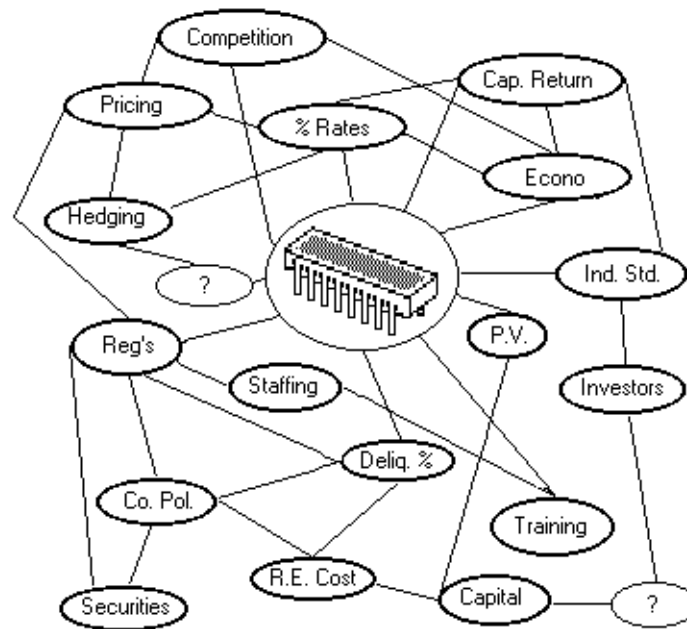


EXPERT SYSTEM TECHNOLOGY IN THE MORTGAGE BANKING INDUSTRY



By: Glen Cooper
Date: 1992

INTRODUCTION

Imagine you are the Vice President of the hedging department for a major financial institution. Monday, after getting your morning coffee, you sit down in front of your computer terminal and say,

"What's your best guess for interest rate movement this week?"

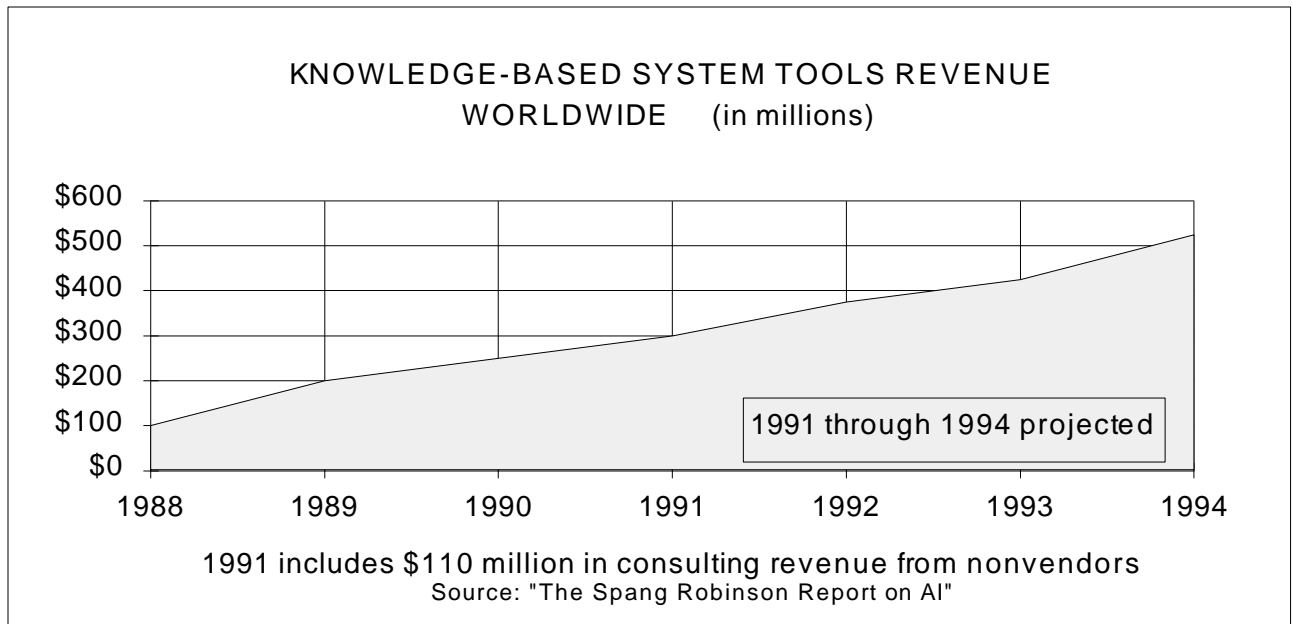
Your computer, which has been working on this problem over the weekend by accessing various data bases around the world, after a brief hum responds with,

"I think this week will be uneventful.
I expect no more than an eight of a point movement."

