, the decision maker is often unable to pick out the data essential to the problem. Necessary information is that which has a high probability of changing a decision and improving decision outcome. This study modifies standard VOI techniques in order to simplify them and encourage their usage.

Connolly, T., & Miklausich, V.M. (1978). Some effects of feedback error in diagnostic decision tasks. Academy of Management Journal, 21(2), 301-307.

A laboratory study was conducted to examine the effects of varying the levels of feedback error on performance in diagnostic tasks. Results suggest that the comprehensive decision quality is contingent on both the quality of information available when the decision is made and the quality of subsequent feedback.

Klayman, J. (1982). Simulations of six decision strategies: comparisons of search patterns, processing characteristics, and response to task complexity. (Working paper #100). Chicago, Illinois: University of Chicago.

This paper addresses questions pertaining to the modifications made in strategies in response to task complexity by decision makers. A primary goal of these simulation studies entails identifying different decision strategies on the basis of information search patterns. It is reasoned that simulation can be very useful in generating, testing, and modifying hypotheses about human decision strategies but care must be taken to insure that the design is representative of the impending specific decision task.

Klayman, J. (1983). Analysis of predecisional information search patterns. In P. Humphreys, O. Svenson, & A. Vari (Eds.), Analyzing and Aiding Decision Processes. Amsterdam: North-Holland.

The present paper discusses the analysis of information gathering patterns as a tool for process tracing. Attention to complex and diverse decision approaches has underscored the necessity of developing more refined process tracing analyses (analyzing information gathering patterns). Two major methods of improving search analysis are examined. An experimental example using these techniques is given, and applications are submitted in three areas.

Klein, G.A. (1980, October). Automated aids for the proficient decision maker. Proceedings of the Smith Conference on Cybernetics and Society.

Proposes a comparison-guided model of decision-making, maintaining that proficient decision makers are able to recognize and subsequently place new situations parallel to ones previously experienced. The types of decisions discussed are complex, those with unusual conditions. It is asserted that a redefinition of the problem by the expert will allow utilization of all resources which may yield a solution to the problem, rather than using a decision aid requiring "rule-following." The author believes that proficiency is not simply following rules and procedures.

Lichtenstein, S., & Slovic, P. (1973). Response-induced reversals of preference in gambling: an extended replication in Las Vegas. Journal of Experimental Psychology, 101(1), 16-20.

An experiment was conducted at the Four Queens Casino in Las Vegas to determine the effects of response mode upon information-processing strategies applied by subjects in gambling decisions. Different strategies were used for choosing among pairs of bets as opposed to assigning monetary values to single bets. Bias was found to occur in favorable and unfavorable gambles as a result of cue-response compatibility.

Morehead, D.R., & Rouse, W.B. (1983). Human-computer interaction in information seeking tasks. Information Processing and Management, 19(4), 243-253.

In this report, the authors utilize a simplified information seeking environment, DBASE (Data Base Access and Search Environment), in an experiment to study human machine interaction. Included in this topic are computer aiding, availability of citation lists, data base structure, and type of search tasks. It is indicated from the results of this experiment that data base structure and type of search task may be combined to create diversified search environments, which greatly influence the user's search performance.

Newsted, P.R., & Wynne, B.E. (1976). Augmenting man's judgment with interactive computer systems. Int. J. Man-Machine Studies, 8, 29-59.

Presents a computer-based technique, An Interactive Decision System (AIDS), with the goal of assisting typical managers in making strategic decisions dealing with qualitative issues by allowing them optimal usage of their available information and resources. This system is based on Kepner and Tregoe's information processing techniques utilized in their decision training agendas. A thorough illustration of the nine steps in AIDS and a discussion of the program and its effectiveness describe this approach.

Norman, D.A. (1980, August). Errors in human performance (Report No. 8004). La Jolla, California: Center for Human Information Processing.

This report's area of concentration lies in human error, particularly error made by skilled operators in complex, demanding systems. Through this analysis of human error, various applications of human information processing are delineated and a classification scheme for errors is outlined. Short-term memory and human attentional limitations are examined in the design of human-machine interfaces.

