Computer Support of Placement Planning: The Use of Expert Systems in Child Welfare

JOHN R. SCHUERMAN
LYNN HAROLD VOGEL

Computers have become commonplace in nearly every setting, from home to office. In addition to their usefulness for managerial tasks, they have the potential to aid the primary decision-making tasks of professional social service workers. The benefits and background of such "expert systems" are explored, and the structure of one experimental consulting program for child welfare workers, PLACECON, is presented.

Interest is increasing in the literature and in practice in using computers to enhance the decision-making effectiveness of social service professionals [Schwartz 1984; Schoech and Schkade 1980, 1984; Sidowski et al. 1980; *CUSS Newsletter*]. This article explores the potential usefulness of computers for social service practitioners in child welfare, using the "expert systems" model to support the placement planning process.

The use of computers in child welfare has tended to focus on the development of centralized computer systems for client tracking, financial man-

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John R. Schuerman, Ph.D, is Professor, School of Social Service Administration, University of Chicago, Chicago, IL. Lynn Harold Vogel, Ph.D, is Assistant Professor, School of Social Service Administration, University of Chicago. Although the authors of this article are listed alphabetically, their contributions are quite distinct. Dr. Schuerman developed the PLACECON program and Dr. Vogel developed the general approach of this article's discussion on expert systems and wrote most of the paper. Both authors are responsible for the content.

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agement, and reporting of worker activity—the set of repetitive and structured control activities common to most automated management systems. These systems collect data to document the location of cases and respond to a variety of external control requirements (e.g., court dates and periodic reviews of worker activity and client progress), rather than to questions about what to do with or for a client in a particular set of circumstances.

A common complaint about these systems is that while line staff provide data for the system, they receive little in return. Thus the systems often induce strong negative feelings in line staff (with subsequent problems of incompleteness and inaccuracy of data), and frustrate management efforts to maintain data integrity.

Research has shown that the primary decision-making tasks of professional social service workers are often not highly structured. They have been characterized as largely intuitive and based more on experience, judgment, attitudes and predispositions than on clearly articulated procedures or models [Golan 1969; Austin 1981; Stein and Rzepnicki 1984]. The reasons why children come to the attention of the state, and the motivations of parents to treat their children in ways that lead to state intervention, are complex and not well understood. This has hindered the development of computer support for decision making by line child welfare staff.

The Placement Planning Process

The child welfare worker is often faced with the task of placement planning at several points in the course of a case. [Jones and Biesecker 1981]. At the earliest point of encounter, the question of placement is central: should the child remain home or be moved while the assessment is taking place? As the assessment proceeds, a variety of placement alternatives may be evaluated, including remaining in the home of a parent or moving to a friend's or relative's home. More dramatic placement alternatives may be considered (earlier or later, depending on the nature of the problems) such as temporary foster care, adoption, or group care. These choices are evaluated and reevaluated at several stages throughout the life of a case, particularly during periodic reviews of progress toward permanency goals. The introduction of computer programs to aid the placement planning process could provide more structure and thus could assist the staff to more clearly formulate permanency goals and more accurately measure progress toward them. If the computer could make available the expertise of more experienced workers to less experienced line staff, it is reasonable to expect more systematic judgments by workers. The expert systems model is one example of how this type of computer support might be developed.

Possibilities for Expert Systems in Child Welfare

The development of expert systems is one of several stemming from research in an area known as ''artificial intelligence''—the general effort to understand and emulate human intellectual processes [Ten Dyke 1984; Schank 1984; Davis 1984]. Expert systems are computer programs that use formal statements of knowledge (in the form of rules giving relationships among facts) and reasoning (procedures for developing inferences from the rules) within a relatively narrow problem area, to provide a possible solution to a specific problem. These systems are designed to provide consultation similar to that of a human expert—someone who is highly trained, skilled, and experienced in a particular area of knowledge. The computer's ability to store vast amounts of data and to apply a large number of rules to the data creates a potential for significantly improving the decisions made by humans.

Expert systems have been developed recently in a number of fields. Programs have been written for the diagnosis of medical conditions, for assessing the likelihood of finding oil in geological structures, and for analyzing complex organic structures. These programs operate with great sophistication, often displaying skill that goes beyond that of unaided human diagnosticians. Reports are already appearing in the literature of efforts to apply this emerging technology to decision-making problems in the field of social welfare (Schoech and Schkade 1980; Schoech et al. 1985).

