

A Truly MAGIC Solution

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Beginning in 1988, the Merced County Human Services Agency in California realized it needed to find a solution to the rising costs of providing human services to a growing population and to the 35-percent turnover rate among its caseworkers. After selecting Andersen Consulting to provide assistance in solving its problems, the agency was helped with a little MAGIC (Merced automated global information control.). MAGIC uses an expert system designed to determine client eligibility for public aid and calculate benefits based on information in the database. Behind the scenes, MAGIC resides on Hitachi Data Systems mainframes, uses database software from Software AG, and connects a series of Hewlett-Packard (HP) minicomputers and microcomputers through an Ethernet local area network. The expert system was created using ADS (Aion development system) from Aion Corporation. In addition to increasing the services provided by the agency, MAGIC earned the 1991 Hewlett-Packard High Tech Award and is a finalist for the *Computerworld* / Smithsonian Award.

The Problem

The Merced County Human Services Agency is committed to the efficient and effective delivery of human services to needy individuals, families, and children. The nature of human services limits the ability

to provide quality care to the population without automation. Problems such as large case loads, frequently changing and complex regulations, worker frustration, and error rates result in high turnover and the loss of critical knowledge and skills.

Delivering modern social services is a complex task. For example, consider the task of determining the Assistance Unit Composition. The goal of Assistance Unit Composition is to determine who in the household is eligible for assistance. The following factors are some that might or might not be considered in the assessment for eligibility: age, disabilities, U.S. citizenship, residence in Merced County, family relationships within the household, and income. Furthermore, most of these factors are interdependent (that is, income cutoffs vary with number of children, citizenship, and residence).

Because of this complexity, the agency had to keep 10 specialized classes of workers trained and knowledgeable to deliver the level of service mandated by law. Each of the five major social service programs—Aid to Families with Dependent Children (AFDC), Refugee Cash Assistance (RCA), Food Stamps, MediCal, and Foster Care—required specialized workers. Within these five social service programs, eligibility workers were further segregated into *intake workers*, who performed the initial case review and interview, and *continuing workers*, who were responsible for ensuring that ongoing eligibility requirements were met.

To compound the situation, the tools of the trade, primarily the body of law that governed the services, was changing at an accelerating rate. If the system was to be automated, it needed to support the complex decision-making process of a caseworker and would have to be easy to maintain. The system would need to support the rapidly changing regulatory environment. In California, during an 18-month period, regulations were changing at an average rate of one a day. In addition to the rapidly changing environment, the new system needed to provide some guarantee that caseworkers would administer the regulations across similar cases in a consistent manner.

Delivering human services is also a time-intensive process. In fact, most costs related to welfare systems can be measured in terms of time: how long it takes from the time a client applies for aid until the client is seen by an eligibility worker, how long it takes to process a client through an interview, and how long it takes to maintain a case each month. However, the reality of publicly funded services in Merced County is that caseworkers could not spend as much time as they needed on each case, nor could enough workers be hired to perform the tasks. The result was an inverse relationship between the amount of work pending and the productivity level of the workers. The situation

created high error rates, high worker frustration, and increased worker turnover.

Prior to MAGIC, the work environment at the agency was deteriorating. Because caseworkers were overburdened, they inadvertently neglected clients, which led to adversarial administrative law hearings and a reduction of worker and client morale. Several other examples of service delivery problems are as follows:

First, clients suffered delays of three to five weeks in Merced County before the initial intake interview. Delays of as long as three months were occurring in other California counties.

Second, the process required the caseworker to spend several hours filling out multiple forms and making budget calculations for each client following the initial interview.

Third, documentation was done by hand in multitiered carbon copy forms. These forms were then filed into case folders for each case. Case folders contained hundreds of forms.

Fourth, the treatment of similar cases was inconsistent. This problem was partially the result of the specialization of application knowledge among the workers.

