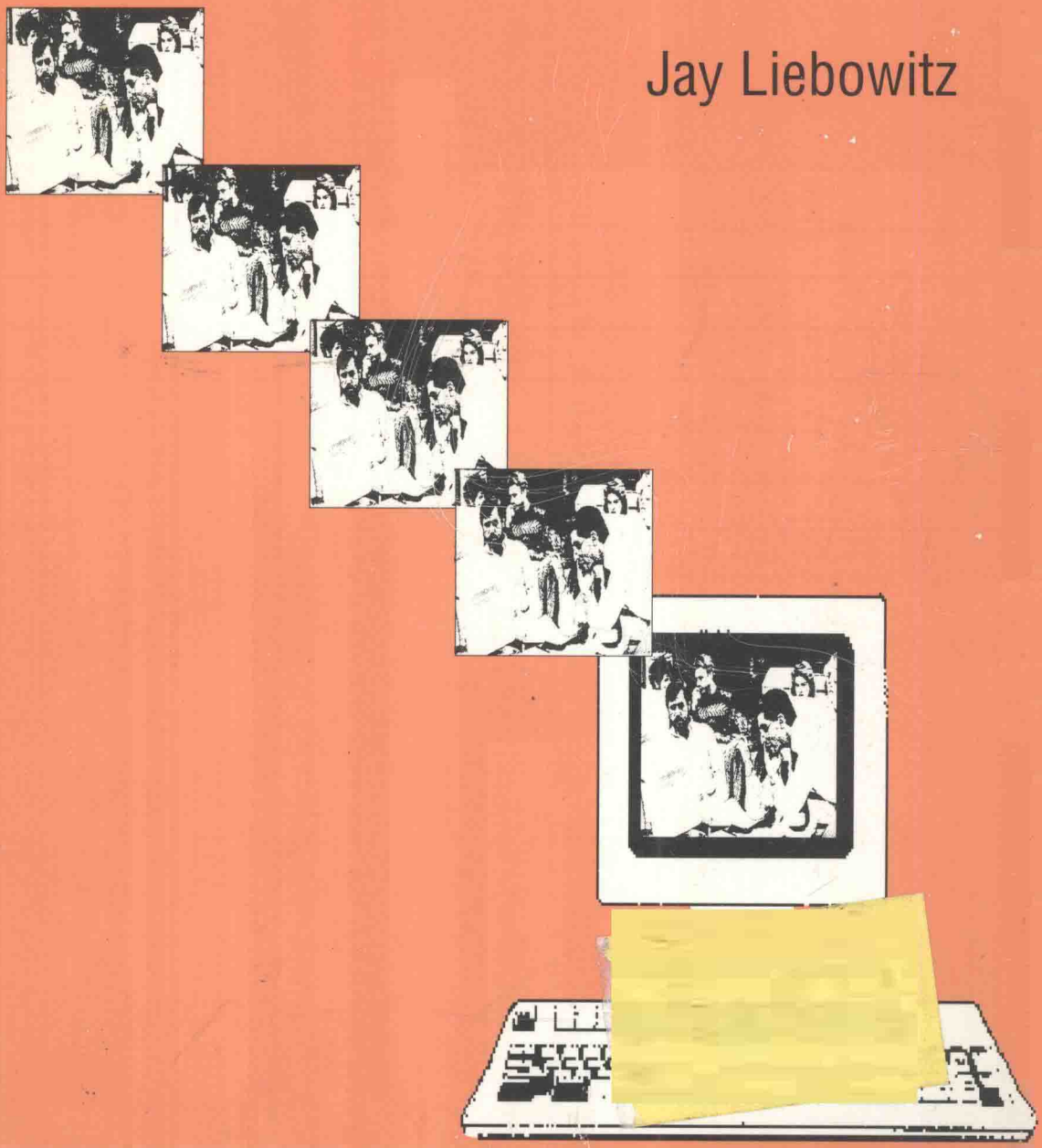
The Dynamics of Decision Support Systems and Expert Systems