Norman, D.A. (1981b). A psychologist views human processing: human errors and other phenomena suggest processing mechanisms. Paper presented at: IJCAI, Vancouver, British Columbia.

Discusses human processing structures by arguing for a different kind of processing mechanism than that which is most commonly referred to in Artificial Intelligence. The form of human error is of major importance in this study. A distinction is made between two major classes of errors, mistakes versus slips, and these two types are examined.

Pitz, G.F. (1970). On the processing of information: probabilistic and otherwise. In G. de Zeeuw et al. (Eds.), Acta Psychologica 34 Subjective Probability (pp. 201-213). Amsterdam: North-Holland Publishing Company.

Advocated is the study of processes such as attention, encoding, and short-term memory in relation to probabilistic information processing (PIP) in order to expand our knowledge of decision making behavior. It is stressed that the information, not the processing itself, is probabilistic in nature. Two models of opinion revision are reviewed which incorporate the use of Bayes' theorem in their models, but recognize human error. Outlined is a PIP model computer program.

Rouse, S.H., Rouse, W.B., & Hammer, J.M. (1982, August). Design and evaluation of an onboard computer-based information system for aircraft. IEEE Transactions on Systems, Man, and Cybernetics, SMC-12(4), 451-463.

This report concerns computer-aided human information seeking. It is proposed that a computer-based information system can considerably reduce the frequency of human errors. Various types of information and styles of presentation are evaluated. Results are submitted which support the hypothesis that computer aiding is often more desirable than computerizing in that the goal should be for computers to help humans overcome limitations and utilize their best skills, rather than replace human operators. The design of an onboard computer-based information system for aircraft is explained.

Rouse, W.B., & Rouse, S.H. (1984). Human information seeking and design of information systems. Information Processing and Management, 20(1), 129-138.

Organizes current literature from various disciplines (i.e., psychology, management, systems engineering, computer science, and library science) to develop the topic of human information seeking and information systems. The nature of information seeking is defined, and through discussion, the contrast is made between information seeking and information processing. The difficulty in defining and measuring the value of information affects the progress which may be made in developing frameworks and formulating methods to evaluate this area of concern. Human information seeking is shown to be a integral part of decision making and problem solving.

Schweiger, D.M., Anderson, C.R., & Locke, E.A. (1985). Complex decision making: a longitudinal study of process and performance. Organizational Behavior and Human Decision Processes, 36, 245-272.

Simultaneous verbal protocols were employed to study individual decision making processes. The authors describe the protocol analysis procedure used and present the coding scheme developed to analyze the data. Results of two experiments show that thought processes used in complex decision making are associated with subsequent performance: subjects using causal analysis performed more successfully than those who did not.

Shanteau, J. (1974). Component processes in risky decision making. Journal of Experimental Psychology, 103(4), 680-691.

The goal of this research study was to utilize the theory of information integration by applying an information processing approach to risky decision judgments. The study challenges the utility theory as used in risky decision making. The multiplying model is advocated, which is supported by data resulting from two experiments.

Shanteau, J. (1975). Averaging versus multiplying combination rules of inference judgment. Acta Psychologica, 39, 83-89.

Two combination rules, averaging and multiplying, which describe sequential inference judgments, were compared through three experiments in this study. Both of these rules depict how successive pieces of evidence are combined with previous judgments to form new judgments. Usage of the averaging rule was supported but the descriptive ability of the Bayesian approach (and other approaches which use the multiplying rule) was questioned. It may be inferred from the averaging result that judgments may incorporate processing rules differently than previously speculated.

Shanteau, J., & Gaeth, G.J. (1983, January). Training expert decision makers to ignore irrelevant information (Human Information Processing Report No. 82-5). Manhattan, Kansas: Kansas State University.

A series of research projects were performed with the goal of revealing the influence of irrelevant information on expert decision makers. Training programs to overcome this effect were discussed and the long-term effects of the training were evaluated.

