APPLIED DECISION SUPPORT

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Preface

Most would agree that computer technology has gone through massive changes since its beginning. We have seen the cost, size, and capacity of computers improve one hundred fold. Practically every segment of our lives has benefited from the technological progress of automation, including the way we manage and run our business affairs. The computer's ability to process large amounts of information in the "wink of an eye" has made it a valuable asset in virtually every aspect of the management process. Whether it be controlling a complicated production process, coordinating the nationwide distribution of a large scale manufacturing and sales operation, or planning multibillion dollar investments, managers have become highly dependent on automation.

The explosion of computer applications in the business world has caused similar growth in the types of information systems used to process and analyze information on the computer. This book is concerned with one special area of information processing known as "Decision Support Systems" or DSS. The term DSS generally applies to systems that are designed to help managers evaluate and analyze complex situations. The phrase "generally applies" is used here because one of the major issues confronting this field is just what distinguishes a DSS from other Information Processing Systems. Ask someone to explain the concept and application of DSS and the answer given will most often depend on who you ask.

Even the majority of literature available today discusses the topic of DSS in rather vague concepts. Open virtually any book and the reader is barraged by an assortment of "buzz words" and confusing terminology (Management Information Systems, Expert Systems, Management Support Systems, Knowledge Based Systems, . . .). To make matters worse, the reader usually has to pause every other sentence to translate some nebulus idea or phrase into every day English. The most simple concepts become couched in abstract terms. This book was designed to provide a user's viewpoint of decision-support applications. The text was written in a nontechnical manner to help the reader understand how topics such as distributed systems, quantitative models, user friendliness, conversational systems, Natural Language Processing, DBMS, ad hoc data query, financial planning, risk analysis, resource allocations, production planning, Expert Systems, Artificial Intelligence, Fourth Generation Lanaguages, and an assortment of other terms fit in the scheme of decision-support applications. There are no prerequisites to understanding the material, nor is any presumption made about the reader's background or experience. The content is targeted to meet the needs of a broad audience in the commercial, military, and public service sector across a wide range of professional endeavors, including:

- Business students requiring an introduction into the concept of decision support and its potential application to real world problems.
- Mid- and line-level managers responsible for coordinating the development, acquisition, and implementation of a DSS.
- Executives searching for a more quantitative approach to solving some of the more difficult problems.

This text provides a broad coverage of the field of DSS. The objective is to establish a general understanding of what a DSS is (and is not), how it is used to support decisions, and what factors contribute to a successful application. The material is designed to help the reader:

- Understand the properties that distingush a decision-support application from other automation efforts.
- Examine the various factors that comprise the decision-making environment and how they affect the required characteristics of a DSS.
- Appreciate the variety of applications where decision support is applicable and the role it plays in reaching complex decisions.
- Understand the various components of a DSS and what must be considered to satisfy a particular requirement.
- Examine the process by which a DSS is developed and implemented.
- Explore some of the pitfalls that must be avoided if the DSS is to become an effective management tool.
- Examine the quantitative and modeling aspects of decision support.
- Finally to survey some actual successful (and unsuccessful) applications and some of the currently available commercial packages.

Michael W. Davis

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1

Introduction

There was a time when managers could make it through the day without consulting their electronic guru—the computer. Today, however, few organizations can survive without the assistance of automation. The complexity of modern decisions has caused managers to become increasingly dependent on the computer's ability to quickly process large quantities of data while acting as an immense reservoir for an endless stream of information. Try to visualize a modern nationwide operation functioning without the use of automation. Imagine coordinating the complex activities of a manufacturing process that ships millions of products, along thousands of routes, from production to warehouse to customers; or a military logistics system that distributes hundreds of thousands of different supplies around the globe daily.

Since the early seventies there has been significant progress in the development of information processing systems, especially in areas where managers have to struggle with complicated decisions. A special breed of computerized systems, known as "Decision Support Systems," have evolved for the specific purpose of helping decision makers reach difficult and "messy" decisions. To understand how Decision Support Systems (DSS) differ from other automated information systems, we need to examine how computer technology, and its application to the management process, has evolved.

TECHNOLOGICAL PROGRESS

Advancements in the field of computer applications can be attributed to three movements: progress in the operational characteristics of computer hardware, improvements in the way computers and humans interact, and an increase in the variety and quantity of applications. The rate at which computer applications have grown is not just a result of these three movements alone, but also the way they stimulate and influence each other to create an "endless circle" of progress (Exhibit 1-1). This relationship will become clear as we examine the progress of computer science over the last few decades.

In the last 25 years, the operational capabilities and features of computers have grown exponentially in three areas: reduction in physical size, increase in speed and storage capacity, and a substantial decrease in cost. Improvements in these areas have occurred in three major "leaps" or stages: mainframe dominance, introduction of minicomputers, and the "micro" revolution.[1] Let us briefly compare the original dinosaurs that used "tubes" to prove digital machines possible, with today's "electronic wonders" that store millions of pieces of information (referred to as "bytes" of data) on a chip the size of your thumb [2,3,12,20].

