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Decision Support Systems: From the Past to the Future

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ABSTRACT

Information Systems researchers and technologists have built and investigated Decision Support Systems (DSS) for almost 40 years. This article is a narrative overview of the history of Decision Support Systems (DSS) and a means of gathering more first-hand accounts about the history of DSS. Readers are asked to comment upon the stimulus narrative titled "A Brief History of Decision Support Systems" that has been read by thousands of visitors to DSSResources.COM. Also, the stimulus narrative has been reviewed by a number of key actors who created the history of DSS. The narrative is divided into four sections: The Early Years – 1964-1975; Developing DSS Theory – 1976-1982; Expanding the Scope of Decision Support – 1979-1989; and A Technology Shift – 1990-1995.

Keywords

Decision support systems, DSS, technology history.

INTRODUCTION

As an academic field of inquiry matures, it becomes important to record and document the history of the field so that new researchers develop a sense of perspective and hence benefit from the knowledge that has been accumulated. In the field of Information Systems (IS) we have reached that stage of development. This article examines the history of one major IS applications area – Decision Support Systems (DSS). It is an extension of a hypertext document at DSSResources.COM that has served as a starting point in a multi-year effort to document the history of DSS. History can be both a guide to future activity in a field of research and a record of the ideas and actions of those who have helped advance our thinking and practice. In a technology field as diverse as Decision Support Systems, history is not however simple, well documented and linear. Different people have perceived this applied technology field from various vantage points and so they have reported and often have different recollections of what happened and what was important. Some of this inevitable perceptual bias can be sorted out, but much more data gathering is necessary. The goal is to reduce the tendency to "reinvent the wheel" and to define an intellectual stream of research.

This paper reports the results of a multi-year data gathering project to develop a narrative history of DSS; it is not a literature review, a critique or a co-citation analysis (cf., Eom, 2002). The narrative is at an intermediate stage of development and this paper is part of an ongoing effort to collect more first-hand accounts associated with DSS development and research. The narrative embedded in this article titled "A Brief History of Decision Support Systems" interprets the complex mosaic of activities, ideas and interactions that were occurring in universities, software companies and in organizations as various computerized Decision Support Systems were built, used and studied from 1964 through 1995. The narrative essay tries to tell a story about a course of events that continues to impact the design of computerized DSS and the success of organizations.

The goal of this paper and project is to encourage documentation of the evolution of Decision Support Systems concepts and of actual innovative decision support system applications. The current historical materials illustrate the wide variety of decision support applications that have been implemented. This proceedings paper is intended as a precursor to a more in-depth historical perspective journal article. The "stimulus narrative" attempts to highlight significant achievements and major turning points associated with Decision Support Systems. As you read the following narrative please ask: How accurate is this version of DSS history? Do I agree with the choice of facts that was included? What facts were left out that might change the narrative or the interpretation? What facts can I add that might be helpful? How would I interpret the historical facts? How can we place this information into a more comprehensive historical context? How might my answers be different if I were from a different academic discipline or from a different culture? In general, asking these questions of people knowledgeable about the history of DSS and collecting their answers is a very important part of interpreting the "facts".

A BRIEF HISTORY OF DECISION SUPPORT SYSTEMS

Decision Support Systems (DSS) evolved early in the era of distributed computing. The history of DSS begins in 1964 and it is important to start formalizing a record of the ideas, people, systems and technologies involved in this important area of applied information technology. Today it is still possible to reconstruct the history of Decision Support Systems from first-hand accounts and unpublished materials as well as from published articles.

This hypertext paper is a starting point in documenting the origins of the various technology threads that are converging at the start of the 21st Century to provide integrated support for managers working alone, in teams and in organization hierarchies to manage organizations and make more rational decisions. This paper is a starting point for collecting more first hand accounts and for building a more complete mosaic of what was occurring in universities, at software companies and in organizations to build and use computerized Decision Support Systems.

The next few sections move from 1964 to the mid-1990s. The DSS threads related to model-oriented DSS, expert systems, multidimensional analysis, query and reporting tools, OLAP, Business Intelligence, Group DSS, and Executive Information Systems are traced and interwoven as they appear to converge and diverge over the years. The article is divided into four major sections including: The Early Years – 1964-1975; Developing Theory – 1976-1982; Expanding the Scope of Decision Support – 1979-1989; and A Technology Shift – 1990-1995.

The Early Years – 1964-1975

Prior to 1965, it was very expensive to build large-scale information systems. At about this time, the development of the IBM System 360 and other more powerful mainframe systems made it more practical and cost-effective to develop Management Information Systems (MIS) in large companies (cf., Davis, 1974). MIS focused on providing managers with structured, periodic reports. Much of the information was from accounting and transaction systems.