You then ask,

"Really, why do you think that?"

The ability to have such conversations with your computer is still many years away. There are, however, techniques available today that allow us to take advantage of the technology that will one day make the above conversations possible. One of the fastest growing of these techniques is a group of computer programs called knowledge-based or expert systems (ES). As the below graph demonstrates revenues from ES knowledge-based systems has been showing steady growth over the past few years and is expected to continue that growth through the years to come.



THE MORTGAGE BANKING INDUSTRY

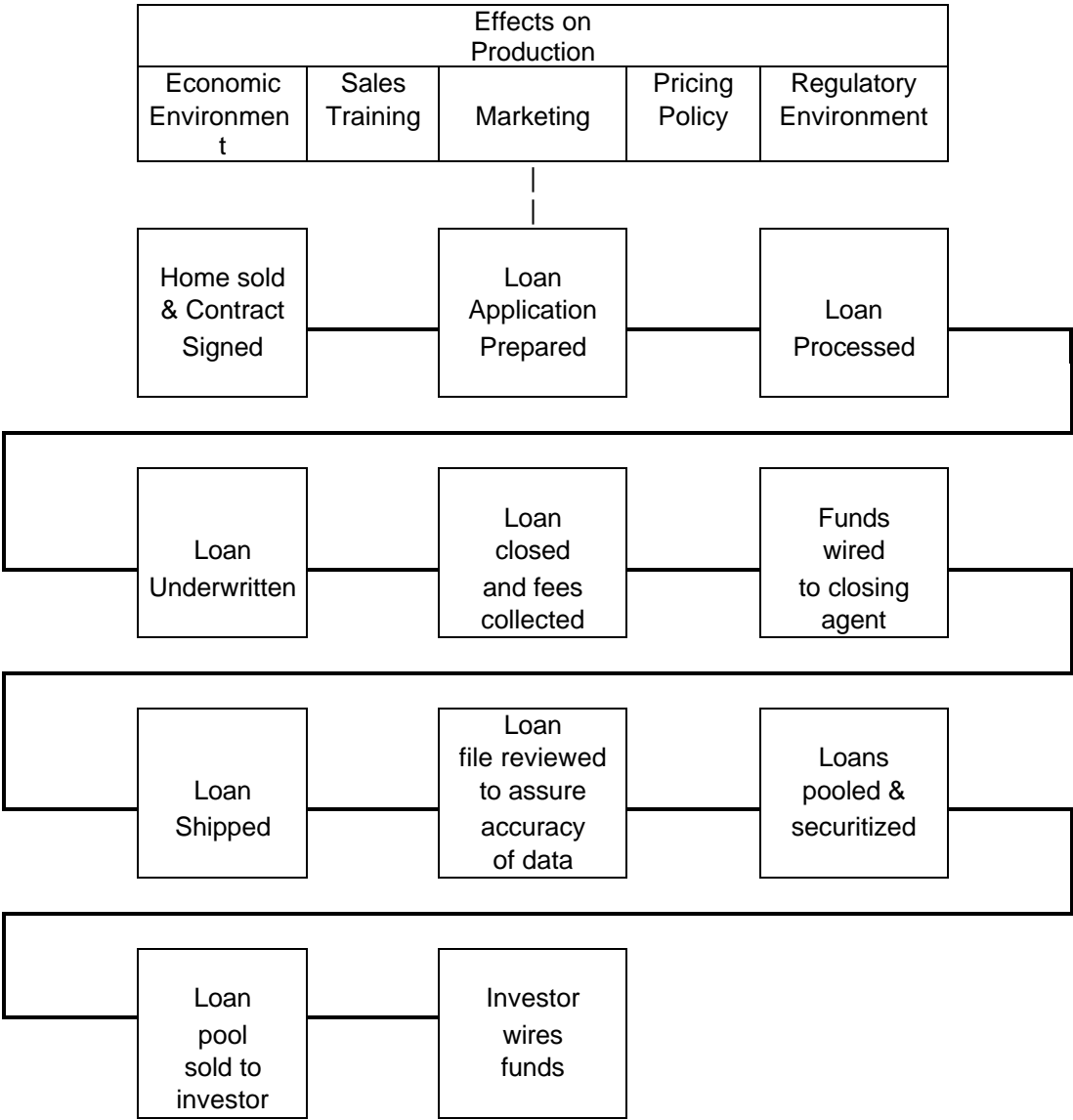
The flow chart on the following page diagrams the two major services provided by the mortgage banking industry. The first service is that of originating home mortgage loans and selling those loans in the secondary market to the ultimate investor/holder of the loans. In order to originate a mortgage loan the mortgage banker must first obtain a completed loan application. The ability to obtain these applications depends on such external factors as the current economic and regulatory environment and on such internal factors as sales force training, marketing promotions, and loan pricing policies. Once the application is obtained the proper legal documents are prepared, gathered, and processed. These documents are placed in a file to be reviewed by a loan underwriter. This mortgage expert, taking into consideration all the necessary regulatory and company guidelines, determines whether funds are to be disbursed on the particular loan file. If the underwriter has determined that this loan is to be approved then the loan is closed, that is the final documents are signed and funds are wired to the closing agent. The loan file is then typically shipped to a central location where it is reviewed to assure the accuracy of all the data within the file, it is pooled with other loans, and ultimately sold to a final investor.