The ENIAC developed in 1946 at the University of Pennsylvania (often considered to be the first large scale computer) and the UNIVAC I (installed in 1951 as the first commercially available computer) filled entire rooms. By the 1960s computer science had passed into a regime of practical and marketable products. The early "mainframes" were much smaller than the computers of the 1950s, and had increased their computational speed and capacity many fold. However, the cost of these systems (like the IBM 360 in 1964 and the IBM 370 in 1970) was so high (in the millions of dollars) that only the largest organizations could afford their own system. In the early 1970s a new line of minicomputer products was introduced. Mini systems (like the DEC 10/20, HP3000, PRIME, and VAX) could provide almost the equivalent capabilities of the mainframes but at a fraction of the cost (under $500,000) and a significant reduction in size.

Finally, in 1977, the microcomputer revolution was born. Although the early microsystems (APPLE, TRS, etc.) were limited in their capacity, they still signaled the beginning of a new era of automation by placing significant computational power on the desktop of the manager. In just a few years, microcomputers quickly advanced to roughly the same capacity and speed as the mini and mainframe systems of the late 1970s by providing core memory exceeding several million bytes for a cost of $4,000

[1]Because of our "here today-gone tomorrow" technology the dividing line between these three classes has become very fuzzy and continually debated. Generally speaking, there are four properties that can be used to assess which class a computer belongs to: memory capacity, speed, size, and cost. Today, however, many microcomputers possess practically the same speed and memory capacity of mainframe and minicomputers of the late 1970s. By today's changing standards, the only method that can be used to group computers into "general" classes is to use their cost and size. The following "rule of thumb" is offered for categorizing computer applications: Microsystems—Systems for under $50,000 that can be placed on a desktop and used by less than ten users (operating simultaneously); Minisystems—Computers priced at under $500,000 that service the needs of a small to moderate sized operation; Mainframe—Large scale computers costing more than $500,000 that satisfy the automation requirements of many organizations.

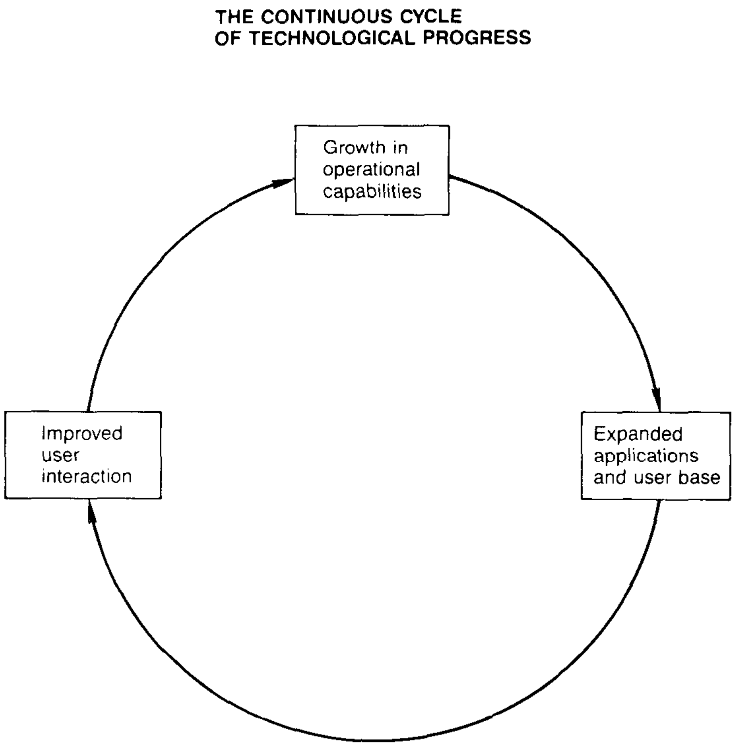

EXHIBIT 1–1 The Continuous Cycle of Technological Progress.

to $50,000. Thus, in a period of roughly 30 years, computer technology moved from a condition where a room full of million dollar hardware was required to obtain 12,000 bytes of memory (for example, the UNIVAC I) to the modern desktop microcomputers that provide two million bytes of main memory for under $10,000.

Remember that originally computers were reserved for scientific analysis and engineering design. Users, for the most part, were highly trained technical experts. Their analytical background made them more tolerant of the complicated procedures (and jargon) required to use and operate computers of that era. Subsequently, the freedom and opportunity provided by the improved generation of computers caused a significant increase in the demand for new and innovative kinds of information processing systems. Organizations soon realized the potential cost saving and productivity improvements that were possible by using computers to process the large volumes of data associated with managing their activities. However, the initial application of computers to the business world was limited to systems analysts and programmers. The operating environment was still extremely technical and confined to "batch processing," often requiring hours, or even days, to obtain results. This form of Information Processing System was still too elementary to allow direct application to the management process.

The idea soon flourished that computerized information systems could be used more effectively if the operating environment would permit use by "nontechnical" individuals and if solutions could be obtained in "real-time." Interactive systems were developed to allow each user to share the computer facility and obtain (almost) immediate results. The decreasing cost and size of computers made them more attractive and practical for a larger base of users. This, in turn, coupled with improvements in the way computers interacted with the user, resulted in a new breed of Management Information Systems (MIS) that could be more readily applied to help organizations process, store, and retrieve large quantities of data.