In the late 1960s, a new type of information system became practical – model-oriented DSS or management decision systems. Two DSS pioneers, Peter Keen and Charles Stabell, claim the concept of decision support evolved from "the theoretical studies of organizational decisionmaking done at the Carnegie Institute of Technology during the late 1950s and early '60s and the technical work on interactive computer systems, mainly carried out at the Massachusetts Institute of Technology in the 1960s (Keen and Scott Morton, 1978 preface)."

According to Sprague and Watson (1979), around 1970 business journals started to publish articles on management decision systems, strategic planning systems and decision support systems. For example, Scott Morton and colleagues published a number of decision support articles in 1968. In 1969, Ferguson and Jones discussed a computer aided decision system in the journal *Management Science*. In 1971, Michael S. Scott Morton's ground breaking book **Management Decision Systems: Computer-Based Support for Decision Making** was published. In 1966-67 Scott Morton had studied how computers and analytical models could help managers make a key decision. He conducted an experiment in which managers actually used a Management Decision System (MDS). Marketing and production managers used an MDS to coordinate production planning for laundry equipment. MDS ran on an IDI 21 inch CRT with a light pen connected using a 2400 bps modem to a pair of Univac 494 systems. Scott Morton's (1967) dissertation research was a pioneering implementation, definition and research test of a model-driven Decision Support System. Scott Morton's colleague and co-author Andrew McCosh (cf., McCosh and Scott Morton, 1978) noted in an email that the "concept of decision support systems was first articulated by Michael Scott Morton in February 1964 in a basement office in Sherman Hall, Harvard Business School".

T.P. Gerrity, Jr. focused on Decision Support Systems design issues in his 1971 *Sloan Management Review* article titled "The Design of Man-Machine Decision Systems: An Application to Portfolio Management". His system was designed to support investment managers in their daily administration of a clients' stock portfolio. Decision Support Systems for portfolio management have become very sophisticated since Gerrity began his research.

In 1974, Gordon Davis, a Professor at the University of Minnesota, published his influential text on Management Information Systems. He defined a Management Information System as "an integrated, man/machine system for providing information to support the operations, management, and decision-making functions in an organization. (p. 5)." Davis's Chapter 12 titled "Information System Support for Decision Making" and Chapter 13 titled "Information System Support for Planning and Control" created the setting for the development of a broad foundation for DSS research and practice.

By 1975, J. D. C. Little an MIT Marketing Professor was expanding the frontiers of computer-supported modeling. Little's decision support system called Brandaid was designed to support product, promotion, pricing and advertising decisions. A few years earlier, Little (1970) in an article in the journal *Management Science* had identified criteria for designing models

and systems to support management decision--making. His four criteria included: robustness, ease of control, simplicity, and completeness of relevant detail. All four of his criteria remain relevant in evaluating modern Decision Support Systems.

Two European DSS researchers, Michel Klein and Leif Methlie (1995) noted "A study of the origin of DSS has still to be written. It seems that the first DSS papers were published by PhD students or professors in business schools, who had access to the first time-sharing computer system: Project MAC at the Sloan School, the Dartmouth Time Sharing Systems at the Tuck School. In France, HEC was the first French business school to have a time-sharing system (installed in 1967), and the first DSS papers were published by professors of the School in 1970. The term SIAD ('Systèmes Interactif d'Aide à la Décision' the French term DSS) and the concept of DSS were developed independently in France, in several articles by professors of the HEC working on the SCARABEE project which started in 1969 and ended in 1974." The Dartmouth research apparently led to the dimensional model and data cubes now associated with data warehousing.

Developing DSS Theory – 1976-1982

In the mid 1970s, both practice and theory issues related to DSS were discussed at academic conferences including many American Institute for Decision Sciences (AIDS) meetings and the ACM SIGBDP Conference on Decision Support Systems in San Jose, California in January 1977. The first International Conference on Decision Support Systems was held in Atlanta, Georgia in 1981. Academic conferences provided forums for idea sharing, theory discussions and information exchange. MIT researchers including Peter Keen and Michael Scott Morton were especially influential in the DSS conferences of late 1970s. Their 1978 DSS textbook provided a broad behavioral orientation to Decision Support System analysis, design, and implementation.

In 1979, John Rockart of the Harvard Business School published an influential article on CEO data needs that stimulated development of what became known as Executive Information Systems (EISs).

In 1980, Steven Alter published his MIT doctoral dissertation results in an influential book titled **Decision Support Systems: Current Practice and Continuing Challenge**. Alter's research and papers (1975; 1977) expanded the framework for our thinking about management DSS. Also, his case studies provided a firm descriptive foundation of Decision Support System examples. A number of other MIT dissertations completed in the mid- and late 1970s also dealt with issues related to using models for decision support.