The formal structure of a simple expert system is indicated in figure 1. The knowledge base is generally a collection of rules about a specific area of expertise. The rules consist of one or more IF statements and one or more THEN statements. When the program attempts to apply a rule, the IF statements are checked, and if true, the THEN statements are confirmed. For example, the following rule might be used in considering placement possibilities for a child:

IF an adoptive home is available, and

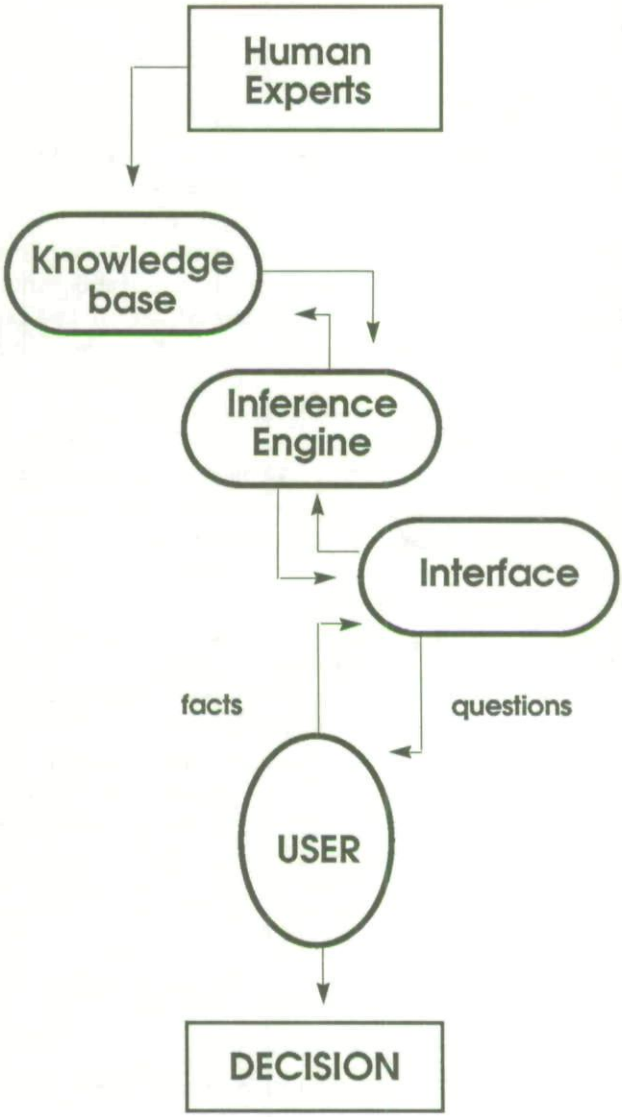
IF the available adoptive home is willing to accept the child,

THEN adoption for this child is possible.

An IF or THEN statement is a combination of an attribute (for example, ''adoptive home available'') and a value for that attribute, such as YES or

FIGURE 1

The Expert Systems model



NO. The program might seek to confirm the first IF, "adoptive home is available," by searching through a list of all possible adoptive homes. In the example above, confirming the two IF statements leads to the THEN statement. The conclusion, "adoption is possible," follows from the two conditions.

Uncertainty

Most expert systems contain the ability to accept certainty factors for each fact. Certainty factors are similar to probabilities in that they provide an assessment of one's confidence in the truth of a fact. This allows the system to handle judgments and hunches. Although we often think of computers as requiring great precision in order to function, certainty factors provide an opportunity to capture the ambiguity of facts in the real world.

In PLACECON, the expert system described below, certainty factors can range from 0 to 1, with 1 representing absolute certainty. For example, the attribute, "adoptive home available," might be estimated as true with a certainty factor of .8, indicating strong confidence (but not certainty) that an adoptive home is in fact available. Alternatively, the attribute "adoptive home available" might be declared as not true, with a certainty factor of .7. This would indicate confidence that an adoptive home is not available. In this fashion, one informs the system of various facts that may not be precise or that one believes with less than complete confidence.[1]

The Inference Engine

A second part of the expert system uses the facts and rules, and associated certainty factors, to make inferences based on user input. This logic system is called the inference engine (see figure 1). Its task is to search through the knowledge base of rules to identify, select, and apply those considered applicable to the problem at hand. The inference engine is the heart of the expert system, since it embodies the system's reasoning mechanism. The specific facts of a particular problem are provided to the expert system by the user and help to determine how the inference engine uses the knowledge base.

