

# The Credit Clearing House Expert System

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The Credit Clearing House (CCH) is a division of Dun & Bradstreet (D&B) Business Information Group's Business Credit Services. CCH functions as the arm of Business Credit Services' Product Marketing Group, dedicated to serving the risk management needs of the apparel industry by assigning credit ratings and dollar-specific credit limit recommendations.

CCH has several thousand customers that use its services. It recommends a credit limit that the D&B subscriber can safely extend to a given client. An example customer of this service is an apparel wholesaler who receives an order from a retailer with which they are not familiar or an order with a high dollar amount that raises some credit uncertainty. The wholesaler would request an evaluation of the retailer and a maximum credit recommendation from CCH.

CCH credit ratings have historically been based on the information found in D&B business information reports. The quality of the CCH service is dependent on three primary factors: (1) the ability of CCH analysts to apply consistent decisions to diverse business situations, (2) the ability to respond rapidly to customer requests, and (3) the ability to update ratings and recommendations with the most current data.

To meet these criteria, CCH was required to maintain a process that

was both time consuming and labor intensive. This manual process presented CCH management with certain business problems that resulted in lost revenue. As an example, a staff of 15 credit analysts was required to maintain a database of ratings and recommendations on roughly 140,000 businesses, but it was estimated that another 60,000 businesses could be of interest to customers but were not reported on because of production constraints inherent in maintaining the existing database. Often, a customer inquiring about one of these "no hits" would abandon the inquiry rather than wait for a CCH analyst to investigate the case and return a rating and recommendation, a task that could take from three days to three weeks.

Lost revenue opportunities based on a lack of account coverage are among the more quantifiable of the problems. Less tangible but certainly as much (or more) of a problem was customer satisfaction with the quality of the analysis for those cases already in the CCH database. The quality issue is really several issues. First, the analytic ability of the most expert credit analysts should be applied to all ratings and recommendations considered. Second, these decisions should be based on the most up-to-date data available. An analyst can do his(her) finest analytic work on a case, but if the data s/he is reviewing are not the most current in D&B's files, it has a direct impact on quality. Third, all analysis topics should be considered and evaluated for each case; that is, evaluation of all data and all areas of analysis should occur for each case. If not properly handled, each of these issues could result in decreased customer satisfaction, which, in turn, could lead to problems when it is time to renew a customer's contract. It became necessary for CCH management to address these quality issues and arrive at a solution that could provide both quality enhancement and cost avoidance.

In further defining the problem, it should be understood that the CCH analyst staff was affected by turnover. The average analyst's tenure is about two years. It is difficult to build expertise in a staff when the life expectancy of an analyst is so limited. The turnover issue also affected the ability of CCH to maintain a completely up-to-date database on existing accounts. It took some time for a new analyst to reach the necessary level of understanding for the job to keep up with the new information coming in each day on the businesses in his(her) area of responsibility. Obviously, training was considerable, and there were many associated costs.

In investigating a solution to these problems, it became apparent that any solution should address the following objectives: (1) improve product quality by developing a pool of analytic expertise that would be impervious to turnover; (2) increase productivity to update existing cases in a more timely fashion and capture those cases that were for-

merly defined as “no hits”; (3) improve quality by including new information as soon as it becomes available; (4) improve the consistency of the ratings and recommendations provided to the customer; (5) enforce the evaluation of all data available to improve both quality and consistency; and (6) as a by-product of the solution, provide a foundation for new and enhanced product development opportunities.

One solution might have been to increase staff beyond the 15 analysts that were currently employed. This solution would have allowed increased account coverage but at an obvious expense to CCH, and it would not have addressed the turnover issue. In addition, the consistency issue would have been compounded by an increased number of individuals creating the credit-evaluation product. It became evident that the solution to the CCH problem would have to be an automated one. Unfortunately, the analytic process had elements of relative complexity that did not conveniently lend the potential application to traditional data processing approaches.