Shanteau, J., & Nagy, G.F. (1984). Information integration in person perception: theory and application. In M. Cook (Ed.), Issues in person perception (pp. 48-86). London: Methuen.

This selected chapter covers some of the principal findings from research conducted on the person perception model with the information integration theory (ITT). Five research studies are alluded to which exemplify the early development and basic assumptions of ITT, which is traced to impression formation. Cases are cited which show how ITT can be utilized in the analysis of socially relevant interpersonal decisions, and also in real-world concerns.

Slovic, P. (1971, April). Information processing, situation specificity, and the generality of risk-taking behavior. ORI Research Bulletin, 11(3), 1-22.

Inter-task consistency of individual differences was ascertained in two structurally comparable risk-taking tasks. A relationship was shown between information processing and situational specificity. As a result of the experiment, it was determined that the two response modes triggered different methods of processing information pertaining to probabilities and payoffs in a way that influenced individual differences and reduced inter-task consistencies. The implication is that it is improbable to find significant correlations between risk-taking measures in structurally different settings or between risk-taking and different behaviors.

Slovic, P., & Lichtenstein, S. (1968, November). Relative importance of probabilities and payoffs in risk taking. Journal of Experimental Psychology Monograph, 78(3), 1-18.

This report examines the beliefs held by people about the relevant importance of probabilities and payoffs and their capability to act on the premise of these beliefs when processing information included in the description of a gamble. Two experiments are described which suggest that there is utility in recognizing decisions about gambling within the context of information processing.

General

Adelman, L., Donnell, M.L., Patterson, J.F., & Weiss, J.J. (1981, February). Issues in the design and evaluation of decision-analytic aids (Technical Report 81-1-304). McLean, Virginia: Decisions and Designs, Inc.

Addresses three important issues which are relevant to the design and evaluation of decision analytic aids and presents a framework which illustrates the decision making organization. The three interfaces identified are: between the decision aid and the user, between the user and the extent to which the decision aid facilitates the decision making processes of the organization, and between the decision making organization and whether or not the quality of the organization's decision making has improved the environment. Without the smooth functioning of the three interfaces, effective integration of decision aids into organizations can not be accomplished. The author covers some ways to attract the user to the aid and to simplify its overall operation.

Beach, L.R., Townes, B.D., Campbell, F.L., & Keating, G.W. (1976). Developing and testing a decision aid for birth planning decisions. Organizational Behavior and Human Performance, 15, 99-116.

A decision aid is promoted which allows one to calculate subjective expected utilities (SEUs) for having a (another) child; a value hierarchy is used. The method is intended to assist people with their birth planning decisions so that they may logically and sensibly weigh the pros and cons. Decisions are divided into "manageable chunks" and the relative utility of each chunk is evaluated. The authors affirm that through the development of this aid they developed a method applicable to other areas besides birth planning.

Charlton, S.G. (1985). Behavior analysis: a tool for test and evaluation. Proceedings of the Human Factors Society - 29th Annual Meeting.

In this study behavioral analysis is applied in the field test environment. Used simultaneously with other evaluation tools, behavior changes can be fully evaluated. In the example provided, behavior analysis was used to document and assess instances of behavioral divergence in the field test of a military system.

Cohen, M.S., & Freeling, A.N.S. (1981, February). The impact of information on decisions: command and control system evaluation (Technical Report 81-1). Falls Church, Virginia: Decision Science Consortium, Inc.

This study applies decision analytic concepts to the problem of determining value of information in the design and evaluation of information systems. Although many current systems furnish an abundance of data, the decision maker is often unable to pick out the data essential to the problem. Necessary information is that which has a high probability of changing a decision and improving decision outcome. This study modifies standard VOI techniques in order to simplify them and encourage their usage.

Dino, G.A., & Shanteau, J. (1984, November). What skills do managers consider important for effective decision making? Paper presented at the Psychonomics Meeting, San Antonio, Texas.