Jay Liebowitz



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The Dryden Press
Chicago Fort Worth San Francisco Philadelphia
Montreal Toronto London Sydney Tokyo

Acquisitions Editor: DeVilla Williams
Project Editor: Karen Hill
Design Manager: Jeanne Calabrese
Production Manager: Barb Bahnsen
Director of Editing, Design, and Production: Jane Perkins

Text and Cover Designer: Nancy Johnson
Production Services: Spectrum Publisher Services, Inc.
Compositor: Kachina Typesetting, Inc.
Text Type: 10/14 New Baskerville Roman

Library of Congress Cataloging-in-Publication Data

Liebowitz, Jay.
The dynamics of decision support systems and expert systems / Jay Liebowitz.
p. cm.
Includes bibliographies and index.
ISBN 0-03-026383-2
1. Expert systems (Computer science) 2. Decision support systems. I. Title.
QA76.76.E95L5 1990
006.3'3—dc20 89-7788
CIP

Printed in the United States of America
901-090-987654321

Address orders:
The Dryden Press
Orlando, FL 32887

Address editorial correspondence:
The Dryden Press
908 N. Elm Street
Hinsdale, IL 60521

The Dryden Press
Holt, Rinehart and Winston
Saunders College Publishing

Cover Source: *Front:* Courtesy of International Business Machines Corporation.
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To my great parents, wonderful wife, Janet, and my loving son, Jason

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Preface

Goal of the Book

In most business information systems curricula, either a course on decision support systems (DSSs) or a separate track in DSSs has been established. Decision support systems have been around since the early 1970s, and their proliferation and use in homes and businesses have increased dramatically over the years. In recent years, however, the impact of artificial intelligence, particularly expert systems (ESs), has accelerated DSS technology, in particular, its applications, design methodologies, and implementation strategies. The goal of this book is to explain DSSs and ESs—the relationships between these two applied technologies, their synergistic effects upon each other, and their differences—and to show what effect their interaction has had on the framework, processes, and technical components for building DSSs.

Who Would Benefit from This Book

There are two major markets for this book: (1) the university student in information systems, computer science, engineering administration, management science, or operations research and (2) the user, or potential user, of DSSs in a business environment.

This book can be used for an advanced undergraduate course or an introductory graduate course on DSSs. Because some knowledge of artificial intelligence should be part of an information systems curriculum, this book emphasizes DSSs but also introduces ESs into class discussion.

Practitioners (i.e., business managers, sole practitioners, staff, etc.) would also be interested in this book. The book helps practitioners learn about emerging trends in DSS technology and the impact of ES technology on DSSs.

Acknowledgments

I am extremely grateful to the Management Science Department at George Washington University for their insights and helpful suggestions. Thanks go to my students for their recommendations as well. I also thank DeVilla Williams, Elizabeth Allebach, Karen Hill, Tom Hoffa, and Elise Oranges for their guidance and efforts throughout the book's development. The reviewers' comments were instrumental in enhancing its quality. I am also forever indebted to my wife, Janet, who allowed me to sneak away between feedings of my son, Jason, to write this book.

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Washington, D. C.
September 1989

About the Author

Dr. Jay Liebowitz is an associate professor of management science at George Washington University. He also serves as an information systems program director at George Washington University. He has gained experience in decision support system and expert system technology through numerous organizations, including the U.S. Navy Center for Applied Research in Artificial Intelligence, NASA Goddard, ICF, and American Management Systems. He is the editor-in-chief of *Expert Systems with Applications: An International Journal* and associate editor of an international journal, *Telematics and Informatics.* He serves on several editorial advisory boards of international journals, and he has been a prolific writer in the computer field.