Bonczek, Holsapple, and Whinston from Purdue University created a theoretical framework for understanding the issues associated with designing knowledge-oriented Decision Support Systems. Their book (1981) and articles created a new perspective on DSS. They proposed a classification scheme for DSS and advocated developing a generalized decision support system that could manage procedural knowledge, reasoning knowledge, and information. Their "foundations" book evolved from research they began in 1974 on a computerized system to support decision makers in the area of water quality management. Holsapple's doctoral dissertation attempted to "generalize what was learned in that application".

Researchers at the University of Hawaii and IBM had been building DSS since the mid 1970s. Ralph Sprague (Univ. of Hawaii) and IBM researcher Eric Carlson's 1982 book titled **Building Effective Decision Support Systems** was an important milestone. It further explained Sprague's 1980 DSS framework of data base, model base and dialog components in DSS. Also, Sprague and Carlson's book provided a practical, understandable overview of how organizations could and should build DSS. Although their book probably created some unrealistic expectations, the problems stemmed more from the limits of the existing technologies for building DSS rather than the limits of the concepts discussed by Sprague and Carlson.

Expanding the Scope of Decision Support – 1976-1989

By the late 1970s, a number of researchers and companies had developed interactive information systems that used data and models to help managers analyze semi-structured problems. These diverse systems were all called Decision Support Systems. From those early days, it was recognized that DSS could be designed to support decision-makers at any level in an organization. DSS could support operations, financial management and strategic decision-making. DSS could use spatial data in a system like Geodata Analysis and Display System (cf., Grace, 1976), unstructured documents (cf., Swanson and Culnan, 1978) and structured multidimensional data (Nielsen Marketing Research). The term and concept of a Spatial Decision Support System (SDSS) evolved in the mid 1980's (cf., Armstrong, Densham and Rushton, 1986). By 1980 a wide variety of quantitative models and techniques were being used in DSS including optimization and simulation (cf., Bonczek, Holsapple, and Whinston, 1981). In 1982 a group of researchers left Xerox PARC and founded Metaphor Computer Systems to build DSS products. Also, some developers began using statistical software packages and Artificial Intelligence technologies as tools for building DSS and management expert systems.

In the early 1980s financial planning systems became popular decision support tools. The idea was to create a "language" that would "allow executives to build models without intermediaries (Gray, 1987, p. 3)". The most popular financial planning system was called IFPS, an acronym for Interactive Financial Planning System. The IFPS software was developed initially as a time-sharing application in about 1976 by Gerald Wagner and Mike McCants, a student of his at the University of Texas (see Power, 2004). Wagner's company, EXECUCOM Systems, marketed IFPS until the mid-1990s. Wagner sold the company in 1984. One major advantage that a planning language has over a spreadsheet is that the model is written using natural language so it is easier to understand and the model can be separated from the data. In the early 1980s, some financial analysts however started using spreadsheet software like Visicalc and then Lotus 1-2-3 for building model-driven financial DSS. Also, in the early 1980s, Humphries, Foreman, and others programmed decision support development software based upon decision analysis models and the Analytical Hierarchy Process (AHP). In a 1988 paper, Sharda, Barr, and McDonnell reviewed the first 15 years of DSS research. They concluded that research related to using models and especially financial planning systems for decision support was encouraging but certainly not uniformly positive.

Another application stream emerged in the 1980s. Academic researchers developed a new category of software to support group decision-making (cf., Gray, 1981; Huber, 1982; Turoff and Hiltz, 1982). Early group DSS were developed at Southern Methodist University, Execucom Systems, the University of Arizona and at the University of Minnesota. Dickson, Poole and DeSanctis (1992) report that Brent Gallup, a Ph.D. student at Minnesota, decided in 1984 "to program his own small GDSS system in BASIC and run it on his university's VAX computer". That system was the beginning of the Minnesota GDSS studies using what was called the SAMM system.

Jay Nunamaker from the University of Arizona and his colleagues wrote in 1992 that "The underlying concept for GroupSystems had its beginning in 1965 with the development of Problem Statement Language/Problem Statement Analyzer (PSL/PSA) as part of the ISDOS (Information System Design and Optimization System) project at Case Institute of Technology (p. 144)". In 1984, a system called PLEXSYS was completed and a computer-assisted group meeting facility was constructed at the University of Arizona. The first facility, called the PlexCenter, housed a large U-shaped conference table with 16 computer workstations. PLEXSYS provided the foundation for the development of the University of Arizona GroupSystems software. Since the mid-1980s, many research studies have examined the impacts and consequences of Group DSS. Also, a number of companies have commercialized Group DSS and groupware.