This study was conducted with the purpose of analyzing how decision makers themselves define decision making competence. Thirty-five bottom-level and twenty-four top-level managers participated in the following: (1) Rated skills that they believed important for effective decision makers; (2) Rated the importance of these skills in upper-level and lower-level decision makers; and, (3) Were evaluated in regards to the effects of gender, their types of organizations, and their levels within their organizations.

Einhorn, H.J., Hogarth, R.M., & Klempner, E. (1977). Quality of group judgment. Psychological Bulletin, 84, 158-172.

Deals with the accuracy of group judgment within and between different populations of groups. The quality of group judgment is defined. Results as well as constraints affecting judgmental quality of various strategies for merging opinions under a diversity of circumstances are discussed. A statistical procedure is introduced that considers which baselines are suitable in the evaluation of the quality of group judgment.

Eklundh, K.S., Marmolin, H., & Hedin, C. (1985). Experimental evaluation of dialogue types for data entry. International Journal of Man-Machine Studies, 22, 651-661.

A definite interaction between type of dialogue and type of data is evident in an experiment which evaluated four fundamental types of data entry dialogue concerning speed. It was found that subjects in this experiment preferred an interaction mode which maximized speed at the cost of less feedback and less

opportunity for error control in the command dialogues. There were no significant differences between the number of errors within each type of dialogue. Authors contend that an adaptable man-computer dialogue is necessary with an irregular data structure in performing data entry.

Fischhoff, B. (1977, May). Decision analysis: clinical art or clinical science? (Technical Report PTR-1042-77-5). Eugene, Oregon: Decision Research, A Branch of Perceptronics.

Draws an analogy between decision analysis and psychotherapy. Areas discussed include evaluating the validity, effectiveness, and underlying assumptions of decision analysis, improving analysts' skills, and social, ethical, and political issues. The comparison with psychotherapy serves to delineate the important issues that should be addressed in a research program.

Hart, S.L. (1985). Toward quality criteria for collective judgments. Organizational Behavior and Human Decision Processes, 36, 209-228.

Addresses the subject of group decision making by presenting evaluative criteria, which were derived from a review of prevailing literature, for judging when a "high-quality outcome" has been reached. A major goal which is hoped to be generated by this project is the construction of a set of empirically derived criteria against which outcome quality may be judged. The most effective procedures for the achievement of a high quality collective judgment are suggested as a result of six factual group problem-solving cases which were evaluated by use of a specially developed questionnaire.

Hogarth, R.M. (1975). Decision time as a function of task complexity. In Wendt/Velk (Eds.). Utility Probability, and Human Decision Making (pp. 321-338). Dordrecht-Holland: D. Riedel Publishing Company.

Discusses the association between decision time and task complexity. A mathematical model is thoroughly explained which examines this association. The model is described as having several observable variables linked to an unobservable variable of the psychological function, i.e., cognitive strain. It is suggested that when a decision maker is faced with different alternatives, he considers two kinds of cost: the time involved in the decision procedure, and the cost of making errors.

Hogarth, R.M., & Makridakis, S. (1981). The value of decision making in a complex environment: an experimental approach. Management Science, 27, 93-107.

An experiment was conducted in which a competitive game was played to assess whether or not the costs of time and effort used to analyze a decision outweighed the benefits. Another objective was to discover strategies to improve decision performance. There were two kinds of uncomplicated decision rules: (1) rules were applied consistently (arbitrary-consistent), and (2) rules were subject to a random component (arbitrary-random).

Howard, R.A. (1979, October). An assessment of decision analysis. Stanford, California: Stanford University.

Presents an assessment of decision analysis by discussing human decision making, decision analysis, the usefulness of decision analysis, ethical concerns, and the challenge that must be faced if the field is to continue its growth. The author explains that "decision making is what you do when you don't know what to do", and cites evidence that people are not good natural decision makers. It is emphasized that decision analysis is not simply a logical procedure, but also an "artistic" process.

Jacobs, T.O. (1976, September). Analysis and evaluation of tactical decision making. Paper presented at American Psychological Association Meeting, Washington, D.C.