The second service performed by the mortgage banking industry is loan servicing. Here the mortgage banker acts as a conduit between the borrower and the investor. In this capacity the mortgage banker collects the payments from the borrowers and forwards those payments, after subtracting a servicing fee, to the investor. The mortgage banker also performs various loan administrative functions, such as, processing loan payoffs, resolving problem loan workout situations, and foreclosing on delinquent loans.

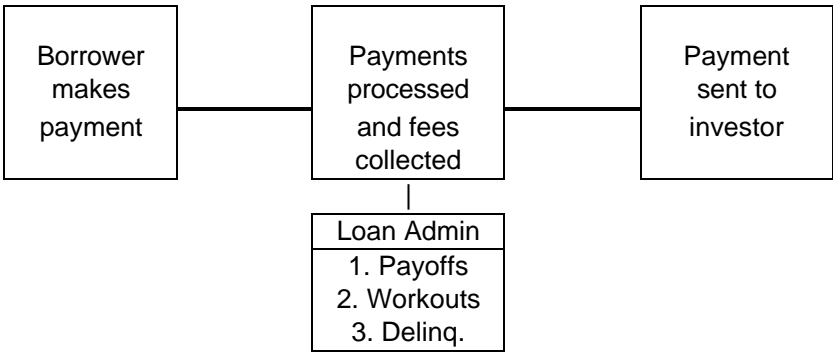
Of course this description has been over simplified. As with most industries there are many additional functions and services provided that can not be enumerated when presenting an outline of this type. However, the above description should give the reader a flavor for the general activities involved in the mortgage banking industry.

MORTGAGE BANKING IN OUTLINE

LOAN ORIGINATION & SALE



LOAN SERVICING



EXPERT SYSTEMS

Briefly stated, an ES is a computer software program that mimics the decision-making processes of a human expert. A human expert is someone with a special skill in a specific knowledge domain. The knowledge domain can be either narrow or wide. For example, the expertise could be in general finance and investments, or it could be in high technology stocks, or more specifically it could be in a particular IBM bond issuances. Anyone of these specialities may be appropriate for an ES. The purpose of an ES then is to allow non-experts to propose questions to the ES about the particular knowledge domain and to receive answers back that are equivalent to those that would be received from the human expert.

A typical ES has four basic components: a user interface, a knowledge base, a group of rules, and an inference engine. The user interface allows interaction between the ES and the user. The knowledge base, which is analogous to a data base, is a collection of facts obtained by interviewing experts. It consists of the facts, assumptions, and heuristics of the system. For example, it might contain Fannie Mae and Freddie Mac requirements for mortgage underwriting, or the characteristics of a good credit profile. The rules represent the process by which the knowledge base is applied. These rules typically take an "IF - THEN" form and are sometimes given probability weightings. Finally, the inference engine is the software program that applies the rules against the knowledge base to solve a particular problem.