### **Expert System Investigation**

In May 1987, Information Technology Research (ITR), a department within Information Management (IM, the data processing division of the Business Information Group), began investigating the use of expert systems in commercial applications. ITR, which was formed to identify, evaluate, and introduce new technologies, published a study in June 1987 recommending that a pilot application be developed within the Business Information Group as a means of researching expert system technology.

The following criteria for choosing an application were set forth in the study document: (1) the business problem must be well understood; (2) the business problem must have a practical solution, with application development in months rather than years; (3) the application should have a clear benefit and a return that is potentially large; (4) the focus should be on an application that can be developed and tested independently and can later serve as the kernel for other applications; and (5) the business problem has not successfully been automated or cannot be automated cost effectively with conventional technology.

The study also went on to detail hardware and software requirements for a development project. A number of vendor tools were evaluated as well as different technical approaches. Developing expert systems from scratch, using either an AI programming language or an AI programming environment, was determined to be too time consuming and would require a certain degree of AI experience and expertise. Therefore, the study recommended developing expert systems by

building knowledge bases with a commercial shell, exploiting the shell's user interface and inferencing logic. In terms of hardware, the study recommended the use of AI workstations or personal computers for their response capabilities and also the separation of the expert system from the mainframe to avoid a possible unfavorable impact on existing mainframe systems. AI workstations were preferred to personal computers because of the perceived limitations of personal computer capabilities at the time.

Within the Business Information Group, ITR was able to identify candidate projects from Business Credit Services, Data Resources, and Information Management for expert system applications. Among these candidates was CCH. Besides fitting the aforementioned attributes, CCH also represented an analytic process that was deemed relatively complex and well defined in terms of both input and output and that required mainframe database inquiry and update without being completely embedded in an existing application. Coincidentally, CCH was then embarking on a redesign of its database and input-output system architecture, providing the advantage of being able to integrate the expert system into the new architecture rather than having to retrofit and rewrite an existing application.

### **Prototype Development and Evaluation**

Following the selection of the CCH analyst's function as the application with which to research the use of expert systems, work began on developing a prototype. In October 1987, the ITR group started the CCH Expert System (CCH-ES) Prototype Project in conjunction with Coopers & Lybrand (C&L), which functioned as a consultant. Using C&L's proprietary expert-apprentice simulation technique, the project team articulated and decomposed the mental processes of CCH credit professionals as they performed their analytic tasks. By restricting communication to questions and answers, the expert was forced to externalize the individual analysis steps and components, as well as the information, algorithms, and rules used and the assessments generated, for each step associated with a particular case.

Once the simulation phase was completed, the project team began constructing a credit-analysis model using C&L's FFAST knowledge-modeling tool as a front end to a run-time version of Inference Corporation's ART running on a Symbolics workstation. The initial version of the knowledge model was coded in FFAST based on the simulation results. With a rough model completed, model refinement took place over the next several weeks. This process involved bringing the experts

in to review each step of the analysis process as captured by the initial model. Based on the experts' feedback, the knowledge engineers were able to further refine each of the analytic phases, effectively externalizing in greater detail the experts' thought processes. By early December 1987, sufficient model development had taken place to allow the entry of test cases for further validation and refinement of the system.

In January 1988, with the initial prototype developed, demonstrations of the knowledge model were given to senior management within various Business Information Group divisions, including IM, Business Credit Services, and Data Resources. After reviewing the work accomplished, the following conclusions were established by the business units:

First, the specific expert system approach used and the functions developed for the CCH-ES prototype were appropriate for their business needs and could be used to improve their products and services.

Second, many components of the CCH credit analysis captured in the model were generic and could be reused for a variety of products. Furthermore, because they were generic, they could be consolidated into a centralized process to generate assessments that could be shared by many products.

Third, the level of analytic sophistication achieved by using expert system technology was significantly superior to what was in existing computer-generated products.

Fourth, the time required to develop system requirements for analytic products can significantly be reduced using the knowledge-modeling approach (the CCH-ES prototype knowledge model was developed in 11 weeks by about 3 full-time programmers).

With the initial prototype completed and following positive feedback from management, fine tuning of the system continued for the next few months. To make the expert system as comprehensive as possible, it was necessary to manually enter over 100 test cases reflecting a wide variety of circumstances. Based on the evaluation of these cases, certain rules were changed, and certain modules were revised. One example was in the area of trend analysis. Because of the flexibility provided by FFAST, this recoding was completed and tested in one week.

### **Hardware and Software Selection for the Pilot System**

When it was determined that the prototype performed within CCH operational standards, work began on expanding CCH-ES into a pilot (pre-production) system. At this time, there were no mature mainframe-based software platforms to support an expert system application. In addition, there was no in-house experience in gauging the resource re-

quirements and operational and environmental impact of this type of system. Therefore, it was decided to pursue a nonmainframe approach in implementing the system to gain experience with this technology without affecting the normal production environment.

Because FFAST was not a commercial package, it could not be used for the CCH-ES pilot. Because FFAST was merely a front end to ART, and most of the FFAST rules were translatable to ART rules with a minimum of recoding effort, the choice of a pilot software platform was leaning toward ART-IM, a C-based implementation of ART. Several other factors involved the selection of ART-IM as the software platform, including the fact that it was C-based; C had advantages over Lisp, which was considered undesirable in D&B's production environment because of its memory management characteristics. Other considerations included efficiency; availability of both development and run-time versions; flexibility in platforms, including the ability to run in an IBM personal computer environment; availability for porting to a DEC environment; and a planned IBM-MVS version. A development tool was needed that would be IBM compatible because of the immediate availability of IBM equipment in the Business Information Group.

DEC was chosen as the production hardware platform because it offered an environment in which processors could easily be upgraded without modifying the application. Also, DEC had a proven IBM link that would eventually be used in an integrated production environment.

## Expert System Design

With the prototype stabilized and the pilot system hardware-software issues resolved, the research staff (now named Applied Research [AR]) began designing and coding the knowledge base in ART-IM. In September 1988, two consultants were brought in from Inference to help in this process. The consultants were able to effectively make the system modular and determine which modules were best done in ART-IM and which would be implemented more efficiently in procedural language (C). With the support of the Inference consultants, the AR project team was able to code the entire knowledge base on personal computers by mid-November 1988.

The four principal modules identified and implemented are shown in figure 1. They include *payment analysis*, which analyzes the credit and payment history of a business; *financial analysis*, which analyzes the current financial statements and three-year trends of a business; *business analysis*, which analyzes the strengths and weaknesses of a business, including prior business history; and *ATB rating and recommendation*,

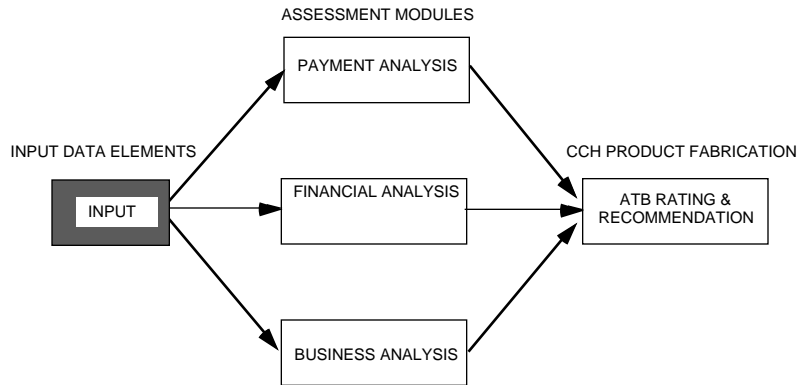


Figure 1. CCH-ES Assessment Modules.

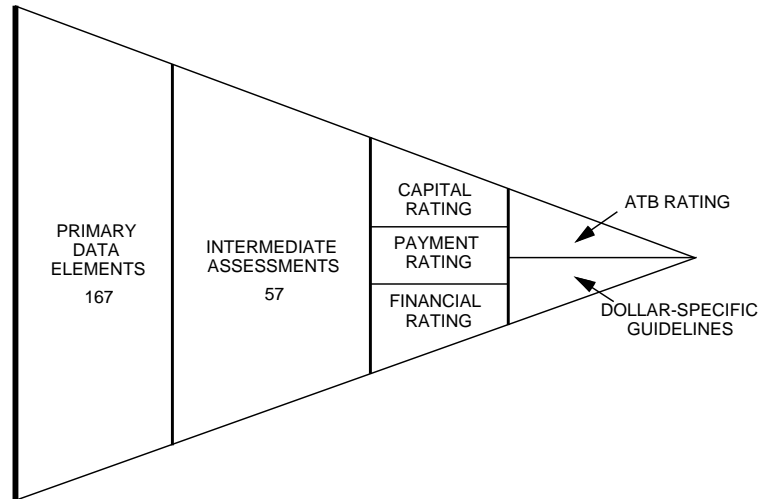
which determines the final rating and overall recommendation. (ATB stands for *Apparel Trade Book*, which is published four times a year by CCH and which now includes the ATB ratings produced by CCH-ES.)

Because of the large amount of data required to process the payment analysis, as well as the statistical nature of this module, it was coded in c. The other modules, primarily analysis and decision rules, were coded in ART-IM.

Generating an analysis and assessment in CCH-ES consists of forward chaining from the initial data through intermediate assessments to final recommendation. As shown in figure two, 167 initial primary (raw) data elements are extracted from the mainframe databases. Rules process these data elements and form a set of 57 intermediate assessments and, from there, form final assessments for the capital rating, payment rating, and financial rating. The final dollar-specific recommendations and ATB rating are then produced.

An example of this assessment process is shown in figure 3.<sup>1</sup> The example shows two financial analysis assessment rules. One rule takes four intermediate assessments (already determined by rules that take raw data and determine initial low-level assessments) and infers a high-level intermediate assessment; another rule takes two high-level intermediate assessments and infers a final assessment for working capital.

While the CCH-ES pilot was being developed, the data requirements to run the system in production were identified and given to an ad hoc development group within IM. In turn, this group developed a temporary data-extraction program that extracted data from several IBM 3090 databases and created a flat file for volume testing the knowledge base. An interface to the mainframe was written that read the data



*Figure 2. CCH-ES Processing.*

from the flat file and preprocessed them for input into CCH-ES running on a Digital MicroVax III. CCH-ES code developed on the personal computers was simply transferred to the MicroVax III, where it was compiled, and a run time CCH-ES system was generated.

### Volume Testing

By early December 1988, all the pieces were in place to begin a volume test of 2800 cases, roughly 2 percent of the total number of cases in the CCH database. These cases were input into CCH-ES, and the results were reviewed by a quality control team of 4 CCH credit analysts. Because of commitments related to the day-to-day operations of CCH, the quality control team was not able to devote full time to the quality review process. Consequently, this stage of the development process was not completed until the middle of April 1989.

During this testing phase, over 30 CCH customers were given demonstrations of CCH-ES, and their opinions on the workings of CCH-ES were solicited. This "reality check" was an integral part of the system evaluation process.

Initial review of the volume test results showed a 92 percent agreement rate of the experts with CCH-ES. The volume test revealed the need for some further system modification. By the end of the fine-tuning process, this rate was raised to 98.5 percent. (In most of the other