Outlines a study in which an illustration of how incumbent generals, colonels, and lieutenant colonels define command and control performances. Five general categories which emerged were: getting and using information, planning, organizing, controlling/directing, and leadership/personnel. Reports on an experiment in which the usefulness of automating analysis and production tasks is analyzed and proves to be applicable to organizational decision making. Among the findings reported are: (a) The battalion level differs from division command level in that the descriptive model suggests a "process-oriented reactive orientation" for battalion level decision makers; (b) the time perspective is very limited for the battalion commander in combat; and, (c) experiments in the area of tactical decision making may require the utilization of real incumbents in realistic situations.

Keen, P.G.W. (1975, Spring). Computer-based decision aids: the evaluation problem. Sloan Management Review, 16(3), 17-29.

Examines the issue of the evaluation problem with computer-based decision aids. The author proposes that a diagnostic approach be implemented which considers all benefits, "soft" and "hard," since it is not always feasible that benefits can be quantified. Evaluation should be initiated prior to the design of the system, when all interested parties reach an understanding as to what the system should ultimately accomplish. A case study is given which exemplifies the necessity of employing the process of evaluation during implementation.

O'Connor, M.F. (1977, July). Procedures for assessing the value of command and control capabilities (Technical Report 77-4). McLean, Virginia: Decisions and Designs, Inc.

Addresses the question: How much command and control (C^2) capability is enough? In order for one to answer this question, the cost of achieving that capability must be weighed against the potential benefits of allocating funds elsewhere. A value is assigned to the action of deciding to deploy a certain C^2 system in a precarious future. The trade-offs which must be made in order to resolve this question are analyzed. The paper is divided into four sections; discussed are: (a) the theory of assessing value for multiple attributed alternatives; (b) the use of scenarios as a solution to the problem with

decision trees; (c) the application of value assessment procedures; and, (d) a specific problem: the trade-offs between cost and multiple performance measures, which illustrates the use of utility assessment procedures with the C^2 problem.

Pearl, J., Kim, J.H., & Fiske, R. (1981, December). An experimental evaluation of the effectiveness of two decision structuring methods. Prepared for Wayne Zachary (Ed.), Computer Augmentation of Human Decision Making. New York: Gordon and Breech.

An experimental evaluation is conducted on the effectiveness of decision-tree elicitation and goal-directed structuring. To analyze these two structuring procedures, a computer simulation of a hypothetical decision making environment, Goal-Directed Decision-Structuring System (GODDESS), was applied. This system promoted an objective evaluation of each decision instituted by the subjects. The main topics of discussion are the simulated model, the experimental approach, and the results. The results illuminate the strengths and weaknesses of the two decision structuring methods. The authors contend that the supremacy of the goal-directed approach would be recognized in a situation where the difference in performance between long-range and short-range planners is more strongly emphasized.

Rouse, S.H., Rouse, W.B., & Hammer, J.M. (1982, August). Design and evaluation of an onboard computer-based information system for aircraft. IEEE Transactions on Systems, Man, and Cybernetics, SMC-12(4), 451-463.

This report concerns computer-aided human information seeking. It is proposed that a computer-based information system can considerably reduce the frequency of human errors. Various types of information and styles of presentation are evaluated. Results are submitted which support the hypothesis that computer aiding is often more desirable than computerizing in that the goal should be for computers to help humans overcome limitations and utilize their best skills, rather than replace human operators. The design of an onboard computer-based information system for aircraft is explained.

Rouse, W.B., & Rouse, S.H. (1984). Human information seeking and design of information systems. Information Processing and Management, 20(1), 129-138.

Organizes current literature from various disciplines (i.e., psychology, management, systems engineering, computer science, and library science) to develop the topic of human information seeking and information systems. The nature of information seeking is defined, and through discussion, the contrast is made between information seeking and information processing. The difficulty in defining and measuring the value of information affects the progress which may be made in developing frameworks and formulating methods to evaluate this area of concern. Human information seeking is shown to be a integral part of decision making and problem solving.