One other component of any ES is the knowledge engineers. These are the people that direct the construction of an ES. They prompt the human expert with questions designed to uncover the expert's reasoning process. The Knowledge engineers then model the expert's knowledge domain using knowledge representation techniques. The knowledge engineers are often required to continually maintain and update an ES.

FACTORS LEADING TO THE DESIRABILITY OF EXPERT SYSTEMS

A factor contributing to Venice's accumulation of great wealth during the 14th and 15th centuries was its ability to maintain accurate accounting records using the newly developed double entry accounting system. This system allowed the Venetians to organize and summarize greater amounts of financial data than was previously possible, thereby, obtaining a significant competitive advantage. Today, financial institutions are driven by similar organizing and summarizing needs. Today's environment is infinitely more complex than Venice of those centuries. It requires systems that can manipulate, monitor, and make inferences from vast amounts of dynamic data.

ES's are the obvious response to this need. The ability to pass large amounts of data through a sieve extracting only relevant information, to "ask" questions about the data and obtain meaningful answers, and to explore data for trends that may not have occurred to the human questioner, will be the competitive advantage of the present and future.

An equally important result of ES is its ability to reduce operating costs by making human capital more accessible. As was noted by Bauer and Griffiths:

Human capital represents the major source of world wealth and also embodies a major asset of the firm. Ibbotson et al. (1985) estimate the value of total human capital greatly exceeds \$30 trillion, the total market value of bonds, stock, real estate, and precious metals. Carrying this analogy to the individual firm level human capital is probably the largest asset of most corporations.¹

Since human expertise is a costly resource, firms like to make it more accessible. ES can make this possible. Building an ES produces economies of scale. These economies are achieved because ES requires only one one-on-one session with the knowledge engineer. Once the system is built multiple copies can be made and distributed.

Other factors leading to the desirability of ES include, the lack of technically trained personnel, the ability to combine the knowledge of many expert opinions into one ES, and the ability to modify the ES as the environment changes. Finally, ES can alter the barriers

to entry. Since the cost of developing a large ES application can be high, a successful system can be difficult for poorly capitalized firms to duplicate, thus effectively excluding them from the market.

CURRENT APPLICATIONS OF EXPERT SYSTEMS

Unfortunately there is very little direct evidence in the financial literature about the design and use of ES's. This is because approximately fifty percent of all existing systems were developed in-house² and the developers see these systems as contributing to their competitive edge. This proprietary nature of ES contributes to the lack of information about their structure and use. Additionally, there is even less disclosure of ES failures as developers do not want to call attention to expensive mistakes or management shortcomings.

However, from a 1989 survey of ES users (non-statistical) the following banking tasks were identified as currently being performed by ES:

- Credit risk assessment/loan pricing
- Monitoring loan quality
- Credit file maintenance
- Loan approvals and rejections
- Credit line determination
- Valuation of collateral
- Problem loan restructuring³

This same survey indicated that relatively simple processes, such as, loan pricing and credit risk assessment represent the most frequently assigned ES tasks. More complex decisions, such as collateral valuation and problem loan restructuring are less frequent ES applications. This can be explained by the current highly structured state of ES technology. ES's do not offer significant flexibility and are, therefore, able to handle only well-defined repetitive tasks. They are currently not suited for unstructured problems requiring human creativity. Finally, the cost of building an ES that may be able to tackle the more complicated task, such as processing mortgage loans, is just too costly for most institutions to fund on their own.

Security Pacific has successfully developed two simple ES systems. One supports the property appraisal process. RESRA (Residential Real Estate Appraiser) reviews the Uniform Residential Appraisal Report filled out during an on-site appraisal and prints a log of inconsistencies. The other system supports their wire transfer operation. This system allows Security Pacific to check the profile of a customer who has requested that funds be wire transferred.

Two moderately sized and very popular systems in use within the general finance industry are MAPS financial analysis software from Management Advisory Services and FAST Advisor from Financial Proformas. Both of these commercially available packages review historical financial information, interpret patterns in key financial ratios, make judgmental evaluations, and provide brief evaluating comments.

A notable exception to the narrow to medium focused ES is Arthur Andersen's Mortgage Loan Analyzer (MLA). Andersen's IBM PC-based package was developed through Aion Development System. MLA uses some 200 data elements to evaluate particular mortgages. In an advisory mode, MLA asks the loan officer questions, that often require subjective answers, and then draws conclusions about the loan. In this way, MLA can acquire new knowledge about how human loan officer's approve or disapprove loans. As a side benefit MLA will document the reasons for an underwriter's final decision.

Another exception is Syntelligence's Lending Advisor. This system which was introduced a few years ago guides loan underwriting personnel through credit analysis, loan administration, and loan review. The costs for this product is high, running as much as \$2 million and its future is unclear as Syntelligence filed for Chapter 11 bankruptcy protection in early 1991.

SHORT-TERM IMPACT OF EXPERT SYSTEMS ON THE MORTGAGE BANKING INDUSTRY

APPLICATIONS

Over the next few years ES use in the lending areas is likely to remain constant. This can be attributed to an apparent strategic decision within most financial institutions to automate relatively simple, repetitive lending and operational decisions, while focusing human resources on the more complex decisions encountered.

As powerful PC's become the standard within the mortgage banking industry, expect to see many more commercially available PC based ES programs. These programs will consist of both easy to use end-user development tools and narrowly focused application packages. The end-user development packages will be integrated with popular spreadsheet programs. In addition they will integrate with EIS systems, thus providing managers with the ability to review EIS system data by establishing a set of rules and having the ES monitor the data stream for exceptions. The applications created by the end-user will automate many relative simple operations, such as, data entry review, equipment maintenance schedules, capital budgeting, and erroneous payment checking, while the manager will search for such things as unexpected loan production decreases and increasing employee turnover. The commercially developed applications will automate routine accounting decisions, financial statement and journal entry review, procedure writing, and payroll processing. Other activities that are good candidates for ES augmentation in the short-term include forecasting, PC systems support, elicitation of client goals, credit line management, market-timing decisions, automatic portfolio insurance and hedging strategies.

Some medium sized systems will also be created over the next three to five years. These systems will automate and/or lend support to slightly more complicated technical areas. Expect to see more mortgage underwriting systems appear on the market. For instance, more systems like Manufacturers Hanover Trust Co.'s Technical Analysis and Reasoning

Assistant (TARA), which monitors bond and interest rates algorithmically, updates trading models automatically, and makes buy/sell recommendations, are likely to appear.

INDUSTRY CONFIGURATION

IBM, Countrywide to Offer Expert System for Mortgages

By KAREN GULLO

International Business Machines Corp. is joining with one of the nation's largest independent mortgage companies to develop a system for underwriting home loans.

IBM's partner is Countrywide Credit Industries, the parent company of Countrywide Funding Corp., the 14th-largest firm in the mortgage servicing business.

The software incorporates expert systems, a form of artificial intelligence, and is designed to speed the handling of mortgage applications.

Expert systems "learn" to evaluate information by drawing from the knowledge of human experts in making decisions or recommendations.

Enhancing Productivity

Countrywide, which is seeking efficiencies to accommodate

personal-computer-based automated loan origination system. Called Edge, the system handles loan application processing — collecting credit information, loan rates, discount points, and other information that is either keyed in or downloaded from Countrywide's mainframes.

Instead of routing an application to an underwriter, the application will go to the expert system, which will either approve the application or flag problem areas, based on criteria programmed into the system.

The criteria follow guidelines on such factors as an applicant's

Countrywide

expects to increase

productivity

by 80%.

As the above headlines, taken from American Banker, suggests, partnerships between computer industry firms and end-users, as well as between computer firms themselves, will increase in the short-term. These partnerships are a means of capitalizing and reducing the risk of building the medium to large systems. These partnerships will not only be a means of developing ES technology but also of marketing it.

As was noted earlier Syntelligence recently filed for Chapter 11 bankruptcy. This type of situation should continue over the next few years as this still maturing market shakes out or consolidates its unsuccessful vendors.

RECOMMENDED INDUSTRY RESPONSE

The phrase for the mortgage banking industry's response to ES should be "cautiously aggressive pursuit."

Caution is needed because ES is still a relatively new and costly science which needs time to develop. Management should be cautious of vendors representing conventional, low-margin credit-scoring systems as state-of-the-art, high-margin expert systems. Many of these systems are like computerized credit scoring systems calculating a numeric index of loan quality from a series of mechanical decision inputs. These are not true expert systems, in the sense that they do not make explicit credit decisions and are not able to explain how and why they reached their decision.