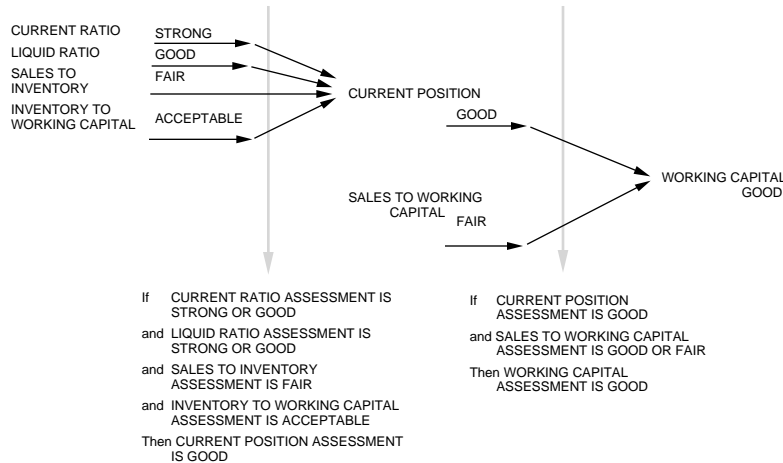


Figure 3. CCH-ES Assessment Example.

cases, analysts did not agree with each other, so there was no consensus on a correct decision.)

Also during this period, certain knockout rules were defined. *Knockouts* are CCH-ES-evaluated cases that D&B forwards to a credit analyst to review or audit. The principal reasons for a case being a knockout include incomplete or missing data, possibly conflicting data, borderline cases, and possible internal inconsistencies. When it determines a case to be a knockout, CCH-ES provides its usual analysis but does not publish (record in the CCH database) its results until an analyst approves. It is then left to the analyst to decide whether to accept the system decision or opt for his(her) own analysis.

### Transitioning the Pilot System into Production

In mid-April 1989, CCH management gave AR the final sign-off for CCH-ES deployment. Concurrent with CCH-ES development, CCH was undergoing a redesign of its mainframe system and database architectures by an IM project team. The plan was to incorporate CCH-ES into the new architecture by July 1989. To help facilitate this integration, AR assigned a project team member to the IM project team for four months. It was this person's responsibility to ensure that the interfaces

between the mainframe case-selection and data-extraction programs, being developed by the IM team, and CCH-ES were correctly implemented in both online and batch modes. This responsibility also extended to the interface between the output of CCH-ES and the new CCH database, where the CCH-ES decisions would reside for delivery to the customer. In addition, the AR consultant assisted a Digital programmer in customizing the communications software between the IBM 3090 and the DEC platform.

The delivery platform hosting CCH-ES is the VaxStation 3000. Three VaxStations are currently in use: one for continued CCH-ES maintenance and testing and two for production use.

In the CCH-ES production version, the payment module was moved from the expert system to the mainframe and recoded from C to COBOL. This move was principally made for ease of maintenance because D&B has many more COBOL programmers than C programmers. Thus, the payment module output (intermediate assessments on payment history) is sent to CCH-ES along with other information. CCH-ES uses the payment assessments, along with the other intermediate assessments CCH-ES generates, to determine the final recommendation.

By mid-July 1989, CCH-ES and the new architecture were put into full production. At this point, all cases requiring review each day were passed through CCH-ES. CCH-ES recommendations were automatically uploaded to the CCH database without any human intervention and made available to the customer. Each knockout case would be delivered online to an analyst who would review the case; results of the review would then be uploaded and made available.

The following timetable summarizes CCH-ES development and deployment:

**1987**

May-June	Expert system study; potential applications identified
June-September	Applications assessed; CCH-ES to go to prototype
October-December	CCH-ES prototype development

**1988**

January-August	Internal selling; fine tuning; testing and evaluation
September-December	Pilot CCH-ES design and development

**1989**

December-April	Volume testing
April-July	System integration; fine tuning
July	CCH-ES in full production

CCH-ES cost approximately one million dollars (internal and external costs) to develop and deploy.

## Use and Performance

CCH-ES has been in continual production use since July 1989. It currently contains approximately 800 ART-IM rules and is invoked either through online transactions or batch transactions as a result of database changes.

Online transactions occur when CCH customers call in for service or when analysts want to review knockout cases. Batch transactions result when there is new business information (updates in the *report file*, D&B's principal business information repository, or the *case summary database*) or when there is new trade information (payment updates in D&B's *trade file*). Whenever such changes occur through updates in the various databases, the applicable cases are run through CCH-ES the next morning. On a typical day, there are 300 online CCH-ES transactions and 2,500 batch transactions.