Smillie, R.J., & Ayoub, M.A. (1980). Job performance aids: evaluation of design alternatives via network simulation. Ergonomics, 23(4), 319-339.

Discusses the utilization of job performance aids (JPAs), which are defined as plans that allow the human component of a system to perform some function he

could not otherwise accomplish without extensive training or complex information processing. Through the employment of computer simulation (as opposed to laboratory experimentation) different combinations of job performance aid formats and the effect of stress on task performance with a JPA is analyzed. The use of computer simulation allows one to estimate and evaluate JPA combinations under varying conditions.

Smith, S.L., & Mosier, J.N. (1984, September). Design guidelines for user-system interface software (Technical Paper ESD-TR-84-190). Bedford, Massachusetts: The Mitre Corporation.

Provides guidelines for the design of user interface software to aid designers, system analysts, teachers, students, human factors practitioners, and researchers in making this process more efficient. The focus is on six functional areas: data entry, data display, sequence control, user guidance, data transmission, and data protection.

v. Winterfeldt, D. (1975, August). An overview, integration, and evaluation of utility theory for decision analysis (SSRI Research Report 75-9). Los Angeles, California: Social Science Research Institute.

Reviews current measurement theories on utility modeling and assessment. Written particularly for decision analysts who are interested in these theories for deciphering and solving real world decision problems which are complex in nature. This paper aims to relate the present utility measurement theory with decision analytic practice. The paper tries to lessen the gap between the theory and practice of utility measurement, which may be attributed in part to the difficulty in comprehension of the mathematical language inherent in the utility theories. It is concluded that even though utility theories can be beneficial in the structuring process of evaluation, they are usually too complex for usage in real world preference assessment.

Weisbrod, R.L., Davis, K.B., & Freedy, A. (1975). Adaptive utility assessment in dynamic decision processes: an experimental evaluation of decision aiding. Proceedings of Conference on Systems, Man, and Cybernetics Society, San Francisco, California.

Supports usage of an Adaptive Dynamic Decision Aiding Mechanism (ADDAM) system to aid decision makers in their administration of dynamic decision tasks. The effectiveness of the decision aiding system was examined through an experimental study which used a realistic decision task. ADDAM allows the operator to organize his own in-context behavior into a methodical mathematical framework. The purpose of this strategy is not simply to present a model for decision making behavior, but also to furnish a foundation for decision aiding.

LITERATURE REVIEWS, OVERVIEWS, AND BIBLIOGRAPHIES

Bandyopadhyay, R. (1977, January). Information for organizational decision-making - a literature review. IEEE Transactions on Systems, Man, and Cybernetics, SMC-7(1), 1-15.

Classifies literature pertaining to organizational decision making into three areas: management science, classical, and behavioral science. Stresses that there is a problem in measuring information value. The author aims to provide insight into the broad area of organizational decisionmaking.

Corsini, R.J. (Ed.) (1984). Encyclopedia of Psychology: Vol. 2 (pp. 42-43). New York: Wiley.

Briefly makes reference to selected authors and their findings in the area of management decision making, including the topics of normative analyses, descriptive analyses, and bounded rationality.

Einhorn, H.J. & Hogarth, R.M. (1981). Behavioral decision theory: processes of judgment and choice. Ann. Rev. Psychol., 32, 53-88.

This review of behavioral decision theory literature argues that the judgmental biases exhibited in laboratory situations may be functional in natural settings. Areas reviewed include attention, memory, learning, feedback, cognitive representation, and conflict. Assuming a broad perspective in the research of decision making may yield the most insightful and generalized results.

Erickson, J.M., & Levit, R.A. (1973, December). Development and application of a decision aid for tactical control of battlefield operations: bibliographic sort of the decision aiding literature (Research Memorandum 73-3). Minneapolis, Minnesota: Honeywell, Inc.

This research memorandum serves as an aid for researchers interested in decision aiding and decision making related to man/computer systems. The bibliographic listings are classified in terms of first author, year, by keyword, or by topical classification.

