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Expert Systems for Decision Support in Business Start-Up

Can Expert Systems Help in Founding a Business?

The need for successful business start-ups is increasingly apparent these days, since new businesses create new jobs and support structural changes in the economy. But the mortality rate of young firms is high. In West Germany, three of four new firms die before their eighth year (Institut der deutschen Wirtschaft 1989).

Empirical studies show that many of the problems faced by new firms occur because of poor planning in the start-up phase. In starting up a business the founder is confronted with many problems (e.g., contacting public authorities, understanding state regulations, obtaining financing, formulating a deed of partnership, choosing a legal status, choosing potential suppliers, planning a system of distribution, assessing the market), which may prove too much for him or her.

In West Germany there is little academic training of entrepreneurs. Only a few entrepreneurship courses are offered in public institutions, so the entrepreneur has to rely on the support of business consultants, lawyers, tax advisers, banks, or regional development agencies. This is a very unsatisfactory situation for the founder for the following reasons:

- If the founder wants to have complete support for his start-up, he has to contact several different

experts: bankers offer advice on the best possible mixture of public money and private bank loans, tax advisers choose the legal form of a business so as to minimize the tax burden, lawyers draw up the business contract, and business consultants assist in setting up a business plan for the first years. But all these decisions are interrelated. The problem is that all of these experts may give the best advice in their own field but neglect to understand the ramifications this advice has for a related area. For instance, a tax advisor may recommend the legal status for the new business which results in the least tax burden, yet fail to consider the implications this choice has for company law or finance.

- It is often difficult for the founder to understand the recommendations of the consultants; for example, the meaning of particular clauses of a deed of partnership are very difficult to understand. (Fuller (1989) discusses how different views of the problem can cause communication barriers between the consultant and his client.)

Expert systems may help overcome these problems and in doing so make business consulting more efficient. Expert systems are computer programs that simulate the reasoning of human experts in a certain domain (Chadwick and Hannah 1986).

Expert systems differ from conventional programs in that the latter manipulate data while the former present the knowledge (expertise) of experts. Conventional programs work on well-defined problems which can be solved by a deterministic algorithm. Expert systems work on more complex problem domains. For example, obtaining financing via public subsidy programs is a complex problem because of the enormous number of programs and the many details which have to be considered. Expert systems use heuristic procedures which are often supported by the use of probabilities and rules of thumb. Expert systems not only produce a solution but also explain their results (Waterman 1986, Sviokla 1986, Kurbel 1989, Hart 1986).

Expert systems also have a different structure than conventional programs (see table 1). The knowledge base contains the knowledge of the expert (facts, heuristics) in the shape of rules (e.g., "If there exist special risks within the business, a legal form with limited liability should be chosen."). This knowledge is processed by the inference engine, which draws conclusions and produces solutions. The explanation facility describes to the user why particular decisions are made and explains the steps used to reach them. The dialogue between the user and the expert system is controlled by the user interface in the form of question menus (Schnupp and Leibrant 1986, Kurbel 1989, Barrett and Beerel 1988).

Nevertheless, an expert system is still a computer system and not a human expert. Davis (1982) lists the following characteristics of human expertise:

- Solve the problem.
- Explain the result.
- Learn.
- Restructure knowledge.
- Break rules.