Figure 4 shows the relationship of CCH-ES to D&B's database systems. The other files not previously mentioned include the *sales conversion file*, containing industry sales norms for various company types and sizes; the *payment output file*, containing the intermediate payment analysis assessments produced by the payment program COBOL module; and the *CCH database*, containing the CCH-ES output. The preprocess program is a COBOL driver that packages the data for shipment to the expert system.

As was previously discussed, CCH-ES produces an ATB rating, a recommendation, and a dollar-specific guideline. (Figure 5 shows an example screen output produced by CCH-ES.) CCH-ES also displays *reason codes*, which provide an explanation of the most salient decision-supporting elements used by CCH-ES to produce its recommendation. Each letter (or numeric number) is a code for a particular supporting element. CCH-ES creates as many as 114 such supporting elements that are available to the analyst for review online. They are also saved with the case to provide an audit trail.

CCH-ES produces its recommendation in subsecond response time. A total response time of 3 to 5 seconds includes IBM 3090 mainframe data extraction, the communication and sending of data from the mainframe to CCH-ES on the DEC, CCH-ES processing, the communication and sending of results back to the mainframe, and the formulation and display of a screen.

All cases are run through CCH-ES. Approximately 89 percent of the cases are automatically handled by CCH-ES without any human involvement. In 1 percent of the cases, there is not enough current background information in the database to make a credit decision. User-defined knockouts currently total about 10 percent of all cases, but this

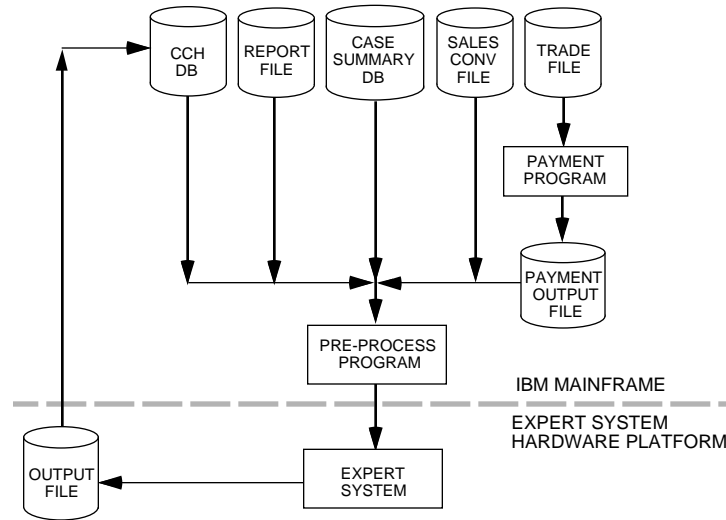


Figure 4. System Flow.

number is expected to gradually be reduced over time. Analyst agreement with CCH-ES continues to be at approximately 98.5 percent on an ongoing basis.

### Maintenance

CCH-ES undergoes a few rule changes every month. These changes typically involve a refinement, a consolidation, or an addition of knowledge. A significant example of an addition is the rules that use new data elements. CCH-ES has helped D&B identify what additional data could be used to improve the decision-making process. In turn, this assistance prompted D&B to make such data available in a retrievable format; new rules are added to intelligently process the new data. There is a new CCH-ES production release each month. The CCH-ES knowledge base has expanded from its initial base of 750 rules in July 1989 to slightly over 800 in January 1991.

CCH-ES is being maintained by one of the system's original developers. Because of the complexity of the system environments involved (C, COBOL, ART-IM, communication links), end users do not have sufficient computer expertise to perform maintenance on their own.

### Benefits

Major benefits from the use of CCH-ES include those for the customer and those internal to CCH and D&B. Customer benefits include the following:

CCH RECOMMENDATION SCREEN	
NAME	<u>COMPANY-X</u>
DUNS NUMBER	<u>00-123-4567</u>
MERCHANDISE CODE	<u>WGZ</u>
ATB RATING	<u>B2C</u>
RECOMMENDATION	<u>RECOMMENDED</u>
DOLLAR GUIDELINE	<u>\$1,000,000</u>
REASON CODES	<u>BEGHJ</u>

Figure 5. CCH-ES Example Output.

