

## EXSYS® Customer Case Studies

**EXSYS Knowledge Automation Systems** are computer programs that use expertise to assist people in decision-making for a wide variety of functions. Thousands of systems are now in wide use worldwide, and span a full spectrum of activities in business, industry and government.

**Exsys CORVID®** is a proven approach to developing and deploying knowledge automation systems. For the first time, it is practical to deliver complex interactive knowledge on a Web page - actual **answers and recommendations** that prospects, clients and staff need. Emulating one-on-one consultations with experts, Exsys CORVID systems can:

- **Deliver Situation-Specific Answers** - Not just page after page of data and content that people have to sift through in order to make decisions
- **Troubleshooting, Tech Support and Diagnostics** - Diagnose and solve problems the way the experts do, and rank recommendations by probability
- **Regulatory and Policy Compliance** - Answers complex questions about regulations, rights and responsibilities as employees and employers, and how they apply to unique work situations
- **Automates Routine Tasks** - Forms, maintenance, scheduling, training, process control, human resources, etc.
- **Free Your Best People to be Even Better** - Lets them solve problems that require intuition and creativity by automating the answers of common, repeated questions
- **Don't Let Expertise Get Away** - Capture valuable knowledge before retirement, job changes or transfers
- **Reach Consensus and Consistency** - Combines the knowledge of your best staff for fast, one-source problem-solving
- **Look Smart to your Prospects and Customers** - Ask individualized, focused questions and provide customized recommendations
- **Bring Knowledge Assets and Interaction to Your Web Site** - A competitive edge that bring prospects and clients back to your Web site

# EXSYS Case Study

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## Network System Monitoring/Repair/Prediction



### *Pacific Bell*

Pacific Bell has developed a set of expert systems to monitor the Loop Maintenance Operating System (LMOS) front-end computers, which serve as transaction managers for mainframes. The software performs three functions - monitoring, repair assistance and problem prediction. All of the LMOS expert systems have improved productivity and reduced down time, and won awards for innovative uses of AI.

**Monitoring:** The MONITOR system constantly monitors LMOS' integrity and checks for errors. If an error is detected, it announces the error to system data specialists through the public address system using a synthesized voice. Data specialists can perform other work and be confident that if there is a problem developing, the system will detect it and immediately contact them.

**Repair:** Once the problem has been detected, the CONSULTANT expert system can be used to walk support personnel through troubleshooting or repair procedures to correct the problem and prevent the system from going down. The CONSULTANT system has expertise in over 12 subject areas. Printed repair recommendations are provided to the user. Prior to the implementation of the software, troubleshooting had to be performed by a limited number of highly trained staff. Now, with expert system assistance, more less experienced people can accurately determine the cause of the problem and correct it.

**Prediction:** In addition to the monitoring function, there is another application, FORCASTER, that checks system files and notifies personnel of impending problems, even before they generate error messages. The expert system logs onto the network to get data and monitor for suspicious trends in file structure, resource allocation, error messages, etc., which could be warning signs of a serious problem. FORCASTER allows potential problems to be corrected before they turn into emergencies. Prior to implementation of this application, this type of monitoring was not practical in time or resources.

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Pacific Bell has also fielded another application for network assistance. NetHELP is an expert system that provides assistance to the users of the Netway network. When a user is having problems with the network, they can call the expert system. The system asks the user questions about the current state of their network and suggests appropriate repair strategies. If the problem requires repair procedures not appropriate for the user, the system automatically issues a "trouble indication number" for the user to refer to and it notifies the appropriate agency to correct the problem. The system provides a 24 hour per day uniform method of correcting or reporting problems within the network. This system was so successful that Pacific Bell sold it back to Netway, the company that developed and markets the Netway network.

# EXSYS Case Study

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## Expert “Know How” Distributed Enterprise Wide

*Texas Eastman Chemical*



Texas Eastman petrochemical plants make extensive use of expert systems throughout their organization. There are a wide range of chemicals and plastics produced through many different types of processes. The company feels expert systems should be widely utilized.