**Table 1
DIFFERENCES BETWEEN CONVENTIONAL PROGRAMS AND EXPERT SYSTEMS**

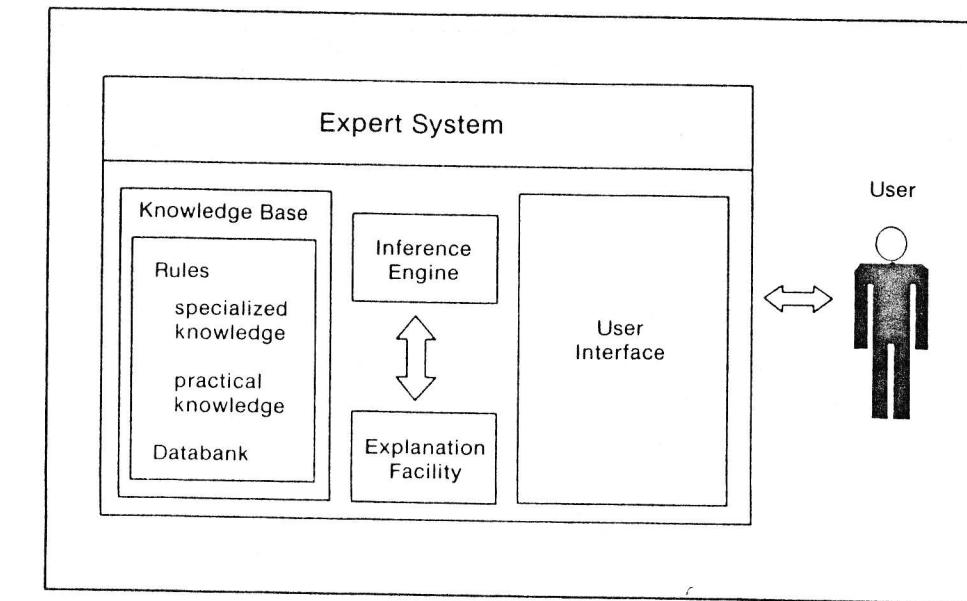
Criteria	Conventional Programs	Expert Systems
Information	Data	Knowledge
Procedure	Algorithmic	Heuristic
Result	Solution	Solution and Explanation

- Determine relevance.
- Degrade gracefully.

Most expert systems achieve the first two characteristics, but they are not able to learn or to break rules. Allowing for these restrictions, however, expert systems can be useful in business start-ups. Expert systems can combine the expert knowledge of many different experts in a particular area. For example, where the choice of the legal form for the business is concerned, tax considerations, legal implications, and financial aspects can all be considered at the same time without contacting several different consultants each time a question arises. Of course, the system should only serve to support the consultant, not to replace the consultant; because of the inherent limitations of expert systems, the expertise of consultants will always be required. With the help of the explanation facility, the founder and the consultant can discuss the reasons for particular decisions so that the founder can understand why he or she should do something. The basic structure of an expert system is shown in figure 1.

The problems of a business start-up are complex. Much information and knowledge has to be considered when making decisions in such areas as combining public subsidy programs for financing or choosing an appro-

**Figure 1
BASIC STRUCTURE OF AN EXPERT SYSTEM**



priate legal form. During the development of an expert system, the information will be structured and the system will systematically take into consideration all the knowledge built into it. Also, supporting a consulting expert with a bundle of interdependent expert systems can increase the efficiency of consulting itself, in that the consultant is aided when coping with the aspects of the start-up which involve complex domains. Comprehensive use of information techniques results in a well-founded consultation.

Possible Problems With the Use of Expert Systems

The use of expert systems, like the use of any other information technology, has its merits but may also present problems. One problem is prejudice against computers as part of the advising process. The founder may be used to receiving advice from human beings and show little trust in advice given by computers. By carefully plan-

ning the consulting process, this lack of acceptance can be surmounted. Before the computer is used, a talk between the founder and the consultant is indispensable so that the founder is not resistant to providing the detailed information necessary to use an expert system. Further, the computer should not play too great a role in the actual consulting, but should only serve as a support; personal contact with the consultant forms the basis of the consulting. This personal interaction may require the consultant to modify or reorganize the solutions given by the expert system.

Another problem concerns liability. Who takes the responsibility for the recommendation of the expert system? In our opinion, it is necessary that the consultant be responsible for the final recommendation because it grows out of both the recommendations of the expert system and the considerations of the consultant.

Another problem is the necessity for constant updating of the expert system. In order to guarantee the user the system's maximum advantages, the knowledge engineer (designer and builder of an expert system) must be continuously aware of the most recent developments and include these within the system (Waterman 1986). It would be ideal if the consultant were able to modify the software himself, but in practice this is very seldom the case. Also, because of the large variety of sources of information that are required for an expert system to function properly, the task of constantly updating the system is best done by the company which developed the system. This may lead to other costs for the consultant and, depending on the software developer's pricing policy, consultants may have to pay for the first version of the system as well as for the updated versions.

The Development of the Expert Systems REFOWEX and GEFOVEX

Bifego(Betriebswirtschaftliches Institut für empirische Gründungs-und Organisationsforschung e.V. at the University of Dortmund) is planning to develop numerous expert systems for the support of business start-ups. The two systems outlined in this article have already been established (Müller-Böling et al. 1989, Müller-Böling and Bröckelmann 1989). The programs assist with two decisions, both of which have medium- and long-term effects for the prospective business: (1) choice of legal form(the REFOWEX system) and (2) the establishing of the deed of partnership (business deed) with regard to the chosen legal form (the GEFOVEX system).