The industry should avoid the tendency to become enamored with computer decision making capabilities. ES simply represent another way to manipulate symbols electronically. Management decision makers should, therefore, be careful not to make decisions based upon the undocumented claims of ES manufactures and consultants. However, although caution is called for with respect to ES, the industry cannot ignore and in fact should aggressively pursue the tremendous potential ES holds. Failure to do so could result in a serious loss of competitive advantage.

One approach to the exploration of ES's potential is to begin providing ES tools and training to technical employees. This approach would result in at least two advantages: first, the technical employees will become familiar with the new technology and, two, management can monitor the types of systems that emerge and then eventually integrate the better systems with each other and with conventional computer processing. Robert Long, president of Thinking Technology Associates, Phoenix, in his book Artificial Intelligence for Commercial Lenders, published by Robert Morris Associates, terms this the "building block approach."

LONG-TERM IMPACT OF EXPERT SYSTEMS ON THE MORTGAGE BANKING INDUSTRY

APPLICATIONS

Today, loan restructuring, problem loan identification and other complicated tasks, do not appear to be deriving much benefit from the application of ES technology. However, ES combined with other infant technologies such as image processing, voice recognition, and neural networks will become key technologies over the long-term. As John P. Singleton Vice Chairman of Security Pacific and Chairman and Chief Executive Officer of its technology unit, Security Pacific Automation Co., is quoted as saying, "Expert systems, artificial intelligence, and neural systems will all create the competitive edge in terms of what they can offer the customer and how quickly they can process transactions..."⁴

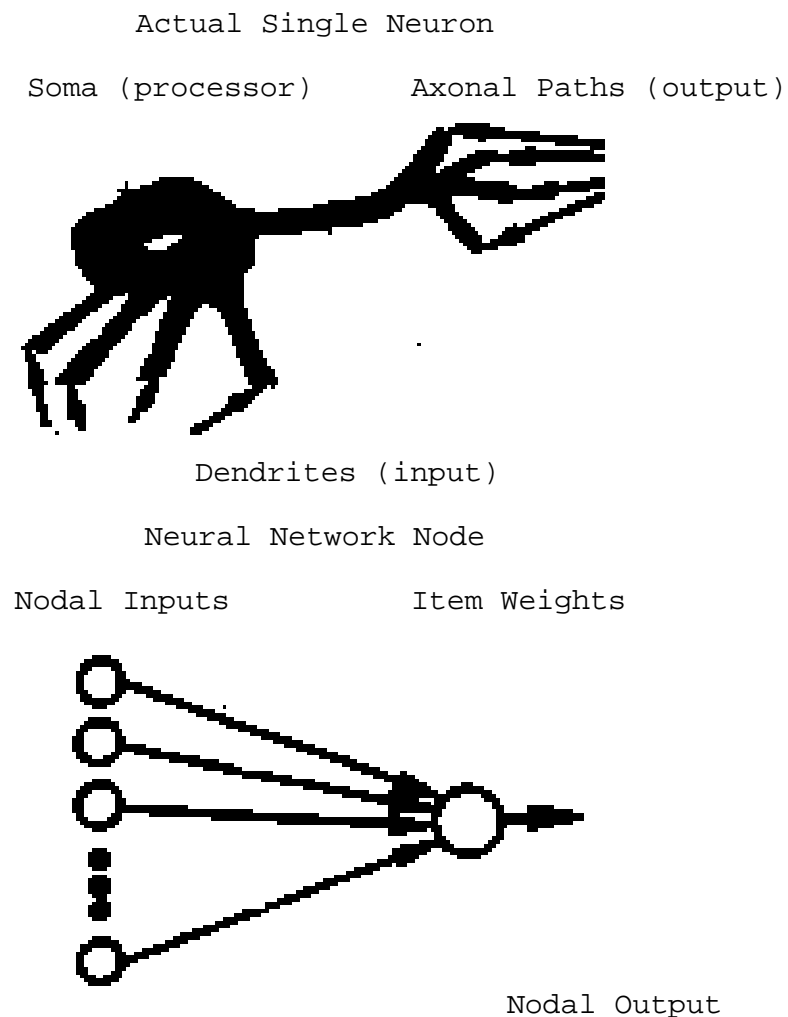
The need for that competitive edge will be the impetus for further advances in ES as well as other technologies. In the long-term anticipate ES and similar technologies to penetrate deeper into previously exclusive human domains.