The Approach

The agency began its search for a solution to its problem in 1984. In 1987, those studying the problem decided that no existing system could offer what they needed to accomplish their mission. At this point, the agency developed a vision of a system that would increase service delivery costs, improve worker morale and productivity, reduce error rates, eliminate program administrative support costs, reduce the initial and ongoing training costs, and insulate the workers from regulatory volatility and complexity.

To achieve its goal, the agency employed focus groups, brainstorming sessions, national user group conferences, and visits to other states to build the vision that was to become MAGIC. At this time, all social service systems were either 3GL mainframe applications or workstation applications that covered far less territory than the agency desired. Because of the complexity of the regulations involved and the frequent updates to these regulations, an expert system approach was chosen. By using object orientation and rules, it was hoped that both the pure written regulations and the heuristics by which the experts deliver human services could be automated and maintained easily. The proposed system would not only include all the rules and regulations necessary to determine eligibility for each client but also would automati-

cally generate legal notices, referrals, and due dates. It would remind an eligibility worker, or family assistance representative (FAR), of deadlines and aid in the actual decision-making process. Within the social services industry, an expert system solution of this scale had never been attempted.

The Technology

The MAGIC solution consists of a multiple-tier client-server architecture based on an open-system application that permits interoperability at all levels. The system resides on an Hitachi mainframe (IBM 370-series equivalent) and runs through the HP 855S minicomputer to HP 386 VECTRA personal computer workstations. Data communications is handled by an Ethernet TCP-IP network. ADABAS supplies the data management services on the mainframe host, and INGRES is used as the data manager on the UNIX-based minicomputer.

Taking full advantage of the client-server design by downsizing applications allows individual workers to capitalize on the workstation's strengths and be freed from the telecommunication and central processing unit constraints of a centralized mainframe solution. MAGIC has offloaded 70 percent of the expensive mainframe online processing to the comparatively inexpensive workstation.

The expert system was developed with ADS, an object-oriented tool that enabled developers to build and maintain a 5700-rule knowledge base. Together, the workstation and the expert system form the *expert assistant*, a combination of programs that enhances the productivity, efficiency, and effectiveness of every worker that uses it.

The expert system is designed to satisfy two goals. First, the FAR work flow must be controlled flexibly. Second, all eligibility logic and heuristics must be contained so that FAR can be a *generic worker*, or a person who could determine the eligibility and process cases for all five human services programs.

The MAGIC expert assistant guides the worker through the interview and subsequent case maintenance by establishing to-do lists of tasks that must be completed before eligibility can be finalized. In addition to the automatic generation of to-do lists, the expert assistant allows the worker to override the default consultation flow and directly select tasks to process from a menulike task list. The to-do list for the task of Assistance Unit Composition is shown in figure 1.

Once FAR selects a to-do item, MAGIC prompts FAR with questions to ask the client. The questions are tailored to the client's situation; families or individuals that have different household compositions or re-

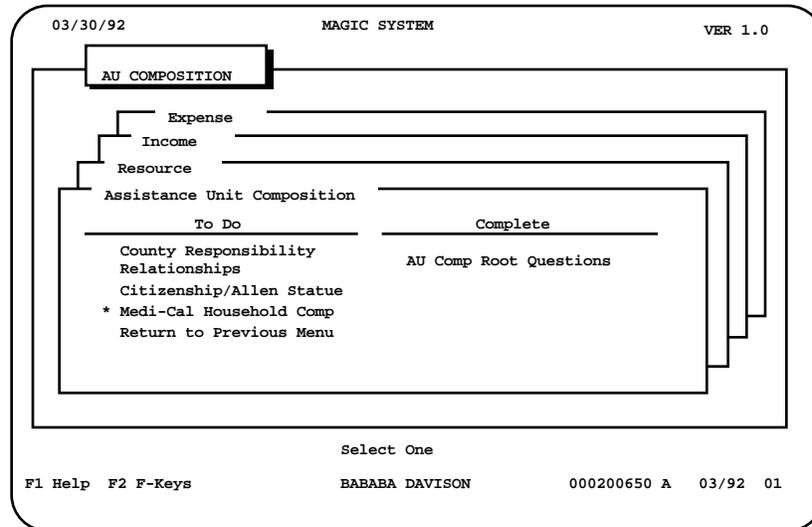


Figure 1. A MAGIC To-Do Screen.

quest different types of aid are treated according to their specific circumstances. The expert assistant then determines the next question to ask based on the previous client answers. These questions are dynamically formatted so that variable information can be included in the question. Answers are usually selected from lists or a standard yes-no selection. In this manner, the interview and data-collection tasks are managed for the worker and require minimal data entry. A sample question screen within the resource task is shown in figure 2.