With respect to the choice of the legal form, in West Germany there exists a large number of criteria which affect the choice among the several alter-

native forms. In setting up a deed of partnership, there are a wide variety of possible clauses within the deed. The clauses have interrelated effects. The characteristics of these two decisions lead to the advantageous application of expert systems.

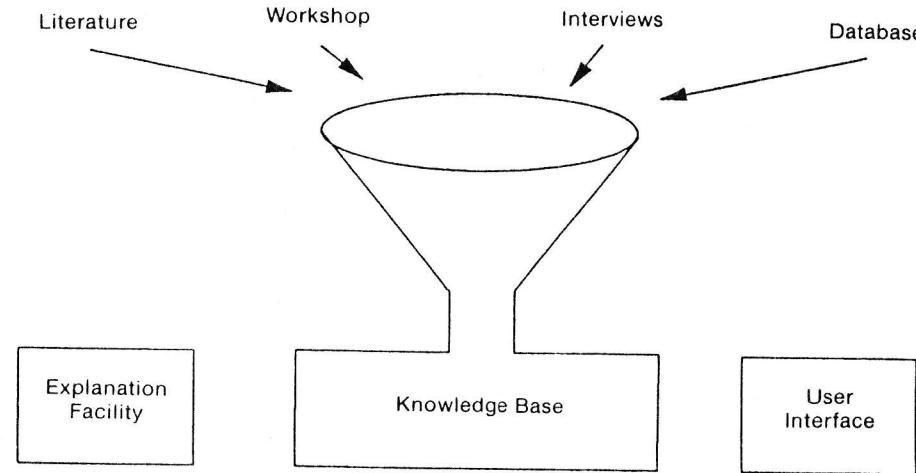
The two expert systems were developed with the help of the shell Xi-Plus. A shell is a tool for building expert systems. A shell can be thought of as an outline of an expert system. To construct the actual program, expert experience and expert knowledge have to be implanted in the form of rules (knowledge base). In addition, the explanation facility has to be developed and interim and final reports designed which make clear the inference procedure of the system and explain the proposed solutions. A user interface has to be created by designing the menu screens and by writing explanations for these screens that help to understand potentially difficult terms used in the questions to be asked by the program. This structure is illustrated in figure 2.

Knowledge Acquisition for REFOWEX

For REFOWEX, the initial task was to get knowledge concerning the choice of the legal form of business. As a first step, the literature on the subject of the legal form was analyzed. In doing so, relevant criteria for the evaluation and choice of legal form were identified, including liability considerations, number of partners, organization of management, minimization of tax burdens, and the image and prestige of each legal form of business.

These criteria served as a basis for discussion by a workshop of experts. Participants in the workshop were tax advisers, business consultants, members of regional development agencies, bankers, and lawyers (i.e., those persons who in their day by day work are confronted with the choice of legal

**Figure 2
STRUCTURE OF REFOWEX**



form and/or its effects). These experts were asked to give their assessment of the criteria developed from the analysis of the literature. They also explained their individual procedures for choosing an adequate legal form. The results can be summarized as follows:

- The experts offered more criteria for the choice of legal forms than were to be found in the literature: for example, the criterion that, if a particular form was a common form with a certain type of industry, it should be strongly considered; and the criterion that the size of a business is also an important consideration.
- Individual experts were found to judge the criteria very differently, depending on their field of expertise. For example, tax advisers attached more importance to the minimization of the tax burden than did other experts. As a consequence of their diverging assessments, different procedures for choosing the legal form (that is, in

weighing the individual criteria) were employed by the advisers.

- On average the following criteria were considered important: size of a business, liability considerations, number of partners, and commonness of use in various types of industries.

After the workshop, interviews were conducted with a tax adviser and a business consultant. These individuals were asked for a detailed description of the procedures they follow when choosing a legal form. The criteria of number of business partners, size of the business, commonness of use of a form within a particular type of the industry, management organization, and tax burden were found to be important.

The results of the analysis of the literature, the workshop, and the interviews were then used to develop the knowledge base. The problem of integrating the heterogeneous knowledge of the various experts was addressed by starting with those criteria which are common among the experts (i.e.,

number of partners, liability consideration, size of the business, commonness of use within a type of industry) and arranging these in a reasonable order. Criteria which could not be brought into this ordering because they were too dependent on the preferences of the individual founders (such as avoiding compulsory disclosure) or the experts were included in the form of annotations. In the program, the founder has to decide for himself which consequences he prefers. Special information which could not be dealt with in workshops and interview, but which was found in the literature, was also included.