Texas Eastman decided to implement expert systems by codifying the “know-how” of top engineers and line operators into expert systems. The systems help automate routine tasks and questions that then free up the experts to tackle unique, complex problems and better utilize their talents. By using the Rule Editor, with its menu options, they were able to take personnel, often with relatively little computer experience, and have them produce expert systems that are now assisting in many aspects of plant operation.

Most of the expert systems at Texas Eastman are small, under 100 rules, but fully cover a specific aspect of a process. By connecting over 400 such systems with external program calls like process monitoring, databases, and in-house developed software, Texas Eastman has effectively produced a total system of well over 15,000 rules. This enormous knowledge base covers many aspects of the plants.

# EXSYS Case Study

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## Material and Process Design Expertise



*Rockwell International*

Material and process considerations are often addressed late in a design process. This is due to specialized knowledge in these areas not being readily available to the design engineer, who can not be expected to be a specialist in all areas of materials. The usual approach has been to have a specialist sign-off on the design later, which can result in expensive time and resource redesign, when a material or process problem is detected too late.

To help solve many of these design problems, **Rockwell International's Autonetics Sensors and Aircraft Systems Division** decided to use expert systems. Many systems have been developed including those for:

- ◆ Corrosion Protection
- ◆ Adhesive Selection
- ◆ Encapsulant Selection
- ◆ Conformable Coating Selection
- ◆ Heat Treatment of Metallic Materials
- ◆ Selection of Soldering Processes

These systems, developed in collaboration with domain specialists, make this “project-rolling” knowledge widely available to the Rockwell design engineers. The engineers using the systems have potential problems indicated before designs are finalized, and are educated by the systems in the process.

# EXSYS Case Study

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## Online Advice System Helps Drive Hewlett Packard E-Business Strategy



*Interactive System Determines Best Hardware and Network Configuration for Customers*

Hewlett Packard's deployment of CAST/BW incorporates advisory products and services. The interactive advice system provides quick, accurate hardware sizing, network configuration, and usage recommendations for SAP Business Information Warehouse implementations. The system turns expert knowledge from SAP, HP internal competency centers, the HP Enterprise Server Group and existing SAP BW implementations, into an easy to use advisory tool. These types of expert systems enable businesses to deliver a wide range of online advice to sales staff, employees, customers and potential clients.

The CAST/BW online advisor functions much in the same way as working directly with the company's most knowledgeable system analyst and product representative – and it's available worldwide, 24 hours a day. It reduces days of work, phone calls, and emails – and guesses and estimates – into a few-minute online interaction that produces an expert recommendation. The system results are presented as a printable HTML page complete with product images, system recommendation and configurations, and it offers direct links to order processing.

*The future of the Internet is based on the fact that trillions of transactions are moving to the Internet. That fact will require vendors like HP, as well as customers, to become smarter about how best to use Internet infrastructure.*

Currently, most Web sites only offer information. It's like walking into a library and wondering how to find the answers you need, and then start "hit-n-miss" wading through the content. By incorporating interactive advisory systems, companies can offer expert advice. It's like walking into a library and working with the most experienced librarians. Or, an online store that you consult with their best sales person to help you select the best product for your specific situation.

The CAST/BW system is implemented as part of the Enterprise Systems Products Store which also offers product information, pricing and ordering of HP 9000 Enterprise Servers, VISUALIZE Workstations and Storage products. The sizing and configuration rules are continuously updated and refined to incorporate new research and new HP products.

Customers are taken through an interactive query session that asks for pertinent details on current SAP R/3 environment business warehouse parameters, industry, maximum number of concurrent users, number of “InfoCubes” (multi-dimensional data stores of individual *business* points of view) to be implemented, and whether cost or performance is the driving factor in the configuration.

The inference engine determines the best hardware configuration based on the rules in the knowledge base as well as the customer requirements, recommends the configuration, and also provides a link to the HP E Commerce Web page. (This allows the customer to price and order the system.) The expert system makes needed external calls to databases and data sources. The results page is dated, customer input is displayed, and a visual diagram with product photos show the appropriate equipment and system configuration, and details on processors and memory. The customer is warned of any problems in performance, and significant upgrades are recommended. A link to the HP’s E-Products section leads to pricing and details for their configuration.