Contents

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The Decision-Making Process

Every individual in an organization, whether at the operating, middle-management, or top-management level, makes decisions on a daily basis. Some of these decisions may not impact the organization on a long-term basis, yet others certainly may. Top management might be concerned with decisions affecting the strategic planning of the firm, while lower-level management might make decisions affecting just that day's activities. At each level of the organization, informational needs on which to base a decision will vary. At the operating level, individuals might want to see the daily production report in order to make a production-oriented decision. Middle management, on the other hand, might want to see only summary weekly production figures and exception reports (i.e., reports indicating where a discrepancy exists). Top management might also be interested in exception reports but would more likely want information leading to long-range planning documents and reports on which to make a decision about where the firm should be three to five years or ten years from now. Needs vary with every decision and every decision

maker, making the decision-making process a complex one. This chapter will address that process and the need for decision-making tools ■ ■ ■

Definition of Decision Making

Decision making involves collecting information, weighing it, searching for other possible options, and making a well-reasoned choice.[1] According to Simon, there are three phases of the decision-making process—intelligence, design, and choice.[2] The intelligence and design phases involve problem finding, problem formulation, and development of alternatives.[3] Problem finding determines the difference between some existing situation and some desired state. Once a problem is discovered, problem formulation involves clearly stating the problem in order to ensure that the "right" problem is worked on. One must be careful not to identify symptoms as the problem itself. For example, an individual might tell a doctor that she has aching finger joints and mentions that arthritis runs in her family. The doctor accepts the aching finger joints as a *symptom*, but the actual *problem* identified, after the doctor questions the individual, might be a diagnosis of thrombophlebitis associated with the use of birth control pills.[12] After the problem formulation stage, alternative generation commences in order to determine possible alternative solutions to the problem. Following the alternative generation stage is the choice phase, which involves selecting a course of action, based upon certain criteria, from those available. Communication and feedback during this intelligence-design-choice process are essential ingredients in ensuring that the proper decision is reached.

Simon's model is a process for individual-based decision making, as opposed to a framework for cooperative, group decision making. Simon's model doesn't recognize explicitly the communication-intensive aspects of cooperative problem solving processes.[15] Davis and Smith, on the other hand, have devised a framework for handling distributed problem solving to reflect the nature of this cooperative process.[15,16] Recognizing that the effectiveness of an organization depends on cooperative problem solving and teamwork, they have included the steps of problem

formulation, problem decomposition, task distribution, solution, and synthesis, which allow the interaction among cooperating individuals to be simulated.

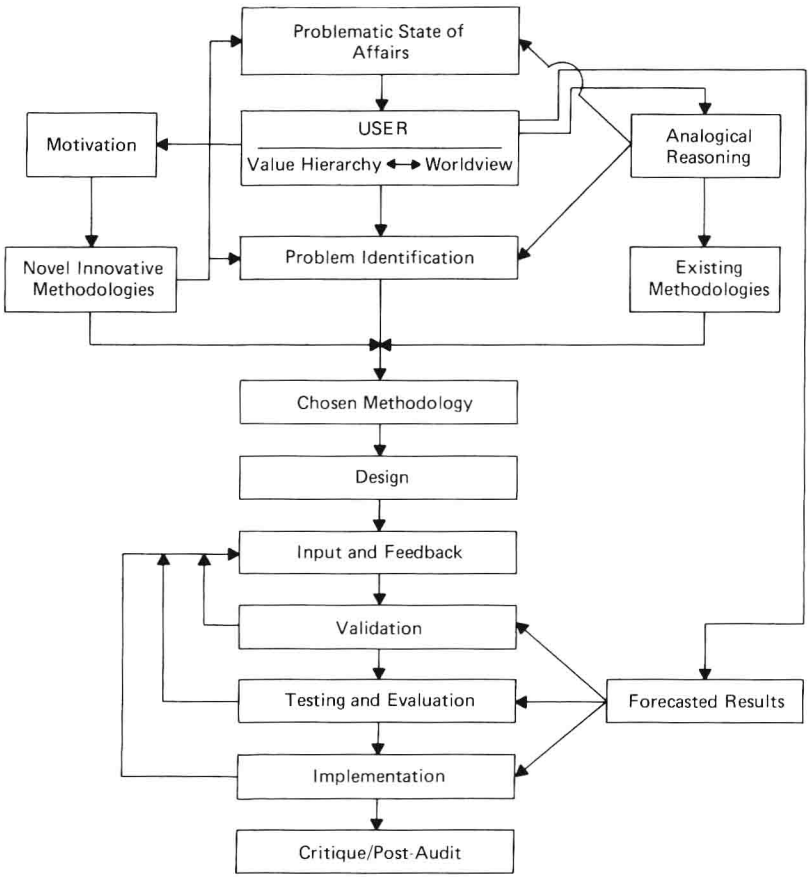
An approach to decision making that is useful for building automated aids involves a ten-step model, as proposed by Liebowitz.[4] This decision-making process combines elements of Sewell's[5] and Silverman's[6] approaches. Figure 1-1 shows this process and the steps are outlined as follows:

1. A **problematic state of affairs** confronts the
2. **User**, who has a **worldview value hierarchy**,
3. Which influences the **problem identification**;
4. **User** then employs **analogical reasoning** to determine **existing methodologies** that relate to the problematic state of affairs and the problem identification;
5. **User** shows **motivation** to seek out **novel innovative methodologies** that could relate to the problematic state of affairs and the problem identification;
6. **User** then selects a **chosen methodology** based on the existing and novel methodologies;
7. The chosen methodology needs **design** and the user identifies **forecasted results**;
8. Design requires **input** and **feedback**;
9. The chosen methodology then needs **validation, testing and evaluation**, and **implementation**, during which input and feedback are obtained after each step;
10. Results from testing and evaluation and implementation are matched against the **forecasted results**, and a **critique** is made.

Worldview Value Hierarchy

The user, i.e., the decision maker, has an innate worldview value hierarchy. Worldviews refer to values that collectively form contexts within which an individual perceives and interprets the world external to the interior of his or her head. Values precipitate from satisfaction of needs and then naturally fall into a hierarchical order. These worldview value hierarchies are, as Sewell explains,

Figure 1-1 Problem-Solving Framework for Information Systems Development



> in the final analysis a distillate of the interpretations with respect to meaning that we have associated through the exercise of judgment—both in the way of acceptance of interpretation from what we judge to be credible outside sources and as product of our innate capacity for direct, critical judgment—with all the experience we have accumulated up to any particular moment.[5]

Every decision maker has this built-in, internalized hierarchy that influences his or her interpretation of experience and problem solving.

Problematic State of Affairs

The user with his or her built-in worldview value hierarchy is confronted, in the framework outlined above, with a situation called a problematic state of affairs. This expression is coined by Sewell, who claims that legitimate, unsatisfied needs are perceived as problematic states of affairs.[5] These needs are congruent with symptoms of the problem.

Problematic states of affairs should be analyzed by examining the problem's local environment, or domain, and the problem's global environment. The global environment pertains to the system enveloping the problematic state of affairs. The local environment relates to the specific subsystem surrounding the problem at hand.

The problematic state of affairs consists of structured, unstructured, and semistructured components. Structured elements can be handled objectively; unstructured components of a problem cannot be dealt with objectively; semistructured elements are between structuredness and unstructuredness.[5] Gorry and Scott-Morton feel that these components are essential for effective managerial decisions.[7] Mitroff and Mason also stress the need for analyzing ill-structured problems.[8]

The problematic state of affairs directly influences the identification of the problem. The symptoms of the problem should not be confused with the definition and identification of the problem. They lead to a problem and should not be mistaken for the problem itself.

Analogical Reasoning

In order to determine possible solutions to a problem, the user employs analogical reasoning to see what previous experiences have related to the problematic state of affairs and problem identification. If there are historical examples that relate to the problem, then the solution to the past problem could be used as a basis for solving the current problem. Silverman in his five-step analogical problem-solving model of problem identification, knowledge acquisition, analog transfer, analog transformation, and introduction into use, elaborates on this concept: