R. King

NORTH CENTRAL DAIRY HEALTH MANAGEMENT
DATABASE WORKSHOP

NEW TECHNOLOGY AND PERSPECTIVES IN THE INFORMATION AGE

by

Stephen B. Harsh
Professor
Michigan State University

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This paper will examine selected current and projected future technologies as they relate to information processing and distribution. The examination is not exhaustive and has as its focal point the agricultural community in general and more specifically animal health issues.

This paper will first review some basic concepts as they relate to information processing and the utilization of information by decision makers. The paper will then examine the various components of an information system and attempt to identify the likely future trends as they relate to these various components.

INFORMATION SYSTEMS CONCEPTS

Today's decision makers are looking for new methods to supply them with information. Good decisions are based upon good supporting information. However, information is not a free good. As Davis points out, "In general, the value of information is the value of the change in decision behavior caused by the information less the cost of information." In other words, given a set of possible decisions, a decision maker will select one on the basis of information at hand. If new information causes a different decision to be made, the value of the new information is the difference in value between the outcome of the old decision and that of the new decision less the cost of obtaining the information.

It should also be noted that information and data are not the same. Davis has defined data as a group of nonrandom symbols which represents quantities, action, things, and so forth. Information is data that has been

processed into a form that is meaningful to the recipient and is of real or perceived value in current or prospective decisions. Therefore, for data to be useful in decision making purposes it must be processed into useful information. Hence, information is data that has been evaluated in the context of a specific problem situation. (See Figure 1)

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+------------+      +------------+      +-------------+
|            |      |            |      |             |
|    DATA    |----->| PROCESSING |----->| INFORMATION |
|            |      |            |      |             |
+------------+      +------------+      +-------------+
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Figure 1. TRANSFORMATION OF DATA INTO INFORMATION

Furthermore, many managers also run under the mistaken impression that more data will make them better decision makers. This is true only if it can be processed into information. For example, commodity prices are only useful to the farm manager if he is able to convert that data into information on which he can base marketing decisions.

Therefore, there is an increasing interest on the part of decision makers in information systems that will support the decision making. A comprehensive information support system has four main components (1) descriptive information; (2) diagnostic information; (3) predictive information; (4) prescriptive information. (See Figure 2)

Descriptive information describes the "what is" situation. An accounting system in its initial stage provides descriptive information. It can indicate profitability, return on investment, and other financial factors. Other sources of descriptive information include commodity price reports, livestock and crop records, and weather forecasts.

Diagnostic information describes the "what is wrong" situation. It reflects a fact value conflict. What might be the cause for my low rate of return on the investment when compared to other similar operations? Why was my average price received lower than the average? This diagnostic information is important in that it helps the manager identify strengths and weaknesses of the business and suggest what should be changed.

Predictive information describes the "what if" situation. This is the process of looking to the future. It explores the impact of alternative proposed changes in the operation. Careful generation of predictive information will greatly enhance the likelihood of success for a business.

Prescriptive information describes the "what should be done" situation. It identifies a plan for the future which the manager will try to implement in

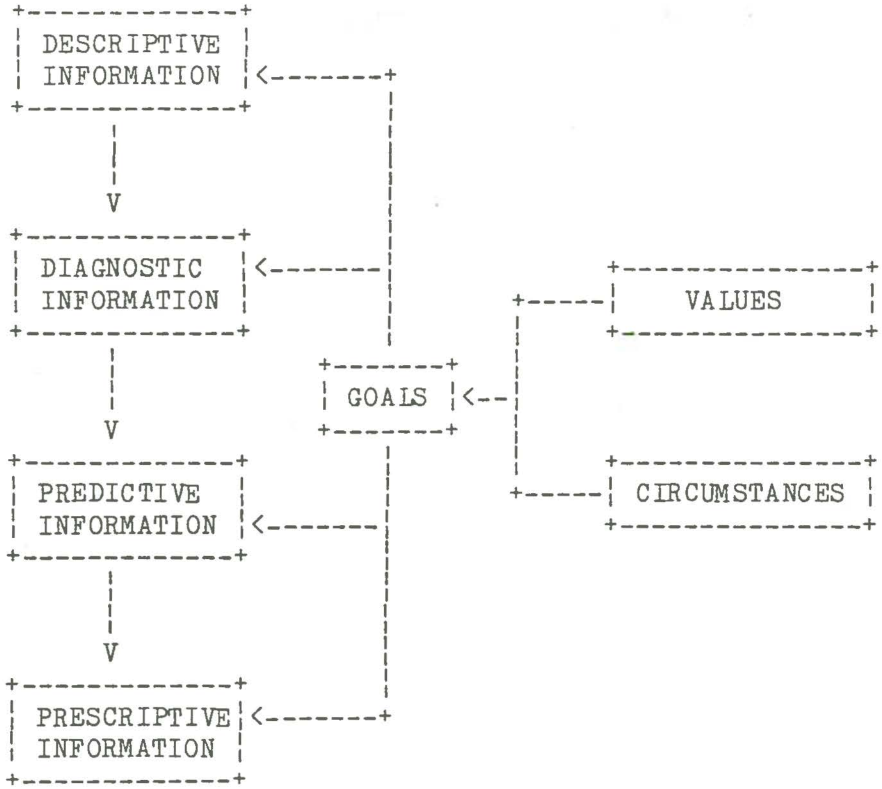

Figure 2. TYPES OF INFORMATION

order to improve upon his overall operation. It is the process of making and carrying out decisions based on being fed adequate information up to the decision making process.

Of course, types of information are influenced by the goals of a manager. For example, in determining diagnostic information what is "good" or "bad" is partly influenced by the values and expectations of the manager himself. Likewise, in looking at predictive information, the alternatives which may be considered are also influenced by the goals of the manager. The goals of a business reflect the basic values of the manager and his family. They are also influenced by the circumstances (e.g., how "good" are my cows, how much credit can I obtain, etc.) facing the manager.

From the preceding discussion, the importance of defining what information is needed for decision making should be obvious. Once the needed information has been defined, then the appropriate processing and supporting data can be quantified. The opposite approach--collecting data with no clear indication of what information is needed--will only result in wasted human and monetary resources.

COMPONENTS OF A COMPUTER BASED INFORMATION SYSTEM

In an attempt to make the processing of data into information a more efficient process, computer technology has been used increasingly. There is every indication this trend will accelerate in the future. For the purposes of discussion I have identified five basic components of a computerized information system. They are as follows:

1. Hardware
2. Software
3. Supporting data bases
4. The end user
5. The support system.

Each of these components will be discussed in greater detail.

Hardware

The advances in computer hardware are well known to all of us.[1] One analogy compares the average 1948 automobile with the computer industry. If the automobile advanced at the same pace as the computer industry, it would be capable of traveling at 500,000 miles per hour, of getting 150 miles per gallon and it would only cost 1.5 cents. It is because of these great advances that we now have computer technology within the affordable range of a large proportion of our population.

The hardware scene is moving heavily towards a hierarchical distributive processing system. This approach uses different sizes and classes of computers to handle different tasks. (See Figure 3) The largest computers in the system (maxi-computers) are used to maintain very large data bases, and/or those data bases which must be shared by the entire user community. They are also used to perform large and involved computational tasks.

The next level in the hierarchical system (midi or mini-computers) are used to store data bases needed by a sub-set of the user community. They are are also extensively used for computational purposes. The lowest level of the system is the micro-computers. These machines are used to store the local data bases and supply computational power needed for decision making and problem solving at that level. A distributive system places processing capabilities and data storage and retrieval functions at the appropriate level such that it will supply to decision makers the needed information in a cost effective fashion.

A major component of the hierarchical distributive processing system is the computers themselves. The future of computer technology appears to be promising. There are new design techniques which now allow engineers to connect a greater number of circuits together within a specified amount of time. An engineer today is able to make ten times more circuit connections than he was able to make ten years earlier.

[1] The remarks that follow are influenced by recent speeches given by Dr. Stephen Knight of Bell Laboratories and Sam Harvey of RHS Associates.

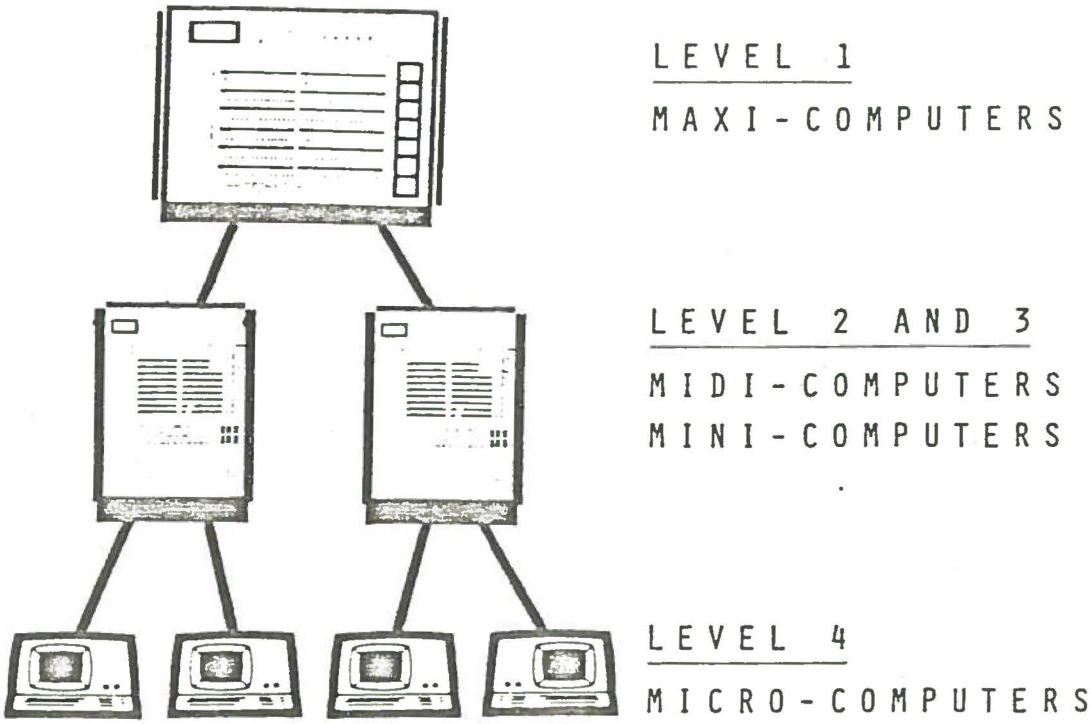

Figure 3. HIERARCHICAL-DISTRIBUTIVE PROCESSING SYSTEM

However, offsetting this increase in the rate to make circuit connections is a decline in the ability of scientists and engineers to densely pack electronic circuits. There is a theoretical limit on how closely one can pack circuits together (e.g., electrons do have mass). Therefore, as circuit designs approach this theoretical limit, the rate of change in which circuits can be densely packed becomes somewhat slower.

In total, the projected advances in chip technology are very encouraging. Dr. Knight believes by the year 2,000 there will be memory chips capable of storing 40 million bytes. Other projections are even more optimistic.

In the storage area the videodisc is a new technology that appears to have a major economic advantage over current storage technology. It is capable of packing data 100 times more dense than the current magnetic media. A double- sided videodisc can hold nearly twenty billion bits of data. Furthermore, it can also be mass reproduced. The chief disadvantage of the videodisc is that it is not reusable. Once the data has been recorded it remains on the disk and it is not possible to erase it and reuse the disk. This non-reusability situation may change in the near future. However, this is a

disadvantage only if the data changes rapidly. For storage of historical data (weather data, disease patterns) its advantages should be obvious.

Overall, these technological advances mean that the computers at all levels of a hierarchical distributive processing system will become more powerful and less costly. It is entirely possible that the smallest computers in the system within a few years will have more capacity than the scientific machines currently found on university campuses.

For a hierarchical distributive processing system to function, there must be a reliable, rapid, efficient and cost effective communications system. With the recent deregulation of the telephone industry, the world of electronic communications has become more competitive. The future potential for improvements in communication systems is rather promising. There are strong indications that communications (including voice) between major communication points will be done digitally. This movement to digital transmission will allow for better utilization of new transmission technologies including satellites and optical fiber.

Optic fiber technology is advancing at a rapid rate. Today it is capable of transmitting two billion bytes per second. Repeaters are needed only every 200 miles. Other advances are taking place in the area of marrying light technology to electronics technology to provide an integrated hardware system for rapid transmission of data and information.

Satellite transmission is also advancing rapidly. It is now possible to acquire a small (1 meter) downlink disc for a few hundred dollars. With the emerging competition in the satellite communications area, the cost of transmission should also drop significantly. By time-sharing a transmission signal, a farmer could receive massive amounts of data which are unique to his particular farm operation in only a fraction of a second. The cost of acquiring this data would be only a small proportion of the current cost of receiving similar information through standard telephone transmission means or the postal service.

This means the hardware technology that we will have available to use in the future may far exceed our capability to use it. Therefore when designing an information system for the future, one should be trying to determine what the hardware options will be three to five years into the future because it will be that long before we will have completed the development of the software and data bases.

Software

Software in today's computer world is one of the major cost components. It is highly likely the software costs will exceed the hardware costs for most applications in the years ahead. A recent study done by Bob Strain at the University of Florida indicates that there are literally thousands of programs available for agricultural users. However, the use of this software has been somewhat limited. Dr. Harlan Hughes, University of Wyoming, has stated that there are basically four factors that contribute to successful agricultural software for the end user. They are (1) it must address a complex problem, (2) it must deal with a problem faced by decision makers, (3) it is software that has been built by a multidisciplinary team, and (4) it generally has a

supporting data base. Most of the agricultural software built to date does not have these characteristics. Indeed, some existing software for microcomputers is nothing more than "recycled" programmable calculator programs that by most definitions were not successful. Therefore, we need to look beyond the software we have currently developed and think about useful software for the future.

There are some encouraging signs in the software area. There is a strong interest emerging in the agricultural community for the development of integrated and decision supporting software. Also, for the management of data there are some excellent general purpose software tools available. The new data base management systems (DBMS) make it easier to enter, edit, error check and retrieve data. Many of these DBMSs use full Boolean logic in the retrieval process and some are capable of handling hierarchical and networked data bases. The new statistical packages for small computers are simple to use and in most cases extremely powerful. The capacity of some of these statistical packages are nearly equal to those located on large mainframes.

Finally, where software does not exist for a particular problem, the availability of non-procedural languages (use of English commands and/or processing aids such as a mouse) make it easier for people with limited programming skills to process data into the information they desire.

Supporting Data Bases

The supporting data bases for agricultural software are currently inadequate. Many of the problems faced by decision makers require data they generally do not have available to them. This includes data from their own operations as well as data external to his operation such as commodity prices and weather forecasts. Therefore, we are capable of building decision support models that are beyond the manager's ability to supply the necessary data that are needed to support these models. Unless we work to solve the problems in this area, it is highly unlikely that the sophisticated software of the future will find wide acceptance.

There are indications that some of our existing data bases have some major problems associated with them. This is especially true of the data bases maintained by the federal government. The report of the President's Reorganization Project for the Federal Statistical System have identified many problems with the federal system. These problems include: 1) lack of policy relevance; 2) periodic threats to integrity; 3) inadequate quality; 4) inadequate protection of privacy of respondents who provide statistical responses and 5) excessive paperwork. The report also stresses that these problems are further complicated by the decentralized nature of the federal statistical work.

As new data bases are developed, attention must be given to the problems identified by the study group discussed above. In addition, consideration needs to be given to administrative issues including: defining, designing, creating, maintaining, monitoring and evaluating the data base. Also, liaison with and training of data base users must be assumed. In most cases, there are no easy solutions to these issues. If all these issues are not adequately

addressed then the data base usefulness will certainly be curtailed. Furthermore, most of these issues cannot be solved by applying new technology but by people working on the issues and problems identified.

The End User

If information systems are to be successfully utilized, the end user's (decision maker's) skills need to be improved. Several universities and other organizations have already conducted workshops which train end users on the fundamentals of the computers. These training workshops explain the various hardware components and expose them to the standard set of general purpose software packages such as electronic spreadsheets, data base management systems, general financial packages and some office support software (e.g., word processing packages). However, to effectively use either the general purpose software or special purpose agricultural software the user must have adequate conceptual skills to apply the appropriate software to his unique problem. For example, if it is an economics problem, the user needs to know whether capital budgeting, cash flow planning, linear programming, or some of the other analysis techniques are appropriate for the problem at hand. This will require a major educational effort before a large proportion of our users have these skills.

Finally, it should be noted that the computer is not likely to change the basic motivation of some users. If a farm manager currently has a strong dislike for record keeping and analysis of problems, it is unlikely the computer will eliminate this dislike. It is not difficult to find farmers hoping for a computer that will somehow "suck up" their bills and receipts and subsequently write the checks, prepare the appropriate financial and tax statements automatically for them. The end user's expectations of the computer must go beyond the belief that it will free them of all paper work if the information system of the future is to find widespread acceptance.

The Support System

If decision makers are going to make effective use of a computer system, they need an adequate support system to assist them. The support system for agriculture is currently very weak. As a rule, farmers feel that the salesmen in the local computer store generally do not know the subject of agriculture and likewise cannot visualize which software packages might be useful to them and/or how to apply them to their particular situation.

A major question which must be addressed is who will assume the responsibility to train the end users on how to effectively use a computer system. At a recent conference held in Texas for vendors of agricultural software and computer systems, there was disagreement on who should perform this role. Some viewed their role as software developers and felt it was the responsibility of someone else to do the training. Others felt their role also included training. How and when this question gets answered will have a major impact to usefulness of computers for farmers.

THE ECONOMICS OF INFORMATION SYSTEMS

Most discussions regarding prediction of the future tend to ignore economic considerations. Before new information systems are developed the

economics must be addressed. New or better (e.g., more timely) information as a general rule will have a cost associated with it. This cost must be evaluated against the perceived value of this new or better information to the decision makers who will utilize the information.

Cost of information systems can be divided between the development costs and the operating costs--including maintenance costs. It is easier to locate funds for the development of an information system (e.g., grant funds from foundations, government agencies or other granting agencies) than for the operating costs. Many information systems really begin to struggle economically when they move into the operational stages. This is because the perceived value to the user community does not exceed the operating costs of the information system.

For an information system to find acceptance in business it must be perceived by the manager that it will improve the profitability of the business. If the information system is able to generate new income (e.g., increase production efficiency or improve marketing decision) or reduce costs (e.g., better utilization or resources) to a greater extent than it will increase costs (e.g., cost of equipment communication fees and software) or reduce income (e.g., bad decision being made because of the new information), then the information system is likely to find favor among business managers. Unfortunately, a number of the information systems developed for agricultural businesses have not correctly addressed these economic issues and thus have not been very successful.

However, there are some non-economic reasons for information systems (e.g., government regulation). In some cases this may be sufficient grounds for a new information system. In most cases it will not be.

There are circumstances which justify the use of public funds for the development and operation of data bases. In addressing the appropriate role of public institutions, attention should be given to possible reasons why public investments in research and public service should be supported. Ruttan has identified three major reasons for public expenditures in these areas. First, he argues the economic incentives for private research are inadequate in agriculture. The social returns exceed the private cost. Therefore, the expenditures for research and public service will have to come from public sources if society is to reap the full benefits or any benefits from new advances in certain areas.

The second reason for public expenditures in these areas relates to the complementary relationship between research and extension activities and the university instructional programs. It would be difficult to have a strong graduate program without a strong research program and vice versa.

The third reason is that these activities contribute to the maintenance or enhancement of a competitive structure in agricultural production, farm supply, and marketing sectors. A good example is the seed industry. The Land Grant System and the USDA have assumed the role of developing new lines of seed corn which serve as the basis for various hybrid crosses. Private seed companies continue to make only modest investments in supporting services such as genetics, plant pathology, and physiology.

SUMMARY

Information is used by managers for decision making. Information is processed data. Therefore, the information needed by the decision maker will influence the data collected and processing used.

Computer technology is increasingly being used to process data into information. The future for computer hardware is bright. The future for other parts of a computer based information system (e.g., software, data bases, etc.) is also promising but to a lesser extent.

Finally, information systems must be viewed in an economic context. Information is not a free good. Will the perceived value of the system exceed the costs of developing and operating an information system? If not, then the success of the information system is questionable.

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