The expert system handles to-do and question transitions through a novel use of ADS states. A *state* is the basic level of organization within the ADS tool. Rules and data elements can be owned by a state, and states can own other states, establishing a state hierarchy. Within the MAGIC system, unique state hierarchies, called modules, are defined. A *module* represents one functional task that might be executed within MAGIC. A partial list of modules within the Assistance Unit Composition task is listed in figure 3. Note that some of these modules correspond to to-do actions that FAR can select from the Assistance Unit Composition screen (figure 1). Other modules exist that govern common user utilities and the transfer of data to the minicomputer and mainframe.

Modules are composed of a parent control state and data-gathering states. *Control states* describe when the module should be called and what goals are necessary for the completion of the module. When FAR selects an item from a to-do list, usually the control state for a module

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03/30/92          MAGIC SYSTEM          VER 1.0
LIQUID RESOURCES          MW01801D
From the list below select the liquid resource
owned by the household
Escrow Account
Employee Deferred Compensation Plan
Keogh Account
Income Tax Refund
IRA
Life Insurance Policy
Mineral Right
Money Market Account
Mortgage
Mutual Fund
More
Select One
F1 Help F2 F-Keys          BABABA DAVISON          000200650 A 03/92 01

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Figure 2. A MAGIC Question Screen.

is called. Control states, in turn, own *data-gathering states*. These states contain the actual questioning logic. Rules within data-gathering states are either backward or forward chaining, depending on whether the questioning is goal or data driven. Most of the data-gathering rules for the Assistance Unit Composition module are backward chaining. A sample rule and its English-language equivalent are described in figure 4.

Within MAGIC, all ADS rules, states, and objects have standardized, although cryptic, names. These naming standards are necessary given that MAGIC is one of the largest deployed ADS systems, both in terms of size (roughly 7000 data elements and object attributes; over 5500 rules) and the number of simultaneous developers. These naming standards have also facilitated the maintenance of the system.

The MAGIC system achieves significant benefits in addition to those previously outlined. One benefit is the automatic generation of notices and the statement of facts, which previously were completed manually. Among the automatically generated documents, it is important to note that many of these documents can be produced in Spanish, Hmong, and Lao, as well as English, because a large percentage of recipients are non-English speaking.