Expert systems can use either "forward inferencing" (forward chaining) or "backward inferencing" (backward chaining) procedures. In forward chaining, the system takes a set of facts from the user and moves toward a conclusion. For example, an expert system might decide what conclusions are possible about placement options, given certain facts about a particular case. In backward chaining, the system begins with a series of hypotheses that are tried one after the other in an attempt to confirm that one hypothesis is optimal under the circumstances. In the process, the system asks about facts needed to draw conclusions. Figure 2 provides an example of backward chaining as used in PLACECON, in which the first alternative tried is "Place Child in Own Home," followed by "Place Child with Relative," and so forth.

PLACECON: A Placement Consultant for Child Welfare

PLACECON is an experimental consulting program for child welfare placement decisions, based on the expert systems approach outlined above.[2] It contains a knowledge base of rules, an inference engine, and permits users to enter data about a specific placement problem. Facts about a case are entered into the system via a microcomputer keyboard, and PLACECON attempts to deduce recommendations for placement.

If the case is new to the system, PLACECON begins by asking some basic facts about the case. After each response, PLACECON requests a certainty factor for the answer.[3] When all the initial facts about a particular case have been entered, PLACECON asks the user to select from a series of options:

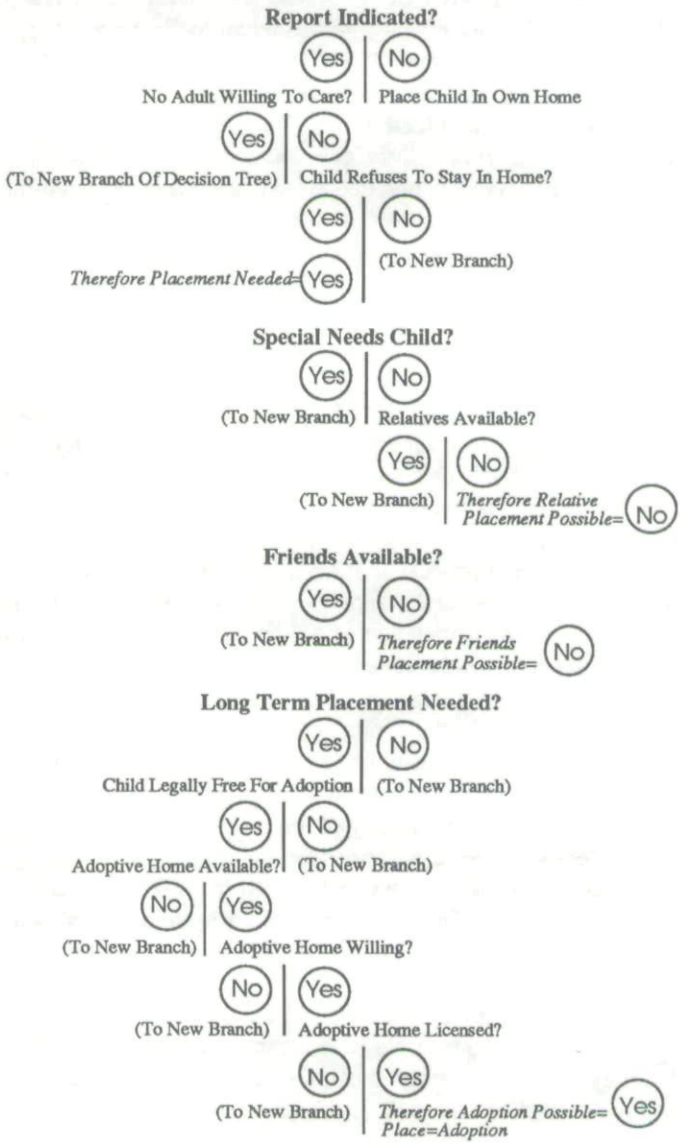
1. Enter more facts from the keyboard.
2. Have PLACECON deduce as many facts as possible from known facts (forward chaining).
3. Have PLACECON ask for facts needed to make a placement recommendation (backward chaining).
4. Have PLACECON report why it wanted to know a particular fact.
5. Have PLACECON report how a particular fact was deduced.

In addition, the user is able to erase facts that were deduced previously (leaving facts that were entered), start a new case, print a list of facts currently in the system, or leave the system altogether.

One of the most interesting uses of the system is to have it ask for the facts needed to make a placement recommendation (cf. 3 above). With this option, PLACECON will attempt to derive whatever facts it can from the facts already known and then will begin asking questions in an effort to arrive at a recommendation (this is the backward chaining process). The questions usually require a YES/NO response and the user is asked for an associated certainty factor. As the program deduces additional facts, they are reported on the

FIGURE 2

A Sample Logical Path for a Placement Decision



computer screen, along with their associated probabilities. When a recommendation is deduced, it is reported, along with its associated certainty factor.