Selecting which products best meet a customer’s needs and requirements can be a very intricate process. But it is one that can be expressed in logic rules relating to customer needs and product specifications. Advisory products built on expert systems can handle conflicting requirements and always give a recommendation of the best fit, even when all customer desires can not be met. Different real-time data can come into play such as inventory, current pricing and customer requirements. Expert systems also provide the ability to change/rerun and go through several different configurations based on different criteria, e.g.: a cost driven vs. performance driven comparison. They also make it possible for staff to identify cross-selling opportunities and be able to sell a much broader, more complex product line.

# EXSYS Case Study

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## Component Failure Prediction

### *Canadian Pacific Railroad*

Still running and providing enormous savings over the last 12 years, Canadian Pacific Railroad uses an expert system to predict component failure in diesel locomotive engines. The system has been highly successful at CP and has saved the company thousands of millions of dollars.



The system bases its analysis on the type and concentration of metal impurities in the lubrication oil from the engine. The oil sample is analyzed in a spectrum analyzer to determine this data. The visual interpretation of these spectra required a skill that takes years to learn and is very difficult to teach.

The expert system developed at CP allowed a PC running the expert system to analyze the data automatically. All of the input required by the system is supplied directly from the spectrum analyzer. The system produces a printed report for the technician telling which components require service and which are likely to fail. The system is highly embedded and there is no direct user interaction with the expert system. In fact, this system was shown at the Texas Instruments Satellite Symposium as an example of an invisibly embedded system.

Many thousands of samples have been run with 98% accuracy. Major cost savings has been realized through the detection and replacement of components before failure. In some cases, the detection of a single failing component has saved more money than the cost of the entire system.

The system has also been modified to predict component failure in diesel marine propulsion engines for the Canadian Navy.

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**" If unchecked, the oil contamination problem would have resulted in \$8 million dollars in damage. The maintenance cost was less than one tenth of the achieved cost avoidance.**

**The US Air Force Oil analysis programs reported a total cost avoidance figure of \$15 million dollars in F-16 engine damages. A conservative estimate for the total cost avoidance generated in the USAF by (expert system) oil analysis would be over \$100 million dollars."**

*Machinery Oil Analysis - Methods, Automation & Benefits,  
1995, Larry A. Toms*

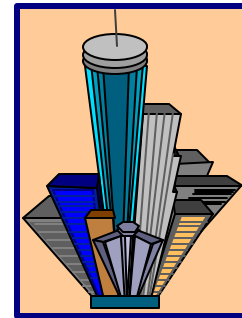
# EXSYS Case Study

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## Commercial Loan Approval Predictor

*Micro Support, Inc.*

An expert system has been developed for banks that specializes in loans over \$30,000,000. Such loans are typically for major construction projects and the source of funds is almost always federal money with extensive regulations.



Before such a loan is issued, a lengthy and expensive study must be performed. On the average, the study can take 6 months, 3200 pages, and \$250,000 to complete. The bank as part of issuing the loan recovers the cost of the study. However, the \$250,000 is recovered **ONLY** if the bank issues the loan. The investment in the study is lost if the loan is not issued. Consequently, there is a great deal of pressure to issue the loan, even if the situation is not as secure as desired.

To solve this problem, an expert system was developed to predict if the full study will result in a loan that will or should be issued. The system divides loans into three categories - likely to be issued, unlikely to be issued and gray area. The loans that are unlikely to be issued can be dropped prior to investing resources in the full study, resulting in great savings. The loans likely to be issued can be pursued with confidence that the costs will be recovered. The predictor recommendations on the gray area loans are examined by the bank loan experts to determine if they should proceed with the full study.

In addition to predicting loan study outcome, the expert system recommends the best source of funding for the potential loan - either Ginnie Mae, Fannie Mae, Freddie Mac or private funds - by evaluating the many requirements associated with each loan. Wide ranges of development techniques were used, including knowledge acquisition phase and decision modeling to establish probability factors during rule generation.