The Project

The development of MAGIC began in October 1988 when Andersen

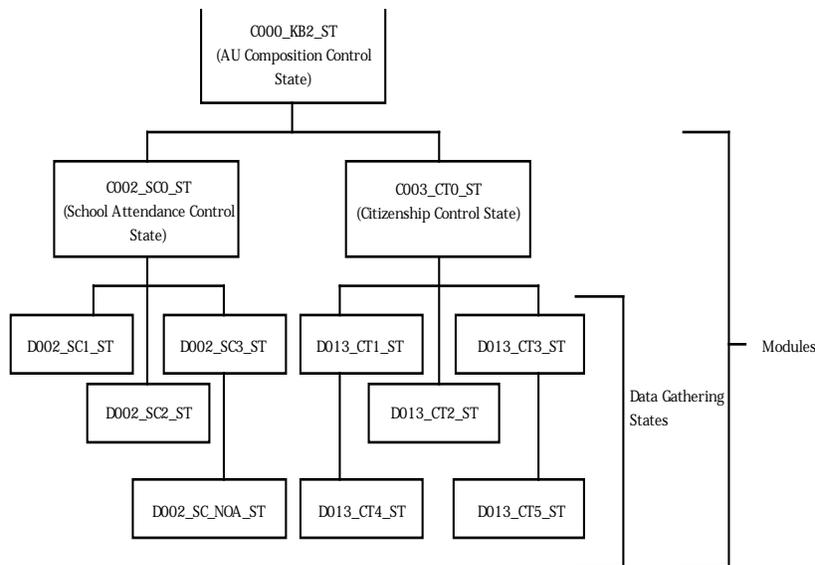


Figure 3. Some of the Modules, Control States, and Data-Gathering States for the Assistance Unit Composition Task within MAGIC.

Consulting started the requirement definition and general system design phase. The makeup of the development team for the expert assistant portion was as follows: 12 Andersen Consulting consultants, 2 Merced County programmers, 8 caseworkers, and 3 California state welfare program analysts.

The project was implemented in the following phases:

October 1989: Detailed design began, and a fast-track process was enabled that brought together design and programming.

April 1990: Began system test of the integrated knowledge base and the mainframe functions.

August 1990: Pilot started. Ten percent of the agency cases were converted to MAGIC.

January 1991: Increased cases to 50 percent of the total agency case load.

July 1991: Began converting the remaining cases to MAGIC.

A major concern was whether a distributed system could accommodate the production volumes for the largest counties in California. It was clear from the outset that each platform would have less trouble than a single mainframe in handling the volume. The main concern was the transmission between the platforms. The high-speed Ethernet TCP-IP network allayed these concerns. Operating at 10 megabits a sec-

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IF    SIZE(INTERSECTION(HC_CASH_MNR_HH_MEM_PA,
                        HC_AFDC_RP_HH_PA)) = 0          AND
      SIZE(HC_PREG_SPEC_ND_SET_PA) > 0
THEN C1 = 0
     FOR HC_PREG_SPEC_ND_SET_PA, C1
       IF    NOT(HC_UNBRN_SET_PA INCLUDES
                 HC_PREG_SPEC_SET_PA(C1))          AND
            HC_REQ_AFDC_PA INCLUDES HC_PREG_SPEC_ND_SET_PA(C1)
       THEN ADD HC_PREG_SPEC_ND_SET_PA (C1) TO HC_AFDC_REC_HH2_PA
     END END END

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"If no minor person is in the reporting set and there is someone in the household who is pregnant, then add that person to the recipient household"

Figure 4. Sample Data-Gathering Rule with English-Language Equivalent.

ond, the transmission between the server and the client workstation was completely transparent. For the downloading and uploading of data, eight 56-kilobyte lines were used for Merced County. In larger counties, T1 lines can be substituted without affecting the overall architecture design.

The maintainability of the rules in the system was a critical element. Concurrent with defining the regulations and proving the maintainability of the knowledge base, regulations in the system had to remain current through the development phase. Even as design was being completed, the rules were constantly changing. An arbitrary date was selected for testing, but in several cases, the necessity of immediate modifications to the expert assistant because of mandated regulation changes required updating the knowledge base. Over the last 18 months, the state of California has seen at least one regulation change each day. A few of these changes involve entirely new methods of determining eligibility for the MediCal program, involving multiple modules and many rules. Thus, to remain current with the regulations, from 2 to 5 percent of the knowledge base rules must be updated each month. Since October 1989, throughout the entire development and implementation period, the rules have been maintained to include regulation changes.

Updating rules in the knowledge base is similar to revising case structures in COBOL modules. The ADS tool provides editing tools that facilitate navigation through the rules and data structure within the knowledge base. The major advantage of the expert system is in the addition of new rules; when the data requirements are identified, new rules or regulations can be inserted into the object-oriented code with ease and efficiency. Where a structured code program might have to be restructured entirely to accommodate new logic, the expert system inference engine simply fires the rules and regulations according to the priorities and parameters that the knowledge engineer determined were appro-

priate.