Farquhar, P.H. (1982). Utility assessment methods (Working Paper 81-5). Davis, California: University of California.

Attempts to integrate current methods for evaluating single-attribute utility functions. Present various new methods of evaluation which may be beneficial in furthering the research in this area, emphasizing the varied steps in the utility assessment process, and contrasting methods of comparative risk. Reviews approximately twenty-four utility assessment methods.

Rouse, W.B. (1983). Models of human problem solving: detection, diagnosis, and compensation for system failures. Automatica, 19(6), 613-625.

Covers models of human problem solving with an emphasis on those models which predict human behavior and performance to support design and evaluation. Areas which are of particular concern in this article are detection, diagnosis,

and compensation of system failures. Proposed is an outline of a model which may influence the integration and progress of understanding human problem solving.

Rouse, W.B. & Rouse, S.H. (1984). Human information seeking and design of information systems. Information Processing and Management, 20(1), 129-138.

Organizes current literature from various disciplines (i.e., psychology, management, systems engineering, computer science, and library science) to develop the topic of human information seeking and information systems. The nature of information seeking is defined, and through discussion, the contrast is made between information seeking and information processing. The difficulty in defining and measuring the value of information affects the progress which may be made in developing frameworks and formulating methods to evaluate this area of concern. Human information seeking is shown to be a integral part of decision making and problem solving.

Shanteau, J. (1985a, August). List of available reprints, preprints, working reports, etc., on judgment and decision making. (Available from James Shanteau, Department of Psychology, Bluemont Hall, Kansas State University, Manhattan, Kansas 66506.

Includes published papers and other papers in their final form, new papers or working papers, and theses and dissertations by students at KSU which are relevant to judgment/decision making.

Slovic, P., Fischhoff, B., & Lichtenstein, S. (1977). Behavioral decision theory. Ann. Rev. Psychol., 1-39.

The author focuses on the psychological aspects of individual judgment and decision making by reviewing descriptive research and examining decision aids. A survey of publications (the majority of them dated 1971-75) on the subject of behavioral decision theory is provided and descriptive studies of judgment are evaluated. An attempt is made to enumerate the errors in decision-making that may arise from judgment biases. Some areas mentioned under the topic of descriptive research include probabilistic judgment, choice, models of risky choice, and regression approaches. An insightful discussion of decision aids, MAUT research, decision analysis, man/machine systems, and use of decision aids clarifies: (a) issues which a decision maker may face, and (b) the systems used to solve problems.

Taylor, E.N. (1983, September). A review of literature relevant to unaided tactical decision making (ARI Research Note 83-35). Alexandria, Virginia: Human Resources Research Organization (HumRRO).

Provides a summary of literature which may be useful in developing and implementing training programs pertaining to tactical decision making. The authors contend that a cause for concern in the military is the question of whether or not decision makers are deciding upon the best courses of action in rapidly changing situations based on the techniques utilized by them to organize, analyze, and present information. Various models of decision making, along with problems in training, are examined with the purpose of developing a methodology for preparing military leaders to make tactical decisions.

v. Winterfeldt, D. (1975, August). An overview, integration, and evaluation of utility theory for decision analysis (SSRI Research Report 75-9). Los Angeles, California: Social Science Research Institute.

Reviews current measurement theories on utility modeling and assessment. Written particularly for decision analysts who are interested in these theories for deciphering and solving real world decision problems which are complex in nature. This paper aims to relate the present utility measurement theory with decision analytic practice. The paper tries to lessen the gap between the theory and practice of utility measurement, which may be attributed in part to the difficulty in comprehension of the mathematical language inherent in the utility theories. It is concluded that even though utility theories can be beneficial in the structuring process of evaluation, they are usually too complex for usage in real world preference assessment.

CATEGORICAL INDEX

I BASIC RESEARCH

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IV LITERATURE REVIEWS, OVERVIEWS, AND BIBLIOGRAPHIES