## EXSYS Case Study

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### Maximum Yield/Minimum Resources Farm Advisors



#### *Agricultural Research Service*

The National Peanut Research Laboratory and the US Dept. of Agriculture have developed several expert systems and farm-planning modules. EXNUT, for example, is an expert system to help manage irrigated peanut production. The system compiles data from individual peanut fields throughout the growing season and makes recommendations for irrigation, the application of fungicides, and if favorable pest conditions might exist.

Peanut farmers were not achieving the yields and quality they knew was possible. Scientists felt expert systems provided the best way to deliver recommendations to the farmers. This technology was also chosen due to its ease of use, its ability to run external programs, and access external data files. The ability to examine the reasons for each decision was also a feature farmers desired.

The scientists collected an extensive knowledge base consisting of plant, soil, weather, and agronomic data. The data provided new concepts for irrigation, fungicide treatment and pest management such as using more plant growth stages, withholding water during certain growth stages, and using the maximum and minimum soil temperature as an indicator of soil moisture and plant health. EXNUT also optimizes irrigation management based upon peanut plant, soil, weather, insects and plant diseases. The system has been evaluated on over 50 farms and thousands of acres of peanuts. The fields managed by EXNUT have consistently produced higher yields and quality using less water and fungicides, than those managed by even the most productive farms without the technology. Additional versions for many other regions have been developed for different growing conditions and peanut varieties.

Many other expert systems have been developed at the NPRL that make decisions on variety selection, land preparation and harvest scheduling, as well as whole farm-planning modules, which use a linear programming interface for optimization. Each of these expert systems function as stand-alone systems or as modules in farm operations management.

# EXSYS Case Study

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## Total Organization Productivity Support



### *Multimedia Trouble-shooting and Repair Systems*

The United States Postal Service offers their employees unique capabilities in their Electronic Performance Support Systems (EPSS). The fully integrated system for computer based training and electronic documentation can be tailored to special needs. EPSS enhance user's productivity and quality of work as well as reduce overall personnel support costs.

The computer based, self-paced training covers all aspects of target system operations and processing and repairs. Electronic documentation provides online, easily updated system support information. The expert system incorporates the multimedia interfaces in a high performance hypertext format that provides the best available expertise in system operation and processing. Alternative platforms and interfaces, including the latest in portable PC technology and digital video are also supported.

The fielded EPSS system, which is fully integrated into the United States Postal Service is designated TOPS (Total Organization Productivity Support). Designed to facilitate on-the-spot maintenance and operation of the US Postal Service's automated ZIP-code mail sorter, it provides a multimedia single source for interactive training, diagnostic assistance, and system support. TOPS dynamically integrates the EXSYS Professional expert system and fully hyper-linked on-line reference with an exceptional visual database. The system provides entry-level personnel with all training and assistance that is required to operate and maintain large, complex letter sorting machinery.

***"TOPS" won the Best Overall Achievement in the Interactive Media Awards presented at the Ziff Institute's Interactive Conference.***

# EXSYS Case Study

## OSHA Hazard Compliance Advisor Helps Thousands



*US Department of Labor, Occupational Safety and Health Administration*

There are several thousands of people currently maintaining properties potentially contaminated with asbestos. With the notification, labeling, record keeping, surveillance and controls required of the real estate industry—this complex and ever evolving information requires the effective use of technology. The Asbestos Advisor is an interactive compliance assistance expert system. It provides expert recommendations to building owners, managers and lessees, as well as contractors of building renovation, maintenance, and housekeeping services.

The system interviews users about buildings and work sites, and the kinds of tasks workers perform there. Based on user input, the system results produce guidance and reports on how asbestos standards may apply to buildings, and may also be focused on a particular project. The system provides pop-up definitions through "hypertext". Other features allow the user to:

- ◆ Print a customized glossary
- ◆ View and print Frequently Asked Questions (FAQ's) organized by topic
- ◆ View sections of regulatory text by topic, in an easy to read format

OSHA made the Asbestos Advisor as useful and as simple to use as possible. Representatives of major trade and labor associations, and the public, were invited to comment on earlier drafts. After about 1200 copies of the Public Test Version were downloaded from the Web site and the DOL LaborNews BBS, changes were made that people thought would be helpful.

