
Management Information Systems and Changing Technologies in Libraries

John E. Ulmschneider

In the past two decades management science has come to regard change as a constant in an organization's operations. Libraries no less than other institutions are subject to constantly shifting demands and constraints. Consequently the flexibility to respond quickly to opportunities and problems has become an important skill for library managers. Such flexibility requires the ability to speak authoritatively on the present state of a library from the basis of accurate management information. Financial information is particularly important, since planning for and dealing with change depends wholly on accurate information about the need for, availability of, and utilization of resources. For resource-strapped libraries, the allocation of resources occupies a central role in many decisions. For this reason library managers increasingly recognize timely and accurate management information, especially financial information, as a strategic resource crucial to the ongoing operations of a library. The health and prosperity of a library depends critically on what information is available for decision makers in the library and how management structure provides for the flow of information to them.

The technology for capturing, disseminating, and analyzing management and financial data in libraries has undergone accelerating change in this decade. Two developments in particular have had important influence. First, the widespread introduction of desktop computers beginning in the early 1980s brought new power and flexibility to individual library managers for the analysis of financial and other data. Second, the growth of computer networks has greatly enhanced the ability of librarians both to capture data and to disseminate it (often in the form of analyzed data) directly to persons with a need to know. While library research and literature have reflected the application of new financial analysis tools available to librarians^{1,2}, the literature (as well as management literature in general) has

only begun to discuss the issues raised by computer networks for financial and other management data. The combination of powerful desktop computers and distributed network data presents new opportunities that improve upon the capabilities of earlier management information systems designs, but it also exacerbates problems associated with duplication of data, timely dissemination of data, locating correct data, and proper analysis and use of the data available.

MIS and Management Science: An Overview

The term management information systems (MIS) traditionally has described the capture and analysis of statistical data about an organization's operations in support of decision making by management. Research and literature about MIS is divided roughly into two camps: the technology and implementation of MIS and the management theory of MIS.

Management theory often recognizes three different types of decision making in organizations, with different management information needs for each decision type³. *Strategic planning* involves setting goals and objectives, defining and refining the mission of the institution, arranging long-term acquisition and allocation of resources, and monitoring the organization's working environment for feedback on progress and for opportunities. *Management control* is concerned with obtaining and allocating resources and ensuring their effective and efficient use to accomplish tasks related to the goals and objectives of the organization. *Supervision or operational control* is the close monitoring of specific tasks carried out to meet goals and objectives. In libraries these tasks are primarily transaction-oriented activities such as circulation, cataloging, reference, and acquisitions. Transaction tasks include most budget and financial transactions, such as generating purchase orders, paying invoices, applying fines, and encumbering monies for monograph and serial orders. Transaction records provide much of the raw data about a library's behavior and activities that become the foundation of management information systems.

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The decision process itself has been variously modeled. Older models describe well-defined stages in a structured decision making process.⁴ Recent research supports a less structured process, characterized by individual differences in analyzing problems and developing solutions, heavy reliance on oral communication among colleagues, and the presence of a considerable ambiguity in both problem analysis and the data brought to bear on a given problem⁵. In particular, newer research shows that decision makers often follow an iterative decision making path that involves formulating alternatives and solutions, gathering information to elaborate or test alternatives, and then refining alternatives or developing new ones. For this reason newer decision models regard unimpeded information transfer, both access to information and exchange of information, as the most important component of the decision making process.

Management information systems as a discrete technology appeared conceptually in the late 1950s as an outgrowth of management experience with computerized financial control systems. Important lessons learned from financial systems included the need to define and standardize operational and statistical data, and the awareness that managers involved in strategic planning had need of comprehensive information on all aspects of an organization's operations, not just its financial operations. Developed primarily in the 1960s and 1970s, the chief technology of management information systems is centralized, comprehensive collections of statistical and financial data, marked by a high degree of data standardization and pervasive computerization of data capture operations. Data analysis is carried out by batch programs and presents results in the form of recurring and ad hoc reports. Ad hoc reports generally are designed to the task, with little flexibility and no interactive management control; managers are required to formulate questions of data and receive the answers at a later time. A few reporting tools provide flexible analysis of data, for instance SPSS and SAS, but their use generally requires programming skills. Libraries rely heavily on MIS technology in integrated library systems, and have achieved particular success in standardization of data descriptions, in collection of statistics, and in computerization of important transaction activities. Today most library automation systems employ MIS-type technologies.

MIS technology resembles a powerful management reporting system, useful for operations control and management of processes, tasks, and

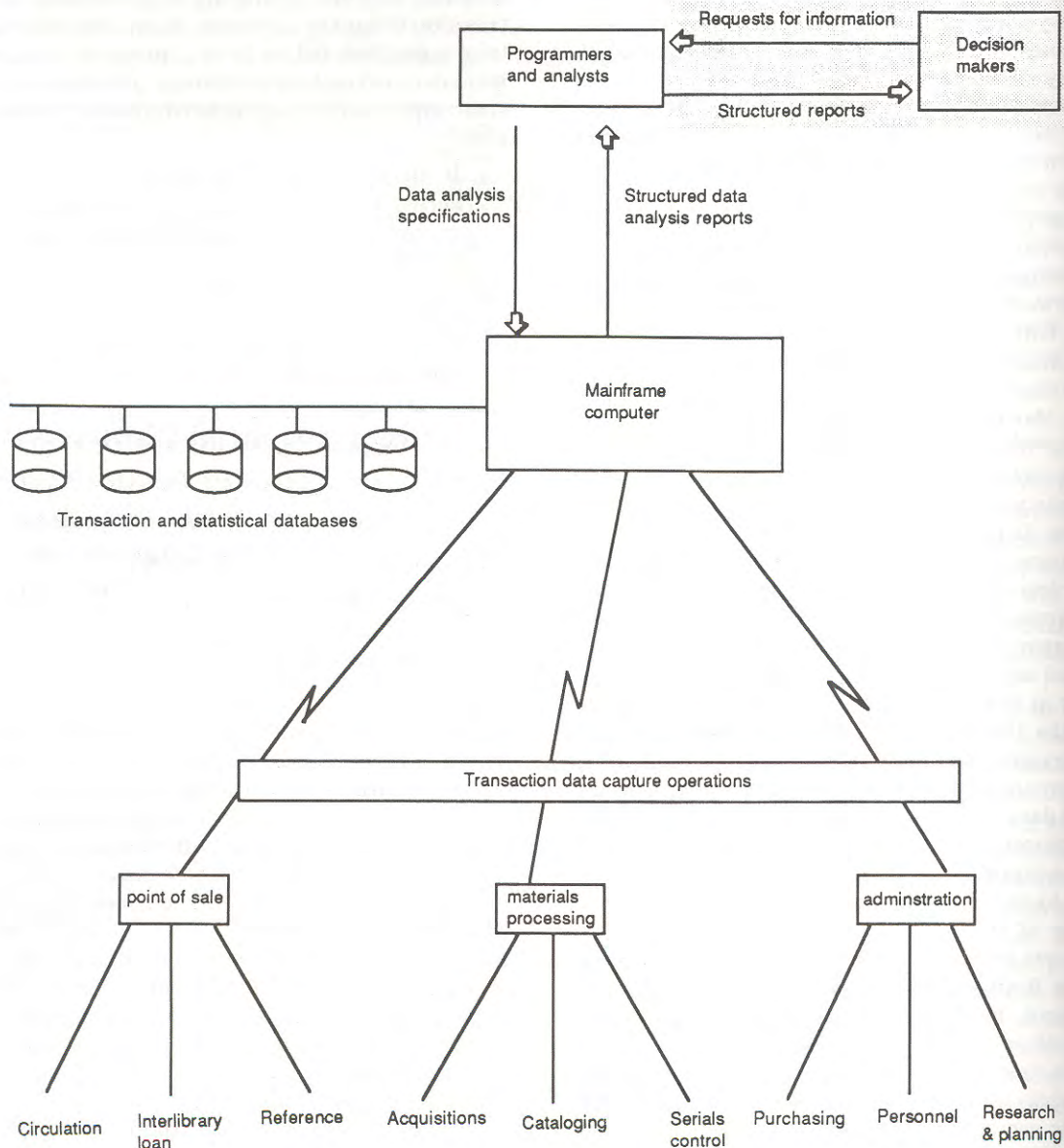
projects. Importantly, MIS has changed the nature of organizational decision making, because it carries with it considerable emphasis on the collection, accuracy, and use of management data. It also has instituted pervasive computerized data capture, setting the stage for easier distribution of data by electronic means. But MIS has been a manifest failure in its support of management decision making in strategic planning and in some aspects of management control for two reasons:

1. It does not provide direct management access to data and does not include much crucial information contained in manual systems or elsewhere;
2. It does not include data analysis tools that support individual managers' exploration of data to develop alternatives and test solutions to problems.

Existing integrated library systems can expect to become one part of a library-wide decision support system, a single computer system on a network connecting many computers.

In the late 1970s management and information scientists developed a new conceptualization of MIS called Decision Support Systems (DSS). DSS incorporates recent findings in management science about the decision making process and addresses most of the major shortcomings of traditional MIS for management control and strategic planning. DSS theory and technology places great emphasis on how *individual* decision makers acquire and employ information in the decision making process. Consequently, DSS emphasizes techniques that provide more integrated and easier access to data and analysis rather than more comprehensive collection of data. It encourages designs that allow physical independence of data from the applications that require data (mainly by standardizing on data exchange formats between applications), relieving managers from dependence on centralized, highly structured data analysis characteristic of traditional MIS. Particularly important to DSS technology has been the introduction of powerful, flexible, inexpensive, and easy-to-use software tools for exploring data. Collections of such tools provided to managers on desktop or otherwise easily accessible computers (such as departmen-

Figure 1
Management Information Systems in Libraries
Typical Configuration



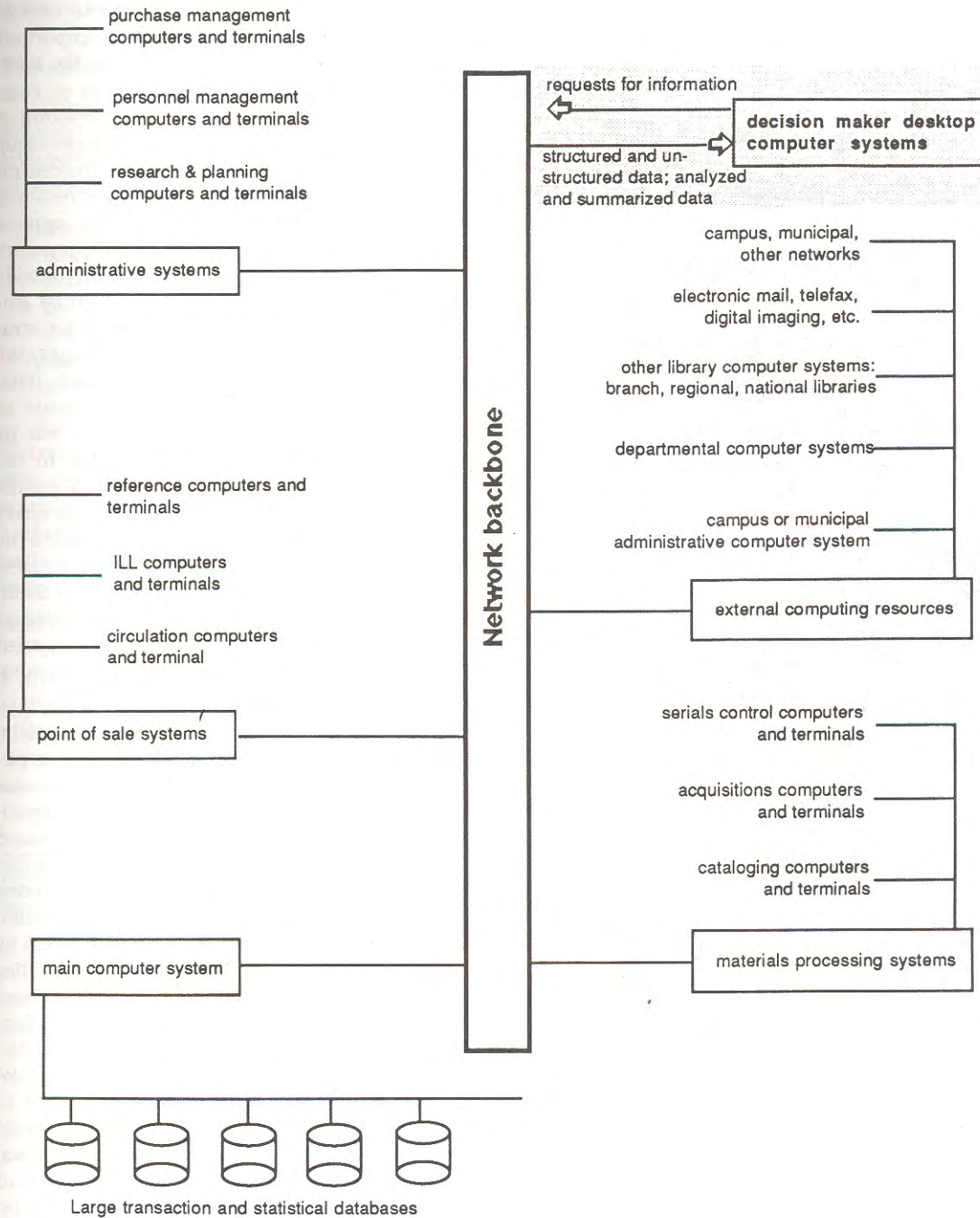
tal minicomputer systems) support the individual cognitive styles of managers involved in the iterative decision-making process.

Decision Support Systems (DSS) and Network Technology

Figure 1 represents a typical library MIS configuration using technologies prominent in the

late 1970s and early 1980s. The typical MIS in this design relies on a large central computer as a distributed resource, gathering raw transaction data from transaction centers and storing it in databases. The central computer represents a relatively costly resource and therefore is not applied to all transaction processing, nor is it available for all management decision making. Data on the computer is provided to managers in the form of

Figure 2
Decision Support Systems In Libraries
Typical Configuration





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structured reports, usually as regularly recurring reports but sometimes as *ad hoc* reports.

Figure 2 shows a library DSS environment that reflects newer technologies gaining prominence in this decade. Traditional MIS emphasizes centralized databases, but in fact data often is distributed in the sense that the central database usually does not contain comprehensive data; a considerable amount of data resides in manual systems or is otherwise not available to central computers. In the evolving library DSS, important data also is distributed, but is more readily available for two reasons: more data resides on computers because of the increased use of desktop or departmental computers, and data is more easily transferred because of network links. The central computer represents a single computing resource in a network of computing resources, applied where appropriate and used by other computers where appropriate. In addition, external (outside the library) computers provide essential environmental information to the library for strategic planning, and are available with roughly the same ease as internal computers and data. Finally, the analysis of enormous amounts of basic transaction data can be carried out by knowledgeable staff appropriately close to the data using their own computers, and the results easily cumulated and delivered to supervisory and administrative staff. Managers can refine the results using their own software tools, request additional analysis, or access the raw data themselves. The result incorporates an intelligent review of raw data into ongoing analysis carried out directly by managers using their own computers and software tools.

The drawbacks of such DSS designs are plain. On the one hand, desktop computers and computer networks combine to generate new tendencies away from centralized, standardized data repositories typical of MIS. The result is increased duplication of data, decentralized and widely distributed data, and difficulties locating needed data. On the other hand, networks help ameliorate the problems inherent in distributed data by providing powerful information transfer facilities (such as electronic mail and multi-user database management systems) notable for their speed, flexibility, and capacity. These facilities not only distribute data as needed for analysis, but make available data formerly difficult for managers to obtain. In addition, the same technologies provide new tools for the analysis and exploration of data, characterized by their power, ease of use, and flexibility, that overcome the limitations of MIS-designed tools.

Importantly, DSS does not solve some fundamental problems in library decision making frequently noted in the library literature. In particular, it contributes nothing to the ongoing effort to standardize descriptions for library data and library statistics⁶. As long as librarians cannot agree, for example, on how collection sizes are measured, the ability of individual DSS to use data from other libraries for environmental comparison will be frustrated.

DSS and Library Financial Management

Three administrative conditions inherent in financial management of libraries (and other nonprofit organizations) motivate the application of DSS to library financial management:

- the need for the most timely, up-to-date financial information possible during decision making
- the requirement for accountability in both expenditures and operations
- the crucial role of financial information in strategic planning and change decisions.

Each situation is in some way poorly served by traditional MIS, but can draw on particular strengths of DSS to meet its needs. Figure 3 summarizes these three conditions, the main drawbacks of MIS in meeting the needs of each, and the particular strengths of DSS in relation to the same needs.

Need for timely information

In a change-oriented environment, decisions frequently must be made on crucial issues in a matter of hours or days. The most up-to-date information possible is required for many decisions. But financial data generally has multiple

sources and is generated by multiple processing centers; locating data quickly can be difficult. In libraries these sources include acquisitions, purchasing, personnel, circulation, and the like. Traditional MIS designs provide a framework for capturing raw financial transaction data from such processing centers, but unfortunately the analysis of transaction data in such a system reaches decision makers only in the form of recurring reports. Changes introduced by recent transactions generally are not known. In addition, much essential data is simply unavailable in traditional MIS designs, locked away in staff experience or manual systems. Decision support systems alleviate these drawbacks in two ways. First, DSS distributes computing power in the form of desktop computers directly to supervisory staff responsible for day-to-day operations. Data formerly residing in manual systems or staff expertise quickly migrates in some form to these desktop systems. Second, DSS employs network designs that provide access both to these desktop computers and to other computers responsible for capturing transaction data and for analyzing transaction data. Software tools mounted on desktop or departmental computers then can access and make use of the most up-to-date management data and analysis, including models and projections, in the course of management deliberations. Software tools are even used to capture, analyze, and present data during management meetings to reflect the results of implementing alternatives, speeding up the iterative decision-making process by providing immediate feedback on the results of certain decisions.

Accountability

Libraries no less than other organizations

FIGURE 3.
MIS and DSS solutions to financial management requirements

<i>Condition</i>	<i>MIS solution</i>	<i>DSS solution</i>
Need for timely information	Recurring and <i>ad hoc</i> batch reports only	Interactive formulation of reports
	Programmer intervention normally required	Data analysis by managers using desktop computers
	Raw transaction data usually not available	Most transaction data and analysis available
Accountability	Emphasis on supervisory and operations analysis	Emphasis on strategic analysis
	Modeling and projection tools require programming	Interactive, end-user modeling and projection tools
Strategic planning	Supports structured data analysis	Supports exploration of data
	Access limited to specific data	Access provided to most data and analysis
	Ignores important data on environment and in non-MIS systems	Includes most computer-managed data

must account in detail for budget expenditures. In addition, the cost effectiveness of library processes and the efficiency of library operations are subject to management and audit review. Financial information figures importantly for input and output measures, for auditing, and for all aspects of cost analysis for services. Analysis and modeling software supplied by decision support systems, such as spreadsheet programs, accounting systems, and project management software, support determinations of the cost effectiveness and efficiency of library operations. With such software tools library managers can explore data and test alternatives quickly and easily, without the need to translate the data requirements of a particular problem into query specifications for generating structured reports. In addition, network access to data residing with parent organizations can assist in evaluating budgets and allocations with respect to the parent organization's goals and objectives, for example, assessing materials expenses in relation to enrollment information.

Role of financial information in strategic planning

Most strategic planning and change decisions involve the deployment or redeployment of institutional resources, very often financial resources. Comprehensive information on financial history and financial resource projections and utilization models are indispensable to planning and decision making. MIS designs focus access to financial data through knowledgeable managers able to produce query specifications that can be understood and translated by technical staff. In contrast, decision support system technology broadens the accessibility and use of financial data to all managers as the need arises. In DSS, networks and desktop or departmental computers encourage librarians involved in strategic or long-range planning to take account of financial data formerly inaccessible to them. The result is more comprehensive and accurate planning for changes and services. In addition, libraries have long used various allocation and charging formulas to manage materials expenditures and the collection of fines and other income (though in many respects with unfortunate results⁷). Financial management information available in DSS tests the accuracy, validity, and usefulness of such formulas.

DSS and Library Financial Data Management in the Future

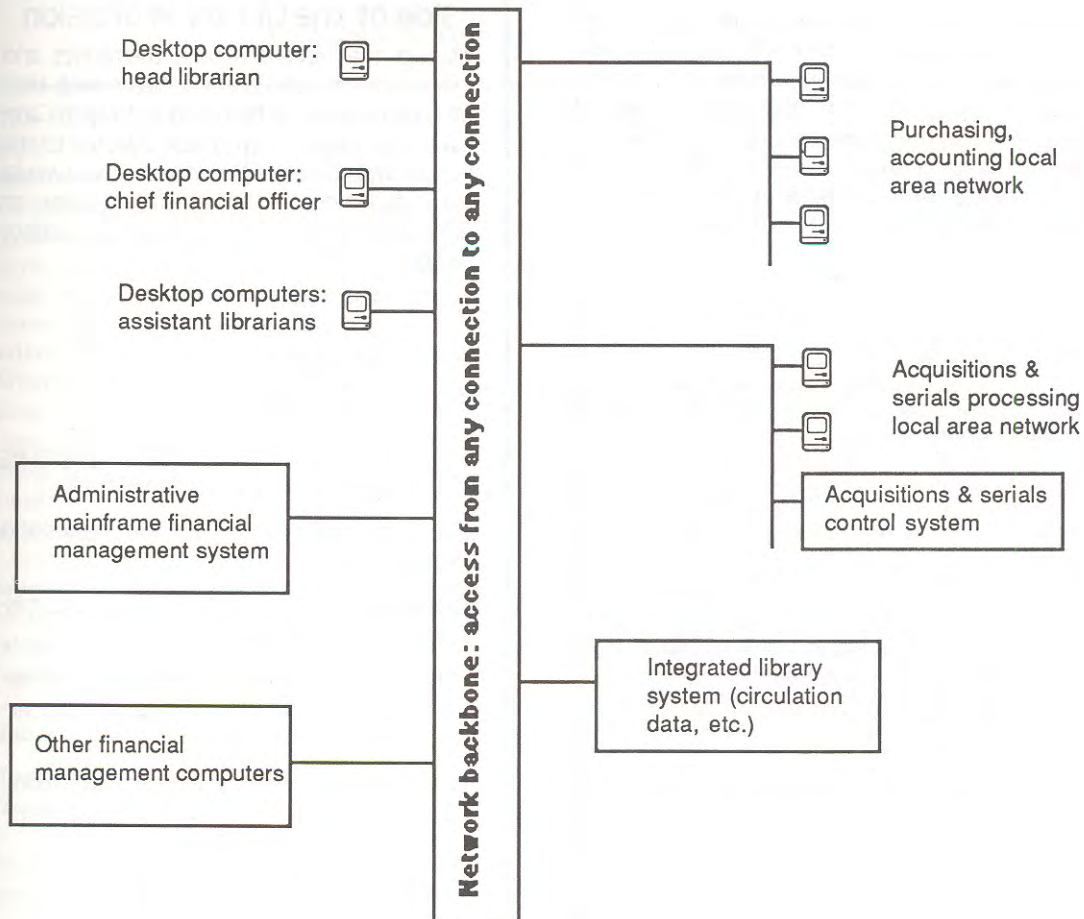
Currently most automated systems supporting library decision makers, including financial

management systems, employ designs characteristic of MIS technology of the late 1970s and early 1980s. The scarcity of capital funds for investment in newer computing and network technologies will perpetuate this pattern in many libraries through the mid-1990s. Larger libraries, however, particularly research libraries at major universities, have begun significant investments in network infrastructure and desktop computer technologies that will continue and increase over the next five years. Generally such investments are motivated by the need to deliver electronic services from library service units directly to patrons, and to communicate better with patrons, the parent institution, and regional and national libraries. But the infrastructure also supports evolving DSS technologies, and research libraries already are exploring how networks and desktop computers might be applied to develop information systems for decision makers. Figure 4 shows how a typical financial decision support system using DSS technologies provided by such infrastructure investments might appear.

A number of issues still must be addressed in the design and implementation of future library decision support systems. These include:

- *Standardization of data descriptions:* Although financial data uses many widely accepted standard descriptions, this is not true of other library management information. Standardization of expression is increasingly important for sharing data, for inter-institutional comparisons, and for accountability to parent institutions.
- *Location of data:* Networks encourage distributed data capture and analysis; frequently important data and findings are present on several computers in a network. This is true of bibliographic information systems as well as management information systems. One solution is development of intelligent "knowledge finder" software that maintains network inventories and assists users in navigating data sources.
- *Security:* Desktop computers and networks offer multiple points of access to sensitive and important data on distant computers, often with the full privileges accorded to data on a local computer. Library managers will need a clear awareness of security issues presented by decision support systems in this context, such as who is allowed access to computers, where data resides, and the nature of tasks (and the data required to carry out those tasks) assigned to different staff.
- *Use of computers by library management:*

Figure 4
Financial Management Decision Support System
Typical Configuration



Many library managers still regard desktop computers as expensive resources appropriate mostly for typical MIS applications, for instance, capturing and managing transaction data. Decision support systems, however, regard desktop computers as essential tools no different from pencils and calculators. Access to data formerly not available to managers is only one-half of a decision support system: access requires tools and expertise to use the data appropriately. Libraries should make the necessary training investment as well as the capital investments required to ensure that library managers will use desktop computers, software tools, and network access to data and analysis in the process of management decision making.

- *Electronic transfer of financial transactions:* Financial data demands special consideration for network communication and desktop computer access, because audit requirements are strict. The ability to carry out financial transactions electronically, with appropriate electronic signatures, is a likely possibility for some libraries: delivering, receiving, and paying orders for library materials directly through network gateways, for example. Libraries already interact with the computerized financial management systems of parent organizations in a number of ways (e.g., online access to central accounting information). As financial administration comes to rely more heavily on electronic management of funds, libraries will need to follow existing financial

standards and ensure that audit requirements are met.

Library decision support systems will continue to evolve with the development of electronic delivery of library services and the process of connecting libraries to local, regional, and national networks. Existing integrated library systems can expect to become one part of a library-wide DSS, a single computer system on a network connecting many computers. The MIS-based design of library information management systems will move in the direction of decision support technologies as networks and desktop computers continue to expand their presence in libraries.

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