First is improved decision quality and consistency. CCH-ES ratings and recommendations are based on the experience and expertise of the most senior CCH credit analysts. Reaction from CCH customers has been extremely positive. They feel that CCH-ES ensures them that all relevant issues will be analyzed; that is, all the rules will examine all the data. ("CCH-ES never has a bad day.")

Second is the increased timeliness of the information. The ratings and recommendations provided are based on the most up-to-date information available.

Third is faster response. Customers get an analysis and recommendation in three to five seconds instead of the one to three days it typically took analysts in the past.

Fourth is expanded coverage. Approximately 20,000 new cases have been added to the CCH database (increased coverage by approximately 15 percent). When a customer requests a new case, information existing in normal D&B files is extracted and sent to CCH-ES, which generates an evaluation and stores the result in the CCH database.

Internal CCH and D&B benefits include the following:

First is the lower cost for each rating and recommendation.

Second is reduced vulnerability to turnover.

Third is reduced staff expenses. The number of CCH credit analysts was reduced from 15 to a smaller number of senior, highly experienced analysts.

Fourth, it allows analysts to work on the most complex cases.

Fifth is the expanded coverage at a minimum cost. CCH-ES automatically evaluates a new case from information in D&B's files. Done manually, the processing of a new case takes from three days to three weeks to accomplish.

Sixth, it helps explicitly identify how data elements are used in the decision-making process and what additional data might be important.

CCH-ES also demonstrates the software development benefits in using expert system technology. These benefits include the following:

First is increased user involvement. Because the expert system is more knowledge intensive than conventional software, it required more user involvement, which ensured that users provided the ongoing monitoring and evaluating of functional requirements and system performance.

Second is decreased development resources. A development team consisting of a knowledge engineer, a software specialist, and an expert credit analyst built the production version of CCH-ES. Software systems at D&B of similar but non-expert scope require significantly more resources.

Third is decreased maintenance resources. Changes to conventional software that can take hundreds, maybe even thousands, of hours can be done in an expert system in one day (including changing rules, implementing, testing, and putting in production).

Fourth is increased responsiveness. Changes can be made more frequently, with faster turnaround into the production environment.

An important benefit not previously given is the improvement in D&B's legal position. D&B requires all systems that affect what is delivered to customers be approved by D&B's legal department before full production. This approval is to protect D&B, its customers, and the subjects of D&B's reports. The legal department felt that CCH-ES would significantly improve D&B's legal position by providing the following benefits:

First, CCH-ES has no bias. All rules are applied automatically and consistently in all cases. There is no possibility of any favoritism, either positive or negative.

Second, it provides an audit trail of recommendations. Pertinent facts, intermediary assessments, and reasoning steps leading to a conclusion are stored with the conclusion and, thus, can easily be retrieved to explain how a particular recommendation is reached. D&B would no longer be dependent on someone's memory to explain a past decision.

A final benefit involves technology transfer. The system provides a successful and highly visible use of expert system technology at D&B. The Business Information Group has begun to disseminate, among other operating units, the means to build other expert systems. This technology transfer has resulted in a number of new expert system projects at D&B.

## Conclusion

CCH-ES has been a major success at D&B. It has provided CCH with an automated credit analyst expert system that can provide expert-level credit analysis decisions consistently and at a high-quality level. Customers have uniformly praised the system. Customer service is enhanced because of the consistent expert-level recommendations, expanded coverage, faster response, and reliability. In addition, CCH internal expenses have been reduced as have the problems associated with staff turnover. Finally, technology transfer has occurred at D&B because a number of new efforts using expert system technology have been initiated.

### Note

1. The rules shown in figure 3 are exemplary only. Actual rules cannot be shown for proprietary reasons.