*“Industry and military users have reported that the Asbestos Advisor has been used by up to 80,000 businesses in the first year it was put on the Internet. The Asbestos Advisor was honored with the NPR Hammer Award, presented by former Vice President Al Gore”. – From BEST IT PRACTICES IN THE FEDERAL GOVERNMENT - A Joint Project of the Chief Information Officers Council and the Industry Advisory Council*

The program was developed in conjunction with EXSYS expert systems development software, and the distribution version of the program uses the EXSYS Runtime program core. Use of EXSYS products is governed by a license granted by EXSYS to the U.S. Department of Labor. The OSHA Asbestos Advisor and many other expert systems, in online interactive and download versions, are available at:

<http://www.osha-slc.gov/dts/osta/oshasoft/>

## EXSYS Case Study

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### Houston Company Using Exsys CORVID Expert System Software to Support Corporate Families on Overseas Assignments



Using Exsys CORVID Knowledge Automation technology in a novel way, Houston-based International Assignment Profile Systems (IAP Systems, Inc.) assists companies in international business in determining whether candidates for overseas assignments, and their families, will adapt to their new environment in a specific foreign country. The IAP System specializes in detecting situations, issues and concerns in an overseas relocation that could result in a mismatch that would be bad for both the employee and the company.

“By conducting a computer-driven, structured interview using advanced expert system and analytic tools that gather information about the employee and spouse’s needs, life style, preferences, parents, children and a host of other relevant subjects, the IAP is able to provide a list of planning issues and adjustments that must occur to insure the success of the assignment,” said International Assignment Profile Systems President, Neill Carson, Ph.D.

A compromised international assignment typically costs a company a minimum of \$200,000, and may go into the millions, with virtually un-measurable human and relationship costs. Research indicates that as much as 80% of the failures in international assignments are due to adjustment and stress issues in the family or from back-home conditions that could have been anticipated and planned for before the assignment.

IAP’s new instrument, the International Assignment Profile (IAP), identifies critical employee and family concerns, and compares these issues to known conditions (both positive and negative) in the specific anticipated location. The IAP uses a “Smart Questionnaire” developed using Exsys CORVID, to interview a family to gather a wide range of information about needs, concerns, and psychological traits, as well as medical conditions, children’s needs (both those accompanying and those remaining in the US with relatives), and aging or ill parents. The data is analyzed and clients are provided with a colorful, easy to understand report detailing the family’s key adjustments, “sleepers” (issues that might emerge as troublesome after arrival) and pleasant or positive matches that lessen some of the anxiety around the assignment.

The questionnaire phase of the system is very user friendly. Since both the employee and their spouse must fill out separate sections of the questionnaire, it was very important to be able to correlate their sessions, and allow the user to stop in mid-session at any point and be able to pick up later where they left off. Also, since the questionnaire must be filled out for each child, it was necessary to allow portions of the system to repeat for the

required number of times. This capability was met through the use of Exsys CORVID's Java Runtime Applet. The user simply goes to the IAP Web site, logs in and runs the system via the CORVID Runtime applet on a Web page.

The expert system uses rules to ask questions in a focused manner. It asks no unnecessary questions, but drills down for more details when the input indicates that is appropriate. All data is automatically sent back to an Access database on the IAP server. If the user is not connected to the Web, the same applet and rules can be run stand-alone with the data written to a disk file that can be sent to IAP.

Upon completion of the interview phase, a family's information is strategically analyzed. This is done by another CORVID expert system. In order to isolate areas of potential concern, the responses are matched against databases and fire neural networks from Ward Systems NeuroShell Classifier to find potential patterns of success or failure. The analytical expert system looks for the obvious problem areas, and also allows a company's own experience with successes and problems determine the findings. CORVID serves as the "traffic cop", asking questions, retrieving data, firing neural nets, and finally sending all the results to a formatted Word document for transmittal to the client.

The system then integrates Access, Excel, Exsys CORVID and MS Word to generate a comprehensive, easy-to-read report. The report is generated in Word using input from the analysis expert system and database information. Excel graphics are integrated into the report, again using data from the database. This allows the generation of a very sophisticated report that clearly highlights the pros and cons of the assignment.

