Chapter 2
Reflections on the Past and Future of Decision Support Systems: Perspective of Eleven Pioneers

Daniel J. Power[1], Frada Burstein[2], and Ramesh Sharda[3]

[1] Department of Management, University of Northern Iowa, Cedar Falls, IA 50614-0125, USA, daniel.power@uni.edu
[2] Centre for Organisational and Social Informatics, Monash University, Caulfield East, VIC 3145, Australia, frada.burstein@infotech.monash.edu.au
[3] Department of Management Science and Information Systems, Oklahoma State University, William S. Spears School of Business, Stillwater, OK 74078, USA, ramesh.sharda@okstate.edu

2.1 Introduction

Periodically members of a research discipline need to examine and reflect upon past accomplishments. Too often we focus on the most recent research on a topic and neglect the origins of a research stream. Examining prior accomplishments and developments in the field of Decision Support Systems can help assess the present state of progress in meeting research and practical needs and can help determine unmet expectations and chart future research directions.

Today Decision Support Systems is a broad area of research and practice. According to DSSResources.com, a "Decision Support System (DSS)" is an interactive computer-based system or subsystem intended to help decision makers use communications technologies, data, documents, knowledge and/or models to identify and solve problems, complete decision process tasks, and make decisions. Decision Support System is a general term for any computer application that enhances a person or group's ability to make decisions. Also, Decision Support Systems refers to an academic field of research that involves designing and studying DSS in their context of use. In general, DSS are a class of computerized information systems that support decision-making activities. Five more specific Decision Support System types include: (1) communications-driven DSS, (2) data-driven DSS, (3) document-driven DSS, (4) knowledge-driven DSS, and (5) model-driven DSS (Power, 2002). Historically, DSS were associated with managerial, long-term, strategic decision-making (Alter, 1980). However, the wide availability of computing resources and increased level of sophistication of DSS users encourage further advancements in research and development of new tools which enhance users' effectiveness in making complex decisions as well as getting access to better information about available decision alternatives.

D. Schuff et al. (eds.), *Decision Support*, Annals of Information Systems 14,
DOI 10.1007/978-1-4419-6181-5_2,

This chapter provides an overview of the field of DSS, its history and a progress report on an ongoing research project to explore the perceptions of selected DSS researchers, who made significant contribution to this field. This chapter comprises analysis of the reflections on the pioneering efforts of these academics and technology entrepreneurs to meet decision support needs using information technologies.

The next section discusses the major milestones, accomplishments and the timeline of DSS research. The third section describes the research project to gather reflections of decision support pioneers and map a trajectory of development of a DSS field using these reflections as a lens. The fourth section reviews the observations of eleven DSS pioneers from their experiences with computerized DSS. The reflections of eleven DSS pioneers are reported, including: James F. Courtney, Paul Gray, Clyde W. Holsapple, George P. Huber, William H. Inmon, Frank F. Land, Andrew M. McCosh, Michael S. Scott Morton, Gerald R. Wagner, Hugh J. Watson and Andrew Whinston. This section also examines issues associated with decision support that the pioneers believe to be still unresolved. The final section is our conclusions about 60 years of DSS research and some recommendations for future research directions.

2.2 DSS Research and Development Timeline

Computerized decision support systems have been in use for almost 60 years. One can trace the origins of DSS to 1951 and the Lyons Tea Shops business use of the LEO I (Lyons Electronic Office) digital computer. Decision support software factored in the weather forecast to help determine the goods carried by "fresh produce" delivery vans (Caminer, 1997; Power, 2007). One of LEO I's early tasks was the capture of daily orders that were phoned in every afternoon by the tea shop staff and used to calculate overnight production requirements, assembly instructions, delivery schedules, invoices, costings and management reports. Both David Caminer and Frank Land, London School of Economics, worked on the LEO I project. Caminer became Director of LEO Computers Ltd in 1959. The SAGE (Semi-Automatic Ground Environment) air defense system for North America built for the U.S. military in the late 1950s and completed in 1962 was another first generation decision support application. It was probably the first computerized real-time, data-driven DSS (Power, 2007).

The management decision system built by Michael Scott Morton in 1966 for his Harvard dissertation started efforts to build model-driven decision support applications with second generation computing technology (cf., Scott Morton and Stephens, 1968; Scott Morton, 1971). Scott Morton studied how computers and analytical models could help managers make a recurring key business planning decision. He conducted an experiment in which managers actually used a Management Decision System (MDS). Marketing and production managers used

the MDS to coordinate production planning for laundry equipment. The MDS ran on an IDI 21 in. CRT with a light pen connected using a 2,400 bps modem to a pair of Univac 494 systems. The term decision support system was first used in Gorry and Scott Morton's (1971) Sloan Management Review article. They argued that Management Information Systems primarily focused on structured decisions and suggested that information systems for supporting semi-structured and unstructured decisions should be termed "Decision Support Systems". Scott Morton and McCosh (1968) described a number of DSS related projects which they collaborated on. By 1970 a number of computing journals started publishing papers on systems supporting better decisions (Sprague and Watson, 1979; Rinehart, 2006).

In general, a model-driven DSS emphasizes access to and manipulation of financial, optimization or simulation models. The core of these is quite often based on simple quantitative models and they provide the most elementary level of functionality. Model-driven DSS use limited data and parameters provided by decision makers to aid them in analyzing a problem situation (Power, 2002). Early versions of model-driven DSS were called "model-oriented DSS" by Alter (1980), computationally-oriented DSS by Bonczek et al. (1981) and later spreadsheet-oriented and solver-oriented DSS by Holsapple and Whinston (1996). The first commercial tool for building model-driven DSS using financial and quantitative models was called IFPS, an acronym for interactive financial planning system (Gray, 1983). It was developed in the late 1970s by Gerald R. Wagner and his students at the University of Texas. Wagner's company, EXECUCOM Systems, marketed IFPS until the mid 1990s. Paul Gray's Guide to IFPS (1983) promoted the use of the system in business schools.

Data-driven DSS emphasizes access to and manipulation of a time-series of internal company data and sometimes external and real-time data. Simple file systems accessed by query and retrieval tools provide the most elementary level of functionality. Data warehouse systems that allow the manipulation of data by computerized tools tailored to a specific task and setting or by more general tools and operators provide additional functionality. Data-driven DSS with On-line Analytical Processing (cf., Codd et al., 1993) provide the highest level of functionality and decision support that is linked to analysis of large collections of historical data. Executive Information Systems are examples of data-driven DSS (Power, 2002). Initial examples of these systems were called data-oriented DSS and analysis information systems (Alter, 1980) and retrieval-only systems by Bonczek et al. (1981).

One of the first data-driven DSS was built using an APL-based software package called AAIMS, An Analytical Information Management System. It was developed from 1970 to 1974 by Richard Klaas and Charles Weiss at American Airlines (cf. Alter, 1980). In 1979 John Rockart's research stimulated the development of executive information systems (EIS) and executive support systems (ESS). In the late 1970s, Courtney and Jensen developed and used SLIM, System Laboratory for Information Management data management system for teaching DSS. These systems evolved from single user model-driven decision support systems and

from the development of relational database products. The first EIS used predefined information screens maintained by analysts for senior executives. In the Fall of 1978, Lockheed-Georgia began development of an EIS called Management Information and Decision Support, called MID (cf., Houdeshel and Watson, 1987). For many years Hugh Watson was an active proponent of EIS (cf., Watson et al., 1997).

Using computer-based communication for decision support had its origins in the early 1960s. Douglas Engelbart's, 1962 paper "Augmenting Human Intellect: A Conceptual Framework" is the anchor for much of the later work related to communications-driven DSS. In 1969, he demonstrated the first hypermedia/groupware system NLS (oNLine System) at the Fall Joint Computer Conference in San Francisco (Engelbart, 1962). Engelbart invented both the computer mouse and groupware. Murray Turoff's (1970) article introduced the concept of Computerized Conferencing. He developed and implemented the first Computer Mediated Communications System (EMISARI) tailored to facilitate group communications.

In the early 1980s, academic researchers developed a new category of software to support group decision-making called Group Decision Support Systems abbreviated GDSS (cf., Gray, 1981; 2008; Huber, 1982; Turoff and Hiltz, 1982). Mindsight from Execucom Systems, GroupSystems developed at the University of Arizona and the SAMM system developed by University of Minnesota researchers (DeSanctis and Gallupe, 1987) were early Group DSS.

The precursor for document-driven DSS is Vannevar Bush's (1945) article titled "As We May Think". Bush wrote "Consider a future device for individual use, which is a sort of mechanized private file and library. It needs a name, and to coin one at random, 'memex' will do". Bush's memex is a much broader vision than that of today's document-driven DSS. Text and document management emerged in the 1970s and 1980s as an important, widely used computerized means for representing and processing pieces of text (Holsapple and Whinston, 1996). A pioneering scholarly article for this category of DSS was written by Swanson and Culnan (1978). They reviewed document-based systems for management planning and control. Until the mid-1990s little progress was made in helping managers find documents to support their decision making.

In the early, 1990s, Bill Inmon and Ralph Kimball actively promoted decision support systems built using relational database technologies. For many Information Systems practitioners, DSS built using Oracle or DB2 were the first decision support systems they read about in the popular computing literature. Ralph Kimball was known as "The Doctor of DSS" and Bill Inmon was the "father of the data warehouse" (Inmon, 1990; Kimball, 1994).

Finally, Bonczek et al. (1981) book created interest in using technologies for creating knowledge-driven DSS. In 1983, Dustin Huntington established a company called EXSYS (www.exsys.com). That company and product made it practical to use PC based tools to develop expert systems and knowledge-driven DSS. These systems were called suggestion DSS by Alter (1980).

The roots of modern decision support research extend to practical applications, theoretical contributions and empirical studies. Early DSS projects emphasized important tasks like production planning and forecasting, monitoring current operations, and monitoring hostile activities to increase national security. The DSSResources.COM resource created and maintained by Dan Power contains a comprehensive entry about the history of DSS (see Power, 2007).

In 2007, DSSResources.com started a feature called "Reflections of Decision Support Pioneers" and posted an initial reflections interview with Paul Gray. The aim of this effort was to document the reflections of the people, who were visionary enough to predict the value of using new technologies in helping people to make better decisions and who started development of the theories and methods in this respect, which laid the ground for the discipline of decision support systems. In the next section we describe the history of the project, its instrument and provide analysis of some data it collected to help identify the future directions for decision support research and practice.

2.3 Reflections on Decision Support Pioneers – Research Project

The initial Decision Support Pioneers page with photos and short biographical sketches was posted at DSSResources.com on September 29, 2006. The URL is http://dssresources.com/history/pioneers/pioneerslist.html. DSS pioneers are being defined and approached based on major intellectual contributions to our understanding of how, what, why, and when computing, information technologies and software are and should be used to aid, assist, support and even replace people in decision making activities, processes, and tasks.

Who are pioneers? Pioneers are those who are brave enough to move forward to the unknown. Pioneers break new intellectual ground and open new areas for research. In this context, it was assumed that DSS pioneers may have written or co-authored a seminal theoretical book or article. Alternatively, the person led a ground-breaking technology implementation. In some cases, a pioneer completed a research study that started an important stream of research. In general, those people on the list made an ongoing and sustained contribution that significantly advanced the field of computerized decision support. A common characteristic of all of the pioneers is that they dealt with new ideas. The review of the history of DSS presented in the previous section referred to many of the researchers and practitioners who justifiably belong to this category based on their contribution to the DSS filed.

People were selected as pioneers based on: (1) perception of experts about who proposed influential new ideas, (2) nominations, (3) literature review, and (4) citations analysis. Based on these criteria 37 individuals are currently included on the DSSResources.com DSS Pioneers page. A number of the pioneers of DSS research and practice have died and many have reached advanced age. We recognize the

many contributions of Robert H. Bonczek (April 17, 1951–June 7, 1985), David T. Caminer (June 26, 1915–June 19, 2008), Edgar F. Codd (August 23, 1923–April 18, 2003), George B. Dantzig (November 8, 1914–May 13, 2005), Gerardine Desanctis (January 5, 1954–August 16, 2005), Oleg I. Larichev (September 20, 1934–January 19, 2003) and Herbert A. Simon (June 15, 1916–February 9, 2001).

The goal of the Decision Support Pioneers page is to recognize those individuals who made major contributions to the study and practice of using computers to support decision making. These influential people developed this applied research area and demonstrated how information technology could be used to support decision making. Identifying these individuals and capturing their perspective helps place the study and practice of building DSS in a historical context.

The DSS pioneers have been asked a common set of questions. The idea is to have everyone associated with innovation in decision support research and technologies respond to the same six questions. The questions include:

- *Q1:* How did you get interested in computerized decision support?
- *Q2:* What do you consider your major contribution to helping support decision makers using computers? Why?
- *Q3:* What were your motivations for working in this area?
- *Q4:* Who were your important collaborators and what was their contribution?
- *Q5:* What are your major conclusions from your experiences with computerized decision support?
- *Q6:* What are the issues associated with decision support that we still need to address?

The pioneers included in this chapter are a highly representative sample of senior DSS scholars from a longer list. In this chapter we report on analysis of the reflections of pioneers focusing mainly on the last two questions. The reflections capture the past and help guide the future of computerized decision support.

2.4 Reflections of DSS Pioneers

This section includes the reflections on the last two questions of James F. Courtney, Paul Gray, Clyde W. Holsapple, George P. Huber, William H. Inmon, Frank F. Land, Andrew M. McCosh, Michael S. Scott Morton, Gerald R. Wagner, Hugh J. Watson and Andrew Whinston. These eleven pioneers had answered our questions prior to June 2010. The two questions addressed in this chapter are useful for the purpose of the chapter of reflecting on the past of DSS history and identifying future directions, thus the questions selected were: “What are major conclusions from experiences with computerized DSS?” and “What are the issues associated with decision support that we still need to address?” The complete transcripts of the interviews are available on the World Wide Web at http://dssresources.com/reflections/index.html.

2.4.1 Major Conclusions from Experiences with Computerized DSS

In the late 1960s, Michael Scott Morton and Andrew McCosh initiated business and management research on Decision Support Systems. They and their colleagues at Harvard and MIT initiated a long stream of research related to model-driven decision support. Both received their DBAs at Harvard. Scott Morton's dissertation completed in 1967 was the first systematic study of a computerized management decision system.

Scott Morton identified two major conclusions from his experience. "First is how slow we humans are to change our routines and organizations, despite evidence there are better ways of doing things. Secondly, I am increasingly struck by the relatively ineffective link between business schools/business research and the realization of better ways of doing things in the 'real' world we all live and work in. It takes a very long time for good ideas (in all fields, not just computers and management) to be adopted and to have an impact on our performance." Scott Morton explained "the American automobile industry is a case in point. . .. DSS is similar, the ideas and concepts were developing in the early 1970s, and the technology became widely available at reasonable cost in the 1980s and in 2008 they are rarely used effectively. When they are, there are huge beneficial impacts; indeed some firms could not exist without them."

McCosh concluded "the most important feature of a DSS is to make sure it is flexible and understood by the company executive who has to use it. If the designer tries to make the whole thing operational in one go, he will almost certainly lose his audience. The exec will get lost. He needs to have a huge role in the design and layouts. If you do not ensure he has big role in development, the model will probably be binned in a few years." Both McCosh and Scott Morton remain optimistic about the need for and effectiveness of DSS.

Frank Land worked with David Caminer at Lyons & Co. on a DSS application for the Leo I computer in the 1950s and went on to teach Information Systems and DSS at London School of Economics. He concluded "The best DSS are those which provide clear explanations of the rationale behind the alternatives offered up for consideration and permit the decision makers to explore the decision space and to bring to the surface underlying assumptions and hidden conflicts. But to make the process work it needs a facilitator with an understanding of group behavior as well as of the way the DSS is constructed."

He noted DSS "at their best, when designed jointly with the decision makers, they can be highly successful." But he had some cautions for DSS builders, "A DSS which is simply parachuted into the decision situation has little chance of being adopted. Ideally the DSS is the outcome of collaboration between the decision makers and systems designers. The way the DSS is deployed is highly dependent on the working style of individual or group decision makers."

Hugh Watson and Ralph Sprague extended the theoretical boundaries of DSS in the 1970s and 1980s. Watson especially examined Executive Information Systems and data-driven DSS. Watson noted in his response to the interview question

"A couple of conclusions come to mind. First, almost everything that is touted as 'new' has significant antecedents. For example, dashboards and scorecards are currently the rage. But if you are familiar the history of decision support, you know that the idea of using performance metrics to monitor what is taking place and to motivate workers is an old idea that dates back to critical success factors in the 1970s and executive information systems in the 1980s. The technology may be new and vendors may hype the ideas as new, but the basic concepts have typically been around for quite a while."

Watson continued, "The greatest days for decision support are still ahead. To date, decision support has not been an integral part of the running of most companies. Most decision support has involved analysts analyzing data and passing the findings on to others. We are starting to see decision support become more pervasive and integrated into business processes and how companies are run. Examples of this include event triggers and alerts that inform organizational personnel through a variety of digital channels about recent developments, business activity monitoring that monitors current operations, and rules engines that automate or support operational decision making. Many of the most exciting developments are due to the availability of real-time data through real-time data warehousing, enterprise application integration (EAI), and enterprise information integration (EII). It isn't a coincidence that leading software vendors such as Microsoft, Oracle, and SAP have recently made significant investments in decision support."

Bill Inmon was also a major proponent of data-driven DSS. Inmon is generally recognized as the "father of the data warehouse" and co-creator of the "Corporate Information Factory. His work on concepts related to data warehouses began with a 1983 Computerworld article, "What Price Relational?" He stated bluntly "Computerized DSS is in its infancy. There are so many possibilities that our grandchildren will look back on us and wonder about how naïve and unsophisticated we were."

Clyde Holsapple and Andrew Whinston have made many contributions to the DSS literature and field. Whinston has edited the major journal in the field for many years and he continues his search for major conclusions and promotes research in the discipline. Holsapple is a prolific author and researcher. He noted "From a practical standpoint, decision support systems have become so widespread in use as to be almost invisible – supporting decisions of consumers, managers, groups, enterprises, and inter-organizational systems such as supply chains." He observed, "many vendors have been quite successful in developing and marketing DSS software and services – with recent major consolidation in this sector indicating DSS importance to strategies of such firms as IBM, Oracle, and SAP." He concluded "From a scholarly standpoint, we see that the DSS field has become a major expansion of the IS discipline, going well beyond its important predecessors of data processing and management information systems, becoming heavily interrelated with newer IS expansions such as organizational computing, electronic commerce, and pervasive computing. Advances in the DSS area have had major impacts on the productivity, agility, innovativeness, and reputation of decision processes and their outcomes. Continuing advances will extend impacts in these directions."

Jim Courtney worked with both data-driven and group DSS. He concluded, "First, everything is connected with everything else, at least in-so-far-as important problems are concerned. Global warming is a clear example of that. You need to try to uncover hidden assumptions and different perspectives that various parties have in making important decisions. You need to define problems as broadly as feasible and include stakeholders affected by the problem in the decision-making process. You must be especially careful in formulating problems, as getting the problem right is critical to solving it. A good solution to the wrong problem may actually make it worse."