The regulation change in AFDC provides an excellent example of how MAGIC's complex eligibility logic is easily and rapidly maintained. In August 1991, the state of California finalized and ordered the implementation of a plan that would reduce the level of assistance and change the method for computing the benefit amount for the AFDC program. Every AFDC household, over 9000 in Merced County, was affected by the new regulation. In less than two days, the knowledge engineers were able to identify the affected modules and rules. Within the next three days, the changes were coded and thoroughly tested. By 16 August 1991, well before the mandated implementation date of 1 September, the Merced County Human Services Agency was processing according to the new regulations. Merced was the first California county to do so. Several other counties were unable to implement the new regulations until November 1991. MAGIC's rigid naming standards and modular structure were essential in helping the developers to make this change.

The Benefits

Since MAGIC was implemented, significant benefits have been achieved. Clients are now seen within 24 to 72 hours. Prior to the implementation of MAGIC, clients experienced delays of three to five weeks in Merced County. Delays of as long as three months were occurring in other counties in the state.

Following the conclusion of the interview, which normally takes about two hours, the client's eligibility and benefits are determined by MAGIC, pending any required verifications. The client is given immediate notice about his/her eligibility status and, if eligible, is advised of when to expect his/her benefits. When the worker completes the interview, he/she is done with this client's case: No further paperwork is necessary. Before the new system was implemented, caseworkers spent several hours filling out more than 700 documents and making budget calculations that were required in addition to the time spent interviewing the client.

Correspondence and fact-finding documentation are automatically generated by the expert assistant as a result of the interview. All the forms and legal notices of approval or denial are available at the nearest printer for the worker to pick up and hand to the client at the end of the interview. The laborious handwritten, multipart carbon copy forms that had to be filed into case folders are finally obsolete now that the MAGIC expert assistant handles the administrative details for the

worker.

Clients with similar case circumstances receive similar treatment. It is now possible to predict the length of interviews for scheduling purposes and supervisory review.

In addition to the administrative benefits gained through MAGIC, many financial benefits were realized as well. Those financial benefits described here are goals of the agency that were developed prior to the implementation of MAGIC; they are based on the assumption that caseworkers would increase their work load from 180 to 275 households. The actual results of the system implementation is that each caseworker is now handling an average of more than 330 households. With all the cases converted to the new system, the original goals are well within the capabilities of the system. Of additional importance, error rates have declined from 3 percent to 1 percent. Monthly case maintenance has fallen from approximately 20 minutes a case to 7 minutes a case.

The goals set forth included the following:

First, the eligibility staff required to support the projected case load could be reduced by 40 percent by June 1992.

Second, approximately \$1 million annually could be saved because of error reduction, equivalent to approximately \$100 million statewide. This estimate is conservative and is based on a 1-percent error rate improvement; the actual error rate improvement might be closer to 2 percent. The MAGIC expert assistant has an apparent error rate of less than 1 percent.

Third is the elimination of clerical support for the eligibility workers.

Fourth is a reduction in the 700 preprinted forms inventory to about 350 forms. Most of the forms required for the intake interview, including the legal notices, are now generated on laser printers using blank stock.

Fifth is a reduction in system operating costs. States with case-load sizes similar to Merced County's have stated that their annual system operating costs range from \$2 million to \$3 million; Merced's cost is \$500,000.

The dollar value of the savings is estimated at \$6 million for the first year. In less than two years, MAGIC will have paid for itself. These estimates are conservative; they do not account for savings because of reduced staff training and improved staff morale.

These administrative and financial benefits are felt directly by the agency, but some of these benefits will be felt statewide if the MAGIC approach is introduced to other counties:

First, the cost and time to bring all 15,000 workers statewide into compliance with new regulations are the same as the cost for a single county.

Second, all counties using MAGIC will deliver the same level of service and use the same approach to eligibility determination and benefit computation, thus ensuring consistent application of all the laws.

Third, the architecture is scalable, allowing several small counties to pool their resources and use a common mainframe as a data repository yet maintain separate minicomputer servers.



Jean Toftely, a medical analyst supervisor, using the AdjudiPro reports.