Most of the 44 rules that constitute PLACECON's knowledge base have been derived from Stein and Rzepnicki's [1983] work on the decision-making process in child welfare. PLACECON follows the "least restrictive placement" or "least disruptive placement" guidelines from the permanency planning literature [Jones and Biesecker 1981] and considers placement options in the following order of preference: home, relatives, friends, adoption, foster home, special foster home, and institution.

One of the assumptions made in the construction of PLACECON, and of expert systems in general is that in practice, even complicated decision-making tasks are composed of layer upon layer of simpler decision-making rules. The challenge for the designer of an expert system is to uncover these simple rules through a painstaking process of questioning workers about how they actually arrive at a decision. (An example of the logic that PLACECON uses to reach a placement recommendation with a given set of worker responses is given in figure 2.)

In our view, a worker usually follows a fairly standard assessment procedure for arriving at a placement recommendation, although the procedure may be idiosyncratic to that worker. One of the major contributions of Stein and Rzepnicki [1983, 1984] has been to try to make the assessment procedure visible and clear, and to remove idiosyncracies that contribute to public perception that the assessment process is inherently intuitive and unstructured. PLACECON builds on Stein and Rzepnicki's work, and eventually it will retain a more complex set of rules than could be recalled by a single worker reviewing a particular case. Other frameworks for the placement process could have been used, and may be incorporated into PLACECON as the program continues to be developed. In the future, it may provide several alternative recommendations, perhaps ranked in order of preference. PLACECON acts as a consultant to the worker, helping to structure both the *process* of assessment and the worker's understanding of the *relationship* between the facts of the case and specific placement options.

Beyond the assumption of identifiable decision-making rules, expert systems such as PLACECON assume: (1) that there are systematic, rational, and identifiable elements in decisions about things like placing children; (2) that those elements are relatively stable; and (3) that such elements are not overwhelmed by constantly shifting political and bureaucratic demands. Political and bureaucratic considerations could be built into expert systems (although we hope that they would be a small part of such systems). At the least, the presence of these considerations will be made more explicit and obvious by an expert system, rather than remaining tacit or implicit as is often the case in human systems. We think that bringing such considerations to the surface in individual cases is a useful side benefit of expert systems.

The Future of Expert Systems in Social Welfare

As expert consulting systems develop, many issues will have to be faced. These range from the highly technical to the philosophical, with a vast middle ground in between [Alexander 1984; Martin 1984]. Explorations of the role of expert systems in fields such as child welfare must consider these issues carefully.

A fundamental requirement for the development of expert systems is that individuals be available who have expertise in the particular problem domain. Most operational expert systems have been built after an extensive process of interviewing acknowledged experts in a particular field and attempting to translate their knowledge (both facts and the strategies they use in their search for recommended solutions) into the rules of an expert system knowledge base—a process known as "knowledge engineering."

Knowledge engineering in the human services may be difficult, given the lack of congruence among experts about the problems presented by particular cases. A group of professional child welfare workers may agree on who is or is not an expert in their setting but the experts themselves may not agree on important aspects of placement planning. For example, experts may disagree about what facts to elicit in conducting an assessment of a child and family. Even with agreement about which facts to use, experts may differ in the interpretation they attach to specific facts. Further, even with agreement about the selection and interpretation of facts, experts may disagree about the placement recommendations that follow from given facts.

Expert systems must find ways to deal with the "softness" and imprecision of decisions in the human services field. Computers are often considered to be precise machines, doing exactly what they are told—the antithesis of human life with all of its uncertainties and seemingly random variations. Major efforts have been made to deal with this problem in the artificial intelligence field, giving rise to such arcane topics as "fuzzy logic systems" [Mandami and Gaines 1981; Negoita 1985]. In PLACECON, the certainty factors provide a rudimentary mechanism to deal with this type of imprecision. The user is asked for a fact and then provided an opportunity to qualify the answer with a number representing his or her confidence in the truth of the answer. But this may not be enough. The estimation of certainty factors may be problematic for individual child welfare workers because it requires probability judgments that workers are not accustomed to making. The user may want to qualify a response in ways that are much richer than that provided by a number between 0 and 1.