"My answers" states Paul Gray, a leader in both GDSS and data-driven DSS research, "reflect where I think we are today."

1. Group decision support systems, under that name, is an idea which has come and, sad to say, has gone. Although there are still vendors such as Groupsystems in Colorado and they have a users group, the concept has not had legs under the GDSS name. That doesn't mean that the many methods, studies, and experiments did not have an effect. They did. What we now have is many uses and extensions, including for example, distributed GDSS.
2. New fields (such as business intelligence, competitive intelligence, knowledge management) came on the scene and are beholden to the findings of the over 40 years of history of the field. Technological inventions, such as the data warehouse and the data mart, also contributed.
3. Many original concepts, however, have been superseded. We started out in management science and computer science and the techniques of these fields were pervasive in its beginnings. We have moved past the elitist view that managers would be able to use Iverson notation (i.e., APL) and the populist view that all managers could do is look at chart books to a much more nuanced and user friendly vision.
4. Some early frameworks (e.g., Alter's taxonomy, Power's, Sprague and Carlson's) have proved durable and highly useful.
5. Although data-driven DSS is still the dominant paradigm, we are starting to see analytics coming back to the forefront as witnessed by Tom Davenport and Jeanne Harris's book *Competing on Analytics* published in March 2007 by Harvard Business School Press.

Group DSS theorist George Huber stated "My experiences with computerized decision support didn't cause me to reach any major conclusions, except to concur with the common belief that DSS greatly increased decision quality and timeliness."

Finally, entrepreneur and academic Gerald Wagner, affirmed "DSS, as I prefer to believe it should be defined, had a short life. It lasted until about 1984 when Executive Information Systems came along. EIS had an emphasis on historical data vs. assumptions about the future. Since then we have been pre-occupied with looking backwards rather than forward. I believe the value of DSS is to 'rehearse the future' using Peter Keen's words. The value is not in endless volumes of historical data. Now Business Intelligence is dominant and it is also not about rehearsing the

future, i.e., it is about looking backward to what has already happened." Wagner continues his efforts to develop financial planning decision support tools to help managers envision the future.

These pioneers have had extensive experience with DSS research, development, implementation, evaluation and commercialization. Their divergent views on their experiences reflect these diverse backgrounds. Whereas Whinston is still searching for final conclusions, many others had strong views on issues related to DSS. Some consider technologies such as model-driven DSS and GDSS to be now past their prime. Many of the pioneers recognize the role of DSS related executive information systems and the popular term business intelligence. They all appear to be still enthusiastic about the prospects and potential of computerized decision support systems.

2.4.2 Continuing Issues Associated with Decision Support

Courtney stated "I think we need to broaden our view of decision making. Mitroff and Linstone would consider our view the technical one, I believe. We need to also be concerned with other individual perspectives, organizational perspectives, ethical issues and even aesthetics in our work. We need to be cognizant of social and cultural issues to the extent that we can to try to avoid some of the mistakes of the past. I believe we really need to think holistically in an age when our technology is having such a vast impact on the planet and all its creatures. I am discouraged that so much IS research is reductionist and that is what the leading journals tend to emphasize. There is also a great deal of emphasis on theory development, but the theories that we have seem quite shallow and don't explain very much."

Six issues were identified as most important by Paul Gray:

1. Increasing the level and breadth of innovation
2. Knowledge transfer from academia to practice, both at the firm and at the vendor level
3. Knowledge transfer to academia from practice (I think we keep up with the vendors)
4. Improving the technical and social science capabilities of academics so that they can explore areas that they now do not touch
5. Getting students interested in DSS. The number of courses being offered at graduate and undergraduate levels seems stagnant
6. Multidisciplinarity. DSS is a multidisciplinary field. Multidisciplinarity would be helped by better interaction between DSS people (who are mostly in business schools) with decision analysts and other people in business schools who study decision making, with computer science, and with psychology and other social science fields

Clyde Holsapple emphasized "One of the issues for which there is a particular opportunity to have a major impact is to better understand the relationship between DSS features and usage on the one hand and decision-maker competitiveness and

performance on the other. From a completely different perspective, there is the issue of how research on decision support systems is regarded within the IS field. All too often, it is treated as a side show, rather than a key component at the heart of IS research. All too often, IS researchers who apparently are not very familiar with the DSS area miss opportunities to enhance their research by recognizing its potential for connections to DSSs." Holsapple argued there is a need for other IS researchers "to greatly improve the depth of their familiarity with the DSS research literature – for enriching their own research and for improving their capabilities as reviewers of DSS-related manuscripts."

Finally, Holsapple concluded "one last issue important for continuing development of the DSS field concerns the attitudes of those who perform and evaluate research. So far, the field has tended to benefit from an inclusive attitude that welcomes innovation, recognizes the applicability of diverse methodologies, and is open to provocative/stimulating work. . .. It is important for DSS researchers not to fall into such a predicament, but to press onward with a pioneering attitude that makes forays into the intellectual wilderness – in efforts to see, understand, and map out new DSS possibilities – rather than incrementally treading along well-worn paths of conformance."

Inmon said there is a long list. "But some of the items include:

- the politics of DSS
- unstructured data and DSS
- metadata and DSS
- business metadata
- non numerical visualization"

"Note the importance of keeping the logic in line with changing conditions in a turbulent world" asserts Frank Land. "Too often decision makers, not fully understanding the underlying logic, rely on a model embedded in the DSS which has ceased to reflect the changed world. Designers, on the other hand, often do not ensure the mechanisms are provided for the rapid and easy updating of the models underlying the DSS."

He argues "The importance of informal systems and their role in decision making is often neglected by systems designers. However, developments in the use of the internet such as Web 2.0 and the ideas behind the open source movement are permitting the informal to infiltrate computer based systems."

Land states "Perhaps most importantly we need to further improve our understanding of how decisions are made and the role played by non-instrumental issues such 'office' politics, human relations and intelligence."

McCosh thinks "we need to spend more time on decision analysis and decision definition than has been the case in recent work I have seen at conferences."

"The general unresolved issue," according to Scott Morton is "understanding the management of change." Without a better understanding of this it is hard to implement and learn from DSS applications. As an engineer trained in the technology it took me a while to understand that the hard problems lie in the "soft" domains of management and of human behavior, not in the hardware and software.

More particularly, there is the still poorly understood shifting boundary between what computers can do well and what humans can do well. This has major implications for the relevant application set for DSS and therefore their successful use in organizations.

Wagner sees the major issue of DSS as "Getting back to its origins and helping decision makers to see alternative futures. Start teaching modeling and logical thinking again. Professors have lost sight of that. Today they teach Excel which is an electronic calculator and not a modeling tool. We are lacking in innovation in terms of the primary focus of rehearsing the future. Data visualization has great promise but there also we are lacking innovation. We have faster, sexier, and prettier charts but they are the same old line and bar charts. There are complicated 3-D and the like but real people can't understand those. The need is for new metaphors for visualizing business data that are intuitive and easily understood by real people."

A major issue according to Hugh Watson, "is to make decision support easier to use and more accessible to everyone. This issue was recognized back in the 1970s when "easy to use" was a defining characteristic of DSS. … In general, decision support applications have become easier to use but additional progress is still needed. For example, we have made strides with visual displays of data and data visualization but they pale in comparison to the video games that the future captains of industry play. A graph that shows actual versus budgeted cash flow does not have the same impact as a screen that shows a growing pile of dollars and audio sounds that indicate whether cash flow is meeting expectations. Google has changed our expectations for how we should be able to locate information. We should be able to "Google" any kind of decision-related information and tool. In most organizations, structured and unstructured data exist in separate silos. Users want to be able to easily access both kinds of data seamlessly. For example, a product manager who uses quantitative data and sees that an ad campaign did not generate the anticipated lift might want to see the video clips of the ads that were run. We also need to make it easier for work teams to use decision support tools collaboratively."

Finally, Andrew Whinston succinctly addresses our challenge. "The world is changing so rapidly that it is hard to predict what should be the next focus. It is driven by constant advances in technology and what people are able to get access to."

Table 2.1 provides a summary of thematic analysis of the pioneers' comments along seven dimensions. Not all pioneers addressed each of the dimensions, but the summary highlights key themes. Comments from the pioneers offer several ideas for continuing research needed related to DSS. They note the need for taking a holistic view, considering organizational, cultural and other issues. They also argue for a greater recognition of DSS research in the IS field, and lament the fact that DSS research seems to have virtually disappeared from leading IS journals. The pioneers argue that we need to continue recognizing the multidisciplinary nature of the DSS field.

Table 2.1 Thematic analysis of pioneers' comments

Author/themes	Complexity of context	Sources of inspiration	Opportunistic view on technologies and theories	Future directions and challenges	Experience from the past	Importance of keeping "the big picture"	Relevance
Courtney	Everything is connected with everything else, at least in-so-far-as important problems are concerned			• Cognizant of social and cultural issues • Need to focus on individual and organizational perspectives, ethical issues and aesthetics	Avoid being driven by academic, rather than practical imperatives	• "Need to try to uncover hidden assumptions and different perspectives" • Current theories tend to be oversimplifying the complexity	Be especially careful in formulating problems. A good solution to the wrong problem may actually make it worse
Gray		Started out in management science and computer science and the techniques of these fields were pervasive in its beginnings	Innovation has to be the focus	• Data-driven DSS is still dominant paradigm; analytics coming back to the forefront • Focus on better DSS education and training	• GDSS learning is still current • New fields (such as business intelligence, competitive intelligence, knowledge management) build on past research	• The need for multidisci-plinary approach • Better skills training to support such needs	• Moved past the elitist view. . . [to] the populist view. . . and user friendly vision • Knowledge transfer between academia and practice is still an issue

Table 2.1 (continued)

Author/themes	Complexity of context	Sources of inspiration	Opportunistic view on technologies and theories	Future directions and challenges	Experience from the past	Importance of keeping "the big picture"	Relevance
Holsapple		Some ground breaking theories from management science still relevant for future theoretical advancement	• New theories still to be discovered • Widespread in use and almost invisible, part of a bigger picture	Major impacts on productivity, agility, innovativeness, and reputation as part of organisational computing	IS researchers still not familiar enough with DSS principles, can benefit from cross-connections to DSS	Explore the dichotomy between individual performance and competitiveness	• Interrelated with newer IS expansions; • Major expansion of the IS discipline
Huber				Opportunities from unconventional use of technologies	Increased decision quality and timeliness		
Inmon	• The politics of DSS • Unstructured data • Business metadata • Non numerical visualization			Computerized DSS is still in its infancy			

Table 2.1 (continued)

Author/themes	Complexity of context	Sources of inspiration	Opportunistic view on technologies and theories	Future directions and challenges	Experience from the past	Importance of keeping "the big picture"	Relevance
Land	Understanding of group behaviour and design rationale is important		Provide clear explanations of the rationale and permit the decision makers to explore the decision space	Assistance of the facilitator may be needed to keep the design rationale clear		A DSS which is simply parachuted into the decision situation has little chance of being adopted	When approached in a deterministic view – could then be sidelined
McCosh		A tool which would help a manager or a business owner to do better or more business	. . . make sure it is flexible and understood by the company executive who has to use it	Need to spend more time on decision analysis and decision definition			
Scott Morton		. . . putting computing power in the hands of the managers was exciting	The ideas and concepts in the early 1970s, the technology at reasonable cost in the 1980s, still rarely used effectively	Need to be clear about the boundary between what computers can do well and what humans can do well	Still need a better understanding of the management of change		

Table 2.1 (continued)

Author/themes	Complexity of context	Sources of inspiration	Opportunistic view on technologies and theories	Future directions and challenges	Experience from the past	Importance of keeping "the big picture"	Relevance
Wagner			The "new" DSS is now a combination of art, technology, and psychology	The value of DSS is to "rehearse the future", not dealing with historical data	We have been pre-occupied with looking backwards rather than forward	Teaching understanding of the technology of DSS is important because if they don't understand "it" and see "it" they won't use "it"	
Watson			The technology may be new and vendors may hype the ideas as new, but the basic concepts have typically been around for quite a while	The greatest days for decision support are still ahead	Almost everything that is touted as "new" has significant antecedents	Exciting developments are real-time data warehousing, enterprise application integration (EAI), and enterprise information integration (EII)	

Table 2.1 (continued)

Author/themes	Complexity of context	Sources of inspiration	Opportunistic view on technologies and theories	Future directions and challenges	Experience from the past	Importance of keeping "the big picture"	Relevance
Whinston			Still in search of major conclusions	Hard to predict what should be the next focus		The field is driven by advances in technology and what people are able to get access to for solving their problems	

2.5 Conclusions

What are major conclusions from experiences with computerized DSS? Based on the literature analysis and reflections presented above, the field of DSS is still pretty relevant. Originating from different reference disciplines, DSS has expanded to be perceived as a multidisciplinary field. Since its origins as an "academic elite" discipline, DSS became a component of any management information system, enterprise resource planning, as well as personal computing tool. Some new terms have been "invented" as successors of the DSS advancements. Among others, business intelligence, knowledge management and various personalized work support tools inherited features originated from "good old ideas" that DSS researchers described in seminal work from 1970s to 1980s.

There is a strong belief that computerized DSS is still "in its infancy" in terms of its sophisticated use of all the opportunities that modern technologies create for more "ubiquitous, invisible and democratic" use of support any time and any place. The driving force behind development of new approaches to decision support still remains the user demand, and this demand should be recognized at all different levels from individuals to organizations and societies in face of solving social and even ethical problems of global magnitude.

A "good old principle" of user-centered design is most relevant to the development of modern DSS tools, which require all along collaboration between decision makers and systems designers. This principle drives development of systems, which are simple enough, but relevant to decision-makers real needs. It was suggested, that the best DSS bring to the surface underlying assumptions and hidden conflicts, which would be impossible without applying computational power and processing capabilities available thanks to modern technologies.

What are the issues associated with decision support that still need attention? From the scholarly perspectives, the lack of underlying theory and, as a result, limited academic impact is recognized as needing attention of future DSS researchers. However, the impact should not be a sole purpose of researchers, rather, the outcome of solid development of tools and techniques, which address real problems of real people.

Although recognized as a legitimate sub-field of information research and practice, DSS is still seen as "a side show", rather than an intrinsic focus of IS research. In this respect, the focus of IS research on informal systems, organizational politics, information management, human relations and competitive intelligence has as strong importance to the design of DSS, which fit demands of modern sociotechnical systems. In the same way, research and teaching about decision-making and decision support should be an integral part of any business information systems education.

The basic research model studied by most of the traditional DSS research suggests a main effect of decision support capability on performance. Little has been done to identify contingencies that impact adoption of DSS or the moderators that influence the success of specific types of systems. The following emerging topics represent a sample:

a. Connected decision makers who are continually linked to decision support information and collaborative technologies including voice and video. Impact on quality of decisions, burnout of decision makers, deskilling decision-making jobs.
b. Real-time data collection and display. Impact of tracking employees and monitoring by managers, information overload, issues of trust and invasion of privacy.
c. Smart devices with built in decision automation. Impact on people, learned helplessness, feelings of intrusion into one's life, increased sense of dependence on technology.
d. Integrated, targeted marketing approaches that take interactions across multiple channels, past history, and predicted future behaviors into account. Marketing effectiveness, customers reaction to perceived invasions of their privacy.
e. Networks of sensors in field operations that allow for optimization of constrained resources, e.g., energy. Efficiency gains from such networks, and robustness of data-intensive settings.
f. "Connecting the dots" and integrating, analyzing, and acting on disparate information on customers, terrorists, drug compounds and molecules. Technology problem versus a human agent problem, degree of human intervention necessary.

There are new opportunities for enhancing decision support with data mining technologies. Some of these have led to rule oriented, automated decision systems that can be employed in real time applications. Interaction with social network systems is enabling a new level of decision support technologies in recommendation systems as well as collaborative decision systems. These tools are being used, for example, to forecast sales of cultural products such as movies and music (Davenport and Harris, 2009; Sharda and Delen, 2006).

The last few years have seen exciting developments in user interfaces. Cell phone inputs through SMS are becoming more common for at least some consumer DSS-type applications. Multi-touch interfaces such as that on the iPhone and iPad, and on the Microsoft Surface platform, are almost revolutionary in enabling entirely new ways of interaction with a DSS application. Many companies, for example, are developing image processing applications to provide purchasing-decision support on smart-phones while a customer is in a store. User interfaces are going to change significantly in the next few years (Kroeker, 2010). Their first use will probably be in gaming and consumer applications, but the business and DSS applications should be explored by DSS researchers.

A third category of technologies to impact DSS research and practice is the availability of massive data generated through RFID and other sensors. RFID tagging is already being used by some companies to make decisions in supply chain management to gain additional efficiency (Nambiar, 2009). RFID technology generates massive amounts of data that can be analyzed to achieve great insights into a company's environment, a major purpose for the very existence of business intelligence and decision support (e.g., Baars et al., 2008).

By now, we have created and studied many DSS, but the lessons learned from the past need more thorough and systematic codification to reduce the tendency to reinvent the practice of building DSS, losing the opportunity to capitalize on the fact that the field has a rich history with some seminal work performed by pioneers to whom we owe the position that DSS research and practice enjoys now. These reflections of pioneers can help understand the progress of the field of DSS to determine what has been learned before from the first hand experiences of those who stood at the roots of the discipline. Their vision for the future research needs resonates with the research efforts of new researchers and is well illustrated in the content of this book. This chapter presents the first attempt at systematic study of the field. It aims to lay the ground for future DSS researchers and practitioners to continue building the solid DSS foundation in order to achieve the dreams of the pioneers in efficient use of advanced technology to support "better ways of doing things in the 'real' world we all live and work in", and move faster in these directions with the "... pioneering attitude that makes forays into the intellectual wilderness."

Appendix: Brief Biographies of Interviewees

James F. Courtney Professor of Management Information Systems at Louisiana Tech University. He received his Ph.D. in Business Administration with a major in management science from the University of Texas at Austin in 1974. He is the co-developer of the Systems Laboratory for Information Management (1981), a software package to support research and education in decision support systems, co-author of Database Systems for Management (1992), and Decision Support Models and Expert Systems (1992).

Paul Gray Professor emeritus and Founding Chair of the Department of Information Science at Claremont Graduate University. He specializes in data warehousing, business intelligence, decision support systems, and knowledge management. He is the author/editor of 12 books, most recently Decision Support in the Data Warehouse with H.J. Watson. He is also the author of over 120 journal articles including three "first papers" in crime in transportation, in telecommuting, and in group decision support systems. He is the founding editor of the Communications of AIS. Paul received a Ph.D. in Operations Research from Stanford University.

Clyde W. Holsapple Rosenthal Endowed Chair in Management Information Systems at the University of Kentucky. His research focuses on supporting knowledge work, particularly in decision-making contexts. He has authored over 100 research articles. His many books include Foundations of Decision Support Systems (with Bonczek and Whinston, 1981), Decision Support Systems: A Knowledge-Based Approach, and the 2-volume Handbook on Knowledge Management. He received a Ph.D. from Purdue University in 1977. His dissertation was titled "Framework for a Generalized Intelligent Decision Support System".

George P. Huber Charles and Elizabeth Prothro Regents Chair in Business Administration, The University of Texas at Austin. His research focuses on decision making and effects of information technologies on organizations. He has authored over 100 articles. Huber published a pioneering public sector decision support application article (1969) co-authored with Charles Holt. Also, Huber wrote pioneering articles on behavioral issues associated with using DSS and GDSS. He received a Ph.D. from Purdue University in 1965.

William H. Inmon Bill Inmon, is recognized as the "father of the data warehouse" and co-creator of the "Corporate Information Factory. His work on concepts related to data warehouses began with a 1983 Computerworld article, "What Price Relational?" As an author, Inmon has written about a variety of topics on the building, usage, and maintenance of the data warehouse and the Corporate Information Factory. He has written more than 650 articles, many of them have been published in major computer journals such as Datamation, ComputerWorld, and Byte Magazine. In 1991 Inmon published a practical how-to guide titled Building the Data Warehouse. Check www.inmongif.com

Frank Land He started his career in computing with J. Lyons, in 1953, working on the pioneering LEO Computer first as a programmer and then as a systems analyst on business decision support applications. In 1967, he left industry to join the London School of Economics on National Computing Centre grant to establish teaching and research in systems analysis becoming Professor of Systems Analysis in 1982. He is a Fellow of the British Computer Society and was awarded a Fellowship of the AIS in 2001 and the AIS LEO Award in 2003.

Andrew M. Mccosh Eminent Scholar Department of Finance, College of Business Administration, Florida International University. He previously served on the faculties at Harvard, Columbia, the University of Edinburgh, the University of Manchester, and the University of Michigan. He has published research in the areas of innovation and business processes, ethics, decision support technology, and financial strategy. He received a DBA from Harvard Business School.

Michael S. Scott Morton Professor of Management at Sloan School of Management at the Massachusetts Institute of Technology. Scott Morton is concerned about organizational and structural changes that US firms must make in order to compete successfully in the global marketplace. He studied engineering at the University of Glasgow in Scotland and finished his studies at Carnegie-Mellon before obtaining his doctorate at the School of Business at Harvard University. His dissertation completed in 1967 was the first systematic study of a computerized management decision system.

Gerald R. Wagner In 1978, Jerry resigned from his position as tenured Professor and Head of Operations Research, College of Engineering, University of Texas at Austin. He then started his first software company Execucom, which became a leading force in DSS. Execucom sponsored the first DSS conference and started the DSS transactions. Execucom was acquired by GTE in 1984. Dr. Wagner is known for

his software including IFPS, VisionQuest, Planners Lab and Web IQ. In 2003, he founded the International Academy for Advanced Decision Support (IAADS).

Hugh J. Watson Professor of MIS and a holder of a C. Herman and Mary Virginia Terry Chair of Business Administration in the Terry College of Business at the University of Georgia. He has authored 22 books and over 100 scholarly journal articles. He helped develop the conceptual foundation for decision support systems in the 1970s, researched the development and implementation of executive information systems in the 1980s, and most recently, specializes in BI and data warehousing. Hugh is a Fellow of the Association for Information Systems and The Data Warehousing Institute. He is the Senior Director of the Teradata University Network.

Andrew B. Whinston Hugh Roy Cullen Centennial Chair Professor in Information Systems at the Graduate School of Business in the University of Texas at Austin. He is also Professor in the departments of Economics and Computer Science. He is founding Editor-in-Chief of the Decision Support Systems journal. Whinston received his Ph.D. in Management from Carnegie Mellon University in 1962. He has authored seminal books in various disciplines. He has also published over 250 papers in leading academic journals in Economics, Business and Computer Science. Most of Dr. Whinston's research has been based at the Center for Research in Electronic Commerce.

References

Alter, S. L. (1980). *Decision Support Systems: Current Practice and Continuing Challenge*. Reading, MA: Addison-Wesley.

Baars, H., Kemper, H., Lasi, H., and Siegel, M. (2008). Combining RFID Technology and Business Intelligence for Supply Chain Optimization Scenarios for Retail Logistics. In Proceedings of the Proceedings of the 41st Annual Hawaii International Conference on System Sciences (January 7–10, 2008). HICSS. IEEE Computer Society, Washington, URL http://people.ischool.berkeley.edu/~glushko/IS243 Readings/RFID-and-BI.pdf

Bonczek, R. H., Holsapple, C. W., and Whinston, A. B. (1981). *Foundations of Decision Support Systems*. New York, NY: Academic Press.

Bush, V. (1945). As We May Think. *The Atlantic Monthly*, 176(1), July, pp. 101–108, URL http://www.theatlantic.com/unbound/flashbks/computer/bushf.htm

Caminer, D. T. (1997). LEO and Its Applications: The Beginning of Business Computing. *The Computer Journal*, 40(10), 585–597.

Codd, E. F., Codd, S. B., and Salley, C. T. (1993). Providing OLAP (On-Line Analytical Processing) to User-Analysts: An IT Mandate. Technical Report, E. F. Codd and Associates (Sponsored by Arbor Software Corporation).

Courtney, J. F. (2007). Reflections on Decision Support, posted at DSSResources.COM, May 21, 2007, URL http://dssresources.com/reflections/courtney/courtney05212007.html

Courtney, J. F., Jr., and Jensen, R. L. (1981, Spring). Teaching DSS with DBMS. *ACM SIGMIS Database*, 12(3), 7–11.

Davenport, T. H., and Harris, J. G. (2009). What People Want (and How to Predict It). *MIT Sloan Management Review*, 50(2), 23–31.

DeSanctis, G., and Gallupe, R. B. (1987, May). A Foundation for the Study of Group Decision Support Systems. *Management Science*, 33(5), 589–609.

Engelbart, D. C. (1962) Augmenting Human Intellect: A Conceptual Framework, October 1962, Air Force Office of Scientific Research, AFOSR-3233, URL www.bootstrap.org/augdocs/friedewald030402/augmentinghumanintellect/ahi62index.html

Gorry, A., and Scott Morton, M. S. (1971, Fall). A Framework for Information Systems. *Sloan Management Review*, 13(1), 56–79.

Gray, P. (1981). The SMU Decision Room Project. Transactions of the 1st International Conference on Decision Support Systems, Atlanta, GA, pp. 122–129.

Gray, P. (1983). *Guide to IFPS (Interactive Financial Planning System)*. New York, NY: McGraw-Hill Book Company.