Executive Information Systems (EIS) evolved from single user model-driven Decision Support systems and improved relational database products. The first EIS used pre-defined information screens and were maintained by analysts for senior executives. For example, in fall of 1978, development of an EIS called Management Information and Decision Support (MIDS) system began at Lockheed-Georgia (cf., Houdeshel and Watson, 1987). In an influential 1982 *Harvard Business Review* article, John Rockart and Michael Treacy described how executives were using EIS in their firms. Nigel Pendse (1997) claims the first Executive Information System product was Pilot Software's Command Center. He notes both multidimensional analysis and OLAP had origins in the APL programming language and in systems like Express and Comshare's System W.

Nylund (1999) traces the developments associated with Business Intelligence (BI) to Procter & Gamble's efforts in 1985 to build a DSS that linked sales information and retail scanner data. Metaphor Computer Systems, a spinoff of researchers from Xerox's Palo Alto Research Center (PARC), built the early P&G DSS. Metaphor alumni latter founded many of the Business Intelligence (BI) vendors: for example, Richard Tanler founded Information Advantage and Katherine Glassey co-founded Brio Technologies. The term BI is a popularized, umbrella term supposedly introduced by Howard Dresner of the Gartner Group in 1989. Business Intelligence describes a set of concepts and methods to improve business decision making by using fact-based support systems. BI is sometimes used interchangeably with briefing books, report and query tools and Executive Information Systems. Business Intelligence systems are intended to serve as management decision support systems.

The journal Decision Support Systems was started in 1985 and the International Society for Decision Support Systems (ISDSS) was founded in 1989.

A Technology Shift – 1990-1995

In the early 1990s, a major technology shift occurred from mainframe-based DSS to client/server-based DSS. Also, some desktop On-Line Analytical Processing (OLAP) tools to support decision making were introduced during this time period. Also, beginning in about 1990, data warehousing and OLAP began broadening the scope of what was possible for BI and EIS and led to a broader category of Data-Driven DSS (cf., Dhar and Stein, 1997). Bill Inmon and Ralph Kimball began actively promoting DSS built using relational database technologies. For many MIS practioners, DSS built using Oracle or DB2 were the only decision support systems they were familiar with from the popular computing literature. Model-oriented DSS were in the domain of operations research and were rarely part of the domain of an Information Systems department. In 1994,

Ralph Kimball was the "Doctor of DSS" and Bill Inmon was the "Father of the data warehouse". Inmon defined a decision support system (DSS) as "a system used to support managerial decisions. Usually DSS involves the analysis of many units of data in a heuristic fashion. As a rule, DSS processing does not involve the update of data (cf., billinmon.com)." Inmon and Kimball focused on building data-driven DSS.

Starting in about 1993, some vendors started recommending object-oriented technology for building "re-usable" decision support capabilities. This trend was slow to impact DSS implementations. In 1994, many companies started to upgrade their network infrastructures. According to Powell (2001), in about 1994 DBMS vendors "recognized that decision support was different from OLTP and started implementing real OLAP capabilities into their databases". Professor Paul Gray (cf., Gray and Watson, 1998) asserts that around 1993 the data warehouse and the EIS people found one another and the two niche technologies have been converging. In 1995, data warehousing and the World Wide Web began to impact practitioners and a few academics interested in decision support technologies. Web-based and web-enabled DSS became feasible in about 1995 (cf., Power, 2000; Bhargava and Power, 2001). The year 1995 marks a major shift in the techbnologies and possibilities for building computerized decision support systems.

CONCLUSION

The history of Decision Support Systems covers a relatively brief span of years and the concepts and technologies are still evolving. Yet much has occurred that remains very relevant, timely and important. Today it is possible to reconstruct the history of Decision Support Systems (DSS) based upon retrospective accounts from key participants as well as from published and unpublished materials. This opportunity to enhance our understanding should not be lost or neglected. Many of the early innovators and early developers are retiring or have developed other research interests, but their insights and actions can be recorded to guide future innovation in the DSS field. It is the desire of the author that this paper results in more email and retrospective accounts that can help all of us understand the "real" history of DSS. The Internet and Web have speeded-up developments in Decision Support Systems and have provided a new means of capturing and documenting the development of knowledge in this research area. The history of DSS is about exploiting technology change, grappling with "tough" problems, and dealing with marketing "fads", "hype" and extravagent expectations. DSS history also shows the leadership of academic researchers in developing innovative applications, the synergies between practice and research, and the struggles of practitioners to inform and innovate with the hope of improving decision making.

Decision Support Systems pioneers came from a wide variety of backgrounds and faced many challenges that they successfully overcame to demonstrate the value of using computers, information technologies and specific decision support software to enhance and in some situations improve decision making. The DSS pioneers created particular and distinct streams of technology development and research that serve as the foundation for much of today's interest in building and studying computerized decision support systems. The legacy of the pioneers must be preserved.

ACKNOWLEDGMENTS

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