Another question that will affect the future of expert systems in the human services is the extent of knowledge that such systems must contain. For example, how much *causal* knowledge must be put into a program for it to be effective? The answer to this question seems to depend on the type of decision the program must make. A program to diagnose problems may need much more knowledge of etiology than a program to make decisions about what actions to take in a particular situation. PLACECON currently fits into the latter category; it has no knowledge of how problems arise—nor does it need any to achieve its present purposes. If its objectives were expanded to include the assessment of family or child problems, it might need to be taught something about the *sources* of family problems in order to successfully provide a recommendation.

Expert Systems in Use in Child Welfare

Expert systems should be considered "consultants" in the placement planning process. Given the room for interpretation that currently exists in any child welfare intervention decision, the judgment of individual workers will continue to play a central role in decision-making processes for the foreseeable future. PLACECON will not replace that process.

If expert systems like PLACECON can be developed beyond the point that they provide only obvious and trivial recommendations, their first potential use is likely to be in large public social service organizations in which the delivery of service is the responsibility of staff members with relatively little professional training. In such agencies, extremely important decisions must be made by people who are often ill-equipped to make them. Good supervision and in-service training programs help, but we suggest that expert systems may provide an additional practical approach to this problem. Ideally, such programs will make knowledge of experts in the field available to all front-line workers.

An alternative use for these systems might be in helping to confirm decisions of staff. Once a decision is made, the program might be used to verify the reasonableness of that decision. In addition, such programs may become an important part of training for new workers. A successful program will contain a considerable amount of knowledge of the field and that knowledge could be tapped for educational purposes.

PLACECON is intended to support just one aspect of the child welfare decision-making process—the selection of a placement option for a particular child. It is conceivable that in future years, child welfare workers will be able to use an entire set of expert systems to support decision-making—each focusing on a specific problem domain within the child welfare system. The development of a set of systems will take a good deal of time and money, however, and their productive use is several years distant.

Expert systems such as PLACECON—though still in the experimental stage—provide an opportunity to explore further the process of decision making in child welfare. By focusing attention on the decision-making processes in various child welfare tasks, and on the rules by which decisions are currently made, these systems will challenge practitioners to be more explicit about what they do during the complex decision-making tasks of placement planning. For researchers, expert systems will push the boundaries of knowledge about decision making and about computer support beyond the traditional concerns of management control into the arena of practice—and therefore promise to contribute to more effective practice. ♦

Notes

1. Rules also have certainty factors associated with them. That is, a rule may deduce its THENs with less than complete confidence. If a rule is successfully invoked, (i.e., if the IFs of the rule are true at least at a threshold level of certainty), the THENs are assigned certainties that are combinations of certainties of the IFs and of the rule itself. Various expert systems use differing procedures for the computation of certainty factors of conclusions. The computation and use of certainty factors is a subject of much debate in the expert systems literature and remains an area for further research.
2. PLACECON is written in LISP, an artificial intelligence programming language. It must be used with a LISP interpreter. Versions of the program exist for 2 interpreters—I.Q. LISP™, a product of Integral Quality, Seattle, Washington, and Golden Common LISP™, a product of Gold Hill Computers. Both of these interpreters run on IBM PC and compatible microcomputers, under the MS/PC-DOS operating system. LISP was designed to facilitate symbolic or nonnumeric data processing, and can use the same representation for program code as for data. LISP is a recursive language, which means that functions in the LISP program can call themselves in the process of operation. This is in contrast to other, more procedurally oriented languages (such as BASIC) in which data and procedures are separate entities, and functions within the program are limited to calling other functions.

   Similar systems could be developed for other interpreters and computers, including mainframes. Persons interested in more information about this work may write to John Schuerman, The School of Social Service Administration, The University of Chicago, 969 E. 60th Street, Chicago, Illinois 60637.

3. We are exploring the possibility of incorporating empirical data from actual placement experiences into PLACECON to provide the user with information on likely outcomes of placement options. This information might be used, for example, to provide empirical evidence for certainty factors for rules. We are working with the Enhanced Case Assessment and Planning System (ECAPS), currently being developed at The University of Chicago, to develop these empirical relationships. ECAPS uses a data base of the placement experience of all children who have been in the care of the Illinois Department of Children and Family Services (IDCFS) since 1976—currently approaching 100,000 cases. ECAPS is being developed by the Social Policy Research Center of the National Opinion Research Center in cooperation with IDCFS, with support from the Edna McConnell Clark Foundation, under the direction of Dr. Mark Testa.

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(Address requests for a reprint to Dr. John R. Schuerman, 969 E. 60th St., Chicago, IL 60637.)