Gray, P. (2007). Reflections on Decision Support, posted at DSSResources.COM, April 7, 2007, URL http://dssresources.com/reflections/gray/gray04072007.html

Holsapple, C. W. (2008) Reflections on Decision Support, posted at DSSResources.COM, April 27, 2008, URL http://dssresources.com/reflections/holsapple/holsapple04272008.html

Houdeshel, Ga. nd, and Watson, H. (1987, March). The Management Information and Decision Support (MIDS) System at Lockheed-Georgia. *MIS Quarterly*, 11(1), 127–140.

Huber, G. P. (1982). Group Decision Support Systems as Aids in the Use of Structured Group Management Techniques. Transactions of the 2nd International Conference on Decision Support Systems, San Francisco, CA, pp. 96–103.

Inmon, W. H. (1992). EIS and the Data Warehouse: A Simple Approach to Building an Effective Foundation for EIS. *Database Programming and Design*, 5(11), 70–73.

Kimball, R. (1994). DBMS Interview: The Doctor of DSS. *DBMS Magazine*, July 20.

Kroeker , K. L. (2010, February). Alternate Interface Technologies Emerge. *Communications of the ACM*, 53(2), 13–15.

Nambiar, A. N. (2009) RFID Technology: A Review of its Applications. In Proceedings of the World Congress on Engineering and Computer Science 2009, Vol. II, WCECS 2009, October 20–22, 2009, San Francisco, CA, USA. Available from URL: http://www.iaeng.org/publication/WCECS2009/WCECS2009_pp1253-1259.pdf

Power, D. J. (2002). *Decision Support Systems: Concepts and Resources for Managers*. Westport, CT: Greenwood/Quorum.

Power, D. J. (2007). A Brief History of Decision Support Systems. DSSResources.COM, URL http://DSSResources.COM/history/dsshistory.html, version 4.0, March 10, 2007.

Rinehart, G. (2006). A Brief History of Decision Support Systems, White Paper – URL http://decisioninterface.com/Documents/DSS%20History.pdf

Rockart, J. F. (1979). Chief Executives Define Their Own Data Needs. *Harvard Business Review*, 67, 2 March–April 1979, pp. 81–93.

Scott Morton, M. S. (1971). *Management Decision Systems; Computer-Based Support for Decision Making*. Boston, MA: Division of Research, Graduate School of Business Administration, Harvard University.

Scott Morton, M. S. (2007). Reflections on Decision Support, posted at DSSResources.COM, September 28, 2007, URL http://dssresources.com/reflections/scottmorton/scottmorton9282007.html

Scott Morton, M. S., and McCosh, A. M. (1968). Terminal Costing for Better Decisions. Harvard Business Review, 46, 3, May–June 1968, pp. 147–56.

Sharda, R., and Delen, D. (2006). Predicting Box Office Success of Motion Pictures with Neural Networks. *Expert Systems with Applications*, 30, 243–254.

Sprague, R. H., Jr., and Watson, H. J. (1979, Fall). Bit by Bit: Toward Decision Support Systems. *California Management Review*, XXII(1), 60–68.

Swanson, E. B., and Culnan, M. J. (1978, December). Document-Based Systems for Management Planning and Control: A Classification, Survey, and Assessment. *MIS Quarterly*, 2(4), 31–46.

Turoff, M. (1970). Delphi Conferencing: Computer Based Conferencing with Anonymity. *Journal of Technological Forecasting and Social Change*, 3(2), 159–204.

Turoff, M., and Hiltz, S. R. (1982). Computer Support for Group Versus Individual Decisions. *IEEE Transactions on Communications*, COM-30(1), 82–90.
Watson, H. J. (2007). Reflections on Decision Support, posted at DSSResources.COM, July 6, 2007, URL http://dssresources.com/reflections/hwatson/hwatson07062007.html

Further Readings

Gray, P. (2008). The Nature of Group Decision Support Systems. In Burstein F.C., W. Holsapple (Eds), *Handbook on Decision Support Systems: Basic Themes* (pp. 371–389). Berlin, Heidelberg: Springer.
Holsapple, C., and Whinston, A. (1996). *Decision Support Systems: A Knowledge-Based Approach*. St. Paul, MN: West Publishing.
Huber, G. P. (2007). Reflections on Decision Support, posted at DSSResources.COM, November 2, 2007, URL http://dssresources.com/reflections/huber/huber11022007.html
Inmon, W. H. (1990). *Using Oracle to Build Decision Support Systems*. Fort Bragg, CA: QED Press.
Inmon, W. H. (2007). Reflections on Decision Support, posted at DSSResources.COM, June 7, 2007, URL http://dssresources.com/reflections/inmon/inmon06072007.html
Kimball, R., Thornthwaite, W., Reeves, L., and Ross, M. (1998). *The Data Warehouse Lifecycle Toolkit*. New York, NY: Wiley.
Land, F. F. (1975). Evaluation of Systems Goals in Determining a Design Strategy for a Computer-Based Information System. *Computer Journal*, 19, 290–294.
Land, F. F. (2008). Reflections on Decision Support, posted at DSSResources.COM, March 16, 2008, URL http://dssresources.com/reflections/land/land03162008.html
Martin, D. (2008). David Caminer, a Pioneer in Computers, Dies at 92. *The New York Times*, June 29, 2008, URL http://www.nytimes.com/2008/06/29/technology/29caminer.html
McCosh, A. M. (2007). Reflections on Decision Support, posted at DSSResources.COM, December 19, 2007, URL http://dssresources.com/reflections/mccosh/mccosh12192007.html
McCosh, A. M., and Scott Morton, M. S. (1997). *Management Decision Support Systems*. London: Macmillan.
Scott Morton, M. S., and Stephens, J. A. (1968). The Impact of Interactive Visual Display Systems on the Management Planning Process. *IFIP Congress*, 2, 1178–1184.
Simmons, J. M. M. (1962). *LEO and the Managers*. London: Macdonald.
Wagner, G. R. (2007). Reflections on Decision Support, posted at DSSResources.COM, July 22, 2007, URL http://dssresources.com/reflections/gwagner/wagner07222007.html
Watson, H. ,, Houdeshel, G., and Rainer, R. K., Jr. (1997). *Building Executive Information Systems and Other Decision Support Applications*. New York, NY: Wiley.
Whinston, A. (2009). Reflections on Decision Support, posted at DSSResources. COM, January 2.

http://www.springer.com/978-1-4419-6180-8

Decision Support
An Examination of the DSS Discipline
Schuff, D.; Paradice, D.; Burstein, F.; Power, D.J.;
Sharda, R. (Eds.)
2011, XX, 224 p. 59 illus., Softcover
ISBN: 978-1-4419-6180-8