IAP Systems moved the system into CORVID when they knew their clients would demand Internet access. In addition to being extremely easy to learn and use, CORVID allowed them to interface readily with the external programs to process data and generate colorful reports, and made deployment to the Web not only rapid, but also financially feasible.

Exsys CORVID allows multiple languages and cultural versions to be presented to the user, with the underlying logic always controlled by the English version. International business is not just Americans going out into the world. Families from Europe are moving to locations like South America; and Asia, and Asians are relocating to the US. Not only does CORVID allow multiple languages, but it also captures the unique features of different cultures in special questions that are asked only to respondents from that location.

All data is retained in the database, and as patterns of success or stress emerge, the system stores these patterns and alerts future users to potential problems or resource issues. Counselors and/or psychologists review each and every report and make comments and suggestions. To see a sample of a full report as a PDF file, go to [www.exsys.com/iap](http://www.exsys.com/iap)

In most expert system applications the user is presented with an answer at the end of the session. In this case, the report is provided to the HR organization at the employees company. This way the HR group can frankly assess if there are overwhelming risks in the assignment, or what steps may be taken to solve potential problems.

Until the IAP, these issues were either ignored or the information was developed by expensive interviews with specialized personnel. The IAP allows HR professionals, external support firms, counselors, or relocation personnel to have a detailed analysis and summarization of all the personal and family information in one place to plan for a successful assignment.

As many as 70 percent of the large US-based companies expect to send more people abroad for work related purposes. However, companies not familiar with sending employees to a foreign country will incur high costs due to inappropriate assignment placements if they don't analyze their employees' needs and those of their families. A compromised international assignment can take a large toll on a family's psychological well-being, as well as a company's fiscal outlay.

According to a survey by Windham International and the National Foreign Trade Council, 62 percent of most companies provide cross-cultural preparation; 38 percent of companies say they offer no preparation whatsoever. The International Assignment Profile does not replace cross-cultural training or coaching; however, it works in tandem to help insure that both the training, as well as the assignment, will not be compromised by factors that could have been foreseen.

The emotional and security issues in foreign assignments have become far more apparent with the increased threats of terrorism. The climate and status of some foreign countries can change rapidly. Exsys CORVID systems can be rapidly updated and quickly deployed on the Web to reflect international situations and the increased psychological factor.

International Assignment Profile Systems is a Houston-based company, founded by Neill Carson PhD, and Don Young EdD, committed to aiding companies in the expatriate management process using computer-assisted artificial intelligence systems. For more information, log on to IAP's Web site at [www.iapsystems.com](http://www.iapsystems.com), and the EXSYS Web Site at: [www.exsys.com](http://www.exsys.com).

# EXSYS Case Study

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## Improved Handling of Lung Cancer Patient Medical Information

An expert system was developed that provides staging, prognostic and therapeutic information relevant to patients with lung cancer.

The user interacting with the system is asked sequential questions regarding the:

- ◆ Characteristics of the tumor of a particular patient
- ◆ Nodal status
- ◆ Presence or absence of metastasis
- ◆ How the staging information was derived (clinically or at surgery)
- ◆ Tumor cell type
- ◆ Therapeutic options being considered (different surgical procedures, radiotherapy, chemotherapy and others)

The system selects the appropriate answers and displays the stage of tumor and relevant prognostic information. The user can change all or some of the conditions (i.e., therapeutic options) and compare the results of the various “WHAT-IF” simulations.

# EXSYS Case Study

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## Expert Assistance System for Examiners

*Online System Provides Quick Determination for Claimants and Employers on Unemployment Compensation Issues*

A major computer consulting company was challenged to convert, update, and enhance a defunct knowledge base system. Now, the **Pennsylvania Unemployment Compensation (UC) Service Centers** use a new EASE system for the Department of Labor and Industry's (L&I) Bureau of Unemployment Compensations Benefits and Allowances (BUCBA). Using EXSYS products and knowledge engineering services, the system has been completely redesigned into a reliable application that implements database analysis and is expanded for use on a network environment via a browser.



The system is designed to assist adjudicators in conducting fact-finding, determining non-monetary eligibility, and writing determinations. It provides capabilities of accessing and transmitting data with L&I's mainframe, and an interface to the Central Offices mainframe (UCAPS). This interface provides access to additional data that is required on Federal reports. The system resides on a Local Area Network (LAN) and operates on multiple sites. It is accessed via a Web browser and accommodates several hundred simultaneous users.

The system lowers deployment costs because it is a Web-based, enterprise-wide solution that can be accessed from different locations and a variety of workstations. The utilization of the standard Web browser user interface offers many benefits:

- ◆ Software distribution issues concerning installation, configuration, and testing on individual PCs are eliminated.
- ◆ Future maintenance and releases are easily implemented as components reside only on the server.
- ◆ A minimal load on the server, even when many sessions (hundreds) are run concurrently.
- ◆ The expert system is accessible from a variety of workstations and locations.
- ◆ The Web browser format eliminates workstation software and hardware compatibility problems.
- ◆ Deployment costs are lower. Residing on the server in L&I's office, all locations with intranet connectivity can operate the system.

EXSYS can also expand and customize these types of systems for use in other states and government agencies. For over 18 years, many companies and organizations have selected EXSYS for our knowledge engineering services, state-of-the-art technology, integration experience, ability to help with knowledge base conversion, and standalone and Web system deployment. Training personnel for future system development and maintenance is also a major factor.



# EXSYS Case Study

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## Pension Fund Advisor

*Nestle Foods Corporation*

Nestle Foods has developed an expert system which provides information on an employee's pension fund status.



The corporation made certain modifications to the original pension fund plan, to bring it into conformance with new standards. Understandably, these changes created a considerable amount of confusion for the participants as well as additional work for the personnel departments fielding questions from all concerned.

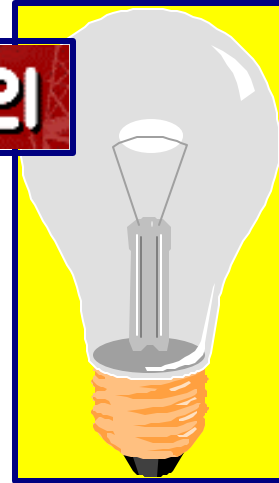
This expert system is not intended to be the official pension “calculator”, but rather a means of giving participants the ability to conduct private interviews with a pension fund expert and ask “What-Ifs”. By providing this expert system to all of the personnel departments, a participant may become far more confident in personal financial planning decisions and the personnel department may focus on other pressing issues.

# EXSYS Case Study

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## Power Plant Outage Prevention

*Electric Power Research Institute*



Bearing system failures constitute one of the leading causes of unplanned outages of power plants. Because of the direct loss of plant availability, determination of the causes of bearing failure, methods of effective repair, and proper maintenance procedures are of paramount importance.

To address these issues, the Electric Power Research Institute (EPRI) produced the Bearing Troubleshooting Advisor (BTA) expert system. The system provides a complete environment for bearing maintenance record keeping, failure troubleshooting, and reference information on information and helps to diagnose bearing problems with greater accuracy. By using BTA and establishing proper bearing maintenance procedures, utilities can reduce the number of bearing failures and forced plant outages.

The expert system helps users determine the mode of bearing failure and possible cause. Through an interactive series of questions and answers, the expert system provides probable failure modes. While answering the questions, the user may also view an example picture of a particular symptom to look for identifying characteristics. After all questions are completed, a detailed analysis is provided of possible modes of failure, causes, repair solutions, and supporting reference text. This information is then automatically stored in the database for future reference and retrieval.

At present, the BTA expert system supports hydrodynamic bearings. In the near future, roller element bearings will also be supported. Bearing failures in other rotating equipment such as pumps, fans, auxiliary turbines and motors can also contribute to plant outages. The vast numbers of roller bearings in a plant require a system that can track relevant bearing, lubrication and maintenance information in a central location for quick reference of individual bearing details as well as complete plant summaries.