The criterion of commonness of use within a certain type of industry, which had been stressed by the experts as being particularly relevant, was included in the expert system in the shape of a database. Data in this database were derived from the German Statistic of Turnover Tax (*Umsatzsteuerstatistik*), which records the number of business enterprises according to their legal form and branch of industry. If a user requires this information, the expert system accesses this database and gives information on those legal forms which are common in an industry.

All this knowledge was first formulated as a set of rules. Next, the procedure of the choice of a legal form was described in a diagram. This "Conceptional Model of Knowledge," which gave the recommended choice procedures for various characteristics of the firms, was then programmed for each type of firm—first for one-man enterprises, then for enterprises with more partners—with the help of X-Plus.

The Knowledge Acquisition for GEFOVEX

In contrast to REFOWEX, GEFOVEX was derived exclusively from literature.

In developing this system, a modular approach was chosen. On the basis of the individually required components of each deed (clauses concerning the headquarters location of a firm, purpose of the firm, and capitalization), factors necessary to determine these clauses (legal form of the business, number of partners, relationship between the partners, capital contributions of the individual partners) were identified, and interdependencies among the various factors on the clauses examined. The knowledge base was then formulated based on these relationships.

The Design of the Explanation Facility

In the explanation facility, the recommendations of the system are explained. REFOWEX, for example, explains why a particular legal form is advantageous. There are two levels of explanation facilities. First, there is an explanation facility within the expert system shell. It answers "why" by indicating all rules which had been considered in making the recommendation. These rules and their relationships are not particularly useful if the user does not know the syntax of the shell and its programming. The second level of explanation is more appropriate for the average user: this level produces reports at several points in the consultation process which explain the actual situation.

The necessity that a common view of the problem be shared by both consultant and client causes a dilemma: to establish such a commonality, the explanation facility has to give detailed explanation and information to the founder. This can lead to information overload. Therefore, the best solution is to present a summary of only the most important arguments. If this procedure does not provide enough information, the consultant has to fill in the gaps.

In order to prevent the final reports (the explanation of the decisions recom-

mended by the expert system) from becoming too lengthy, interim reports have been built into REFOWEX at crucial points of the consulting process. GEFOVEX also includes explanations concerning the formulation of a deed of partnership at crucial stages in the consulting procedure. These explanations provide information concerning individual clauses. However, for GEFOVEX, since the deed is simply the sum of the clauses, no final report is needed.

The Design of the User Interface

The user interface structures the dialogue between the user and the computer. In both REFOWEX and GEFOVEX, a menu leads the user through the consulting process and allows the user to either choose a response from a number of possibilities or enter characters or numbers. An important component of the user interface is the help facility which is provided by the program. As opposed to the explanation facility, which gives the reasons for the decisions made, the help facility explains technical terms which might be unclear to the user in the course of making responses. In the design of any user interface, the screen layout, the careful formulation of the questions, and the ordering of the questions are particularly important.

The Validation of the Systems

Any expert system requires validation. To ensure that REFOWEX appropriately represents the knowledge of experts in choice of legal form, the following validation activities were carried out:

- The system was demonstrated to experts for evaluation. The experts tried it out on test cases and evaluated the solution and the consultation process. Based on feedback from these trials, alterations were made in the information offered by the explanation facility

and in the structure of the knowledge base.

- A detailed documentary report was written and sent to the members of the workshop for review. However, little feedback was obtained from this mailing; most of the workshop participants did not respond.
- The system was presented at workshops and seminars where experts and founders could experiment with REFOWEX. This activity brought some supplementary information but no major alterations.

To validate GEFOVEX, we printed out example consultations and sent them to a business consultant and tax advisor for his comments. His suggestions for refinement are being incorporated into the system. Following these modifications, the consultant will test the system in actual practice. Only after GEFOVEX meets his requirements will the system be placed on the market.

Summary

Expert systems offer a powerful way to ease the consultant's burden. While these systems have their costs and drawbacks, and will certainly never replace the consultant, the successful development of the REFOWEX and GEFOVEX systems illustrates the usefulness of the approach. Examples of consultations using REFOWEX and GEFOVEX are available from the authors.

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