Also expect, as Jeff Bulter, Chief Information Officer for Countrywide Funding Corporation, suggested during a recent interview, the sharing of ES programs between companies. Today's companies must send data between each other for review and approval. In the future, companies will supply each other with their own on-site "ES representative." If the ES representative approves of the data then the company will guarantee its approval as well.

Finally, expect an increasing use of ES backward reasoning techniques, whereby the ES module is not programmed to supply answers to questions but instead is programmed to develop its own questions and then provide the answers. Such systems could provide a powerful tool for analyzing prepayment and loan delinquency rates, and economic trends.

A WORD ABOUT NEURAL NETWORKS

Neural networks are a second very promising new technology. Although not the focus of this study, some discussion time should be devoted to them. A neural network is a computer software program that models the functioning of neurons in the brain. As the below diagram shows the neuron has input, processing, and output systems. As also indicated below neural network nodes model this basic neuron structure.



In the brain's neuron electrical charge is passed through the dendrites to the soma. When the charge in the soma reaches some critical level, it passes the charge to the neurons attached to its axonal paths. In a similar way, each time information is added to a neural

network node, new items weights are calculated and when the output nodal reaches some critical level the signal is passed to the next node.

ES depends upon a series of IF-THEN rules that are pain-stakingly extracted from experts and then programmed into a knowledge base. Neural networks do not require any predefined knowledge base. They create their own knowledge system based on the inputs (and possibly outputs) to which they are exposed. Additionally, changes in the problem do not require reprogramming; the system simply retrains itself. It is this continual adaptation and improvement that represent the neural network advantage.

Neural networks can also work with noisy and incomplete inputs and produce the correct output. This is done when the network fills in the gaps in incomplete information. This ability to generalize by filling in gaps in information is also a very useful function of neural networks.

Although the neural network system may sound very promising it is still in its infancy and like any emerging technology, has its problems. One of its biggest problems is that once running the weights and algorithms become so complicated that extracting how the system is achieving its results becomes impossible. It, therefore, becomes a "black box" from which there is no way to tell how it is working.

RECOMMENDED INDUSTRY RESPONSE

The most important techniques that firms can develop in response to these advancing technologies is in the area of risk based cost/benefit analysis. Such techniques should focus on avoiding the common pitfall of committing hundreds of thousands of dollars to an emerging technology that has a slim likelihood of providing commensurate benefits.

WHERE WILL WE BE IN THE 21ST CENTURY

The imagined conversation between you and your computer in the introduction of this paper will become a reality in the 21st century. Computers will not only be able to converse sensibly about large amounts of data but will quite possibly exceed human abilities to make conclusions about that data. As both management and consumers become more and more comfortable with these abilities we can expect the computer and its intelligence to impact all facets of the market place and our lives.

CONCLUSIONS AND GENERAL RECOMMENDATIONS

The use of expert systems and in general artificial intelligence (AI) will grow in the years ahead. The mortgage banking industry must prepare for its impact by continually monitoring and exploring AI techniques. In the short-term the industry should focus on small to medium gains in productivity through AI technology. Once the industry has accumulated the experience with and acceptance of this new technology, and after the industry has developed its AI cost/benefit analysis techniques, larger systems can be attempted. The industry must endeavor to maintain connectivity between systems. The eventual link up of separately created systems will surely create competitive advantage. Under any eventuality the industry must recognize that AI technology simply represents another way to manipulate information. Technology wizardry, no matter how fantastic cannot replace the customer and, in the age of the customer, the firm that identifies the right customer service to provide or provides it best, whether through high or low technologies, will be the firm that survives.

NOTES

¹ Bauer, Richard J., Jr.; Griffiths, Mark D., "Evaluating Expert System Investment: An Introduction to the Economics of Knowledge," Jrnl of Business Research , Vol: 17 Iss: 2 Sep 1988 p. 224.

² Plath, D. Anthony; Kloppenborg, Timothy J., "Do Expert Systems Help Make Better Lending Decisions?" Jrnl of Retail Banking , Vol: 11 Iss: 4 Winter 1989 p. 30.

³ Plath, D. Anthony; Kloppenborg, Timothy J p. 30.

⁴ "Technology Gets Top Priority at Security Pacific: An Interview with John P. Singleton." Bankers Magazine , Vol: 174 Iss: 3 May/Jun 1991 p. 10.

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