THE BIRTH OF DSS

For years MIS prevailed as the primary media for applying computerized systems to the management process. In areas where large amounts of information had to be accessible for easy review (financial accounting, inventory tracking, production coordination, etc.), MIS became an effective tool. However, the fixed structure of MIS applications [5,13,16,17,19] and the abundance of information that could be recalled led to another obstacle. In the more complex operational settings, managers soon became saturated by the amount of available information. A mechanism was required to somehow "cull out" or consolidate the barrage of data into a concise and readily useful form. To this end, a new MIS "offshot" appeared to allow managers to easily focus on selected sets of information germane to the particular decision. For some of the more difficult applications, analytical and mathematical procedures were merged within the MIS framework to provide managers with more quantitative and integrated results.

In the early 1970s the term "Decision Support System" (DSS) was coined for that segment of information systems primarily intended for use in supporting complex decisions. The concept was that DSS applied in situations where the decision maker was immersed in an environment of complex issues and interrelated factors at such a level that it exceeded human abilities to "weed through the chaff" and visualize the best course of action. In the years that followed, a variety of interpretations have been applied to the concept, purpose, and distinguishing properties of decision support applications ([18] surveys the various perspectives and views applied to DSS).

The evolutionary path from which today's decision support applications emerged was not a clear-cut process. Opinions as to what distinguished DSS from other automated systems was often predicated on the background of the individual making the distinction. Those specializing in the development of information systems viewed the realm of DSS with a slant toward applications that allowed the manager to interactively query large reservoirs of data and to isolate information that was of particular interest to a specific problem on an ad hoc (as needed) basis (often referred to as an "ad hoc data query"). Similarly, individuals with a financial background envisioned financial planning to be the central focus for DSS [10,15]. At the other end of the spectrum, professionals who used analytical procedures and mathematical models to analyze complex problems, began to recognize the potential for placing quantitative automated tools in the hands of the manager. By direct involvement in the decision process, the intuitive insight of the decision maker could be combined with the power of quantitative procedures. These individuals perceived that the major thrust of DSS was toward more complex and difficult problems [21]. In reality, the distinction between DSS and other automated systems

stems not from the internal procedural mechanism of the system (Data Base Management, analytical procedures, etc.), but from the purpose of the application and how it is used to help formulate decisions, analyze policies, or evaluate alternative courses of action.

The multiple evolutionary paths under which DSS has evolved is likely to have contributed to the significant confusion about the concept of DSS, what distinguishes it from other information systems, and in what areas decision support is applicable. Much of the problem can also be attributed to the rate of technological change, and the "free for all" process by which "catch" phrases became popular and misused. The tendency to misinterpret the intent of DSS also caused an initial barrier to the successful application and growth of the DSS concept. The promise of "true user friendliness" was never realized in the early systems. As a result, many of the potential users viewed the concept as another "bandwagon" fad and were put off. In recent years, however, a renewed awareness and interest in "real" DSS applications has burgeoned. Although imposters still exist, the merit of true decision support has resulted in a variety of successful efforts.

Later, we will discuss the concept and application of DSS in detail. For the moment, consider that the purpose of a DSS is to establish an integrated framework between the problem, the machine, and the decision maker. The DSS couples the speed and thoroughness of automation with the insight of human experience and, where appropriate, a proper blend of quantitative support (Exhibit 1-2). We can characterize the distinction between DSS and other information systems as:

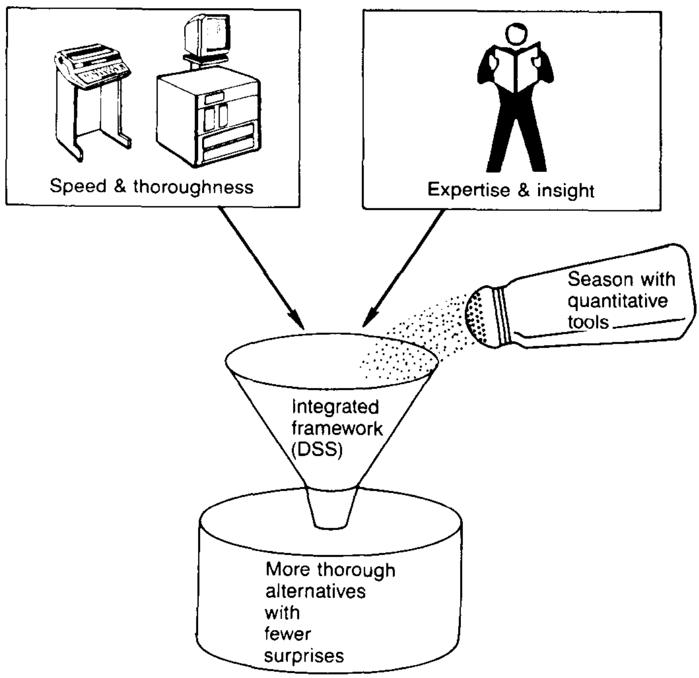

EXHIBIT 1-2 Decision Support—Providing an Integrated Framework.