# EXSYS Case Study

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## Web-based Expert System Helps the Navajo Nation Caseworkers

(TANF)

The Navajo Nation's Tribal Temporary Assistance for Needy Families (TANF) welfare program provides financial and human services to approximately 28,000 Navajo clients throughout the Navajo Nation. An online advisory solution, called **Case Worker Advisor**, facilitates the transition of responsibility to the Navajo Nation for administering the welfare program for the states of Arizona, New Mexico, and Utah.



The **Case Worker Advisor** captures the top expertise of caseworkers in decision-making for processing recipient (client) applications. The system evaluates eligibility based on TANF regulatory program guidelines. It incorporates the cultural aspects, philosophy, and thought processes of the Navajo caseworkers, streamlines and expedites current assessment methods, and assists less experienced caseworkers. This provides a more consistent, efficient and effective evaluation process, which results in clients receiving benefits faster. Caseworkers are able to spend more time with clients and less time doing paperwork.

*“We can offer our clients a more effective, equitable assistance program that reflects the Navajo’s strong traditions and complex family systems. The Case Worker Advisor expedites the application process and serves over 11 locations on the Navajo Nation. In programming the expert system we accounted for our unique cultural heritage, while following complex federal, state and tribal guidelines.”* – Alex Yassa, Navajo Nation’s TANF Project Director

As a Web-based solution, the system is designed to allow caseworkers to work with their clients in remote locations and to receive accurate recommendations and instruction. **Case Worker Advisor** also provides TANF with the accounting and reporting capabilities required by state and federal auditors. The initial system was deployed and supported in St. Michaels, Arizona, with planned expansion to several additional sites throughout the Navajo Nation.

# EXSYS Case Study

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## Tax and Legislative Auditing and Reporting

*Langton Clarke*

EXPERTAX enables users to diagnose and analyze tax-related matters, which are extraordinarily complex and dominated by few specialists. It is a major expert system in the business sector due to its size, complexity and detail of its knowledge base, application domain and functionality. Using this expert system, Langton Clarke distributes their highly specialized tax expertise to apprenticed auditors or to those with less experience in tax matters. The system develops a detailed work schedule, indicating to the auditor the steps he must take to perform a high standard audit. Use of the expert system enhances the quality of tax audits, increases productivity and gains new clients.



The EXPERTAX domain determines Net Taxable Income, Tax Equity, Taxable Income Found, Value Added Tax and Company Taxation, as well as special Tax Planning. Human expert interviews were transcribed verbatim, and analyzed to produce a reasoning object list and knowledge map. The expert system was developed using a continuous prototyping strategy through new interviews and adding enhancements to the system. Expertise was also acquired from expert-novice sessions.

The runtime version of EXPERTAX is being run on several machines. Interaction is made simple through menus that allow users to answer more than one response alternative. The system also enables the user to make a (What If) sensitivity analysis, modifies information from cases already dealt with, and examines the comparative effect in the expert system's conclusions. Cases defined by interaction (audits, comprehensive analysis such as planning, training new auditors, comparisons among companies, variances in fiscal years, etc.) are saved for later updates. The expert system alternatively issues a data and conclusions report that is incorporated into working papers, serves the auditor as a work guideline, and as a checklist for the supervisor or manager.

# EXSYS Case Study

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## In the Field Procedural Assistant

*Pacific Gas and Electric*

An expert system has been developed to assist personnel in the field with servicing and maintaining PG&E's electric revenue meters. The system provides the ability to quickly index and reference information pertaining to safety precautions, operating policies, diagnostics, testing and maintenance procedures. Conceptually, the meterperson's assistant is designed to provide the user with information on what to do next, where to get additional help or reference, what is important and why. It provides assistance to the user with the following metering tasks:



- ◆ Servicing and maintenance recommendations relating to equipment recalls
- ◆ Safety precautions
- ◆ Testing procedures on test setups and calculations
- ◆ Troubleshooting solutions based on the past performance of particular meters
- ◆ Reporting including special notes regarding each different type of meter

The meterperson's assistant system can also be used as a training tool because it can describe reasoning behind its recommendations, and can make calls to external graphics programs for clarification when situations are difficult to describe with just text.

# EXSYS Case Study

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## GE Identification of Common Metals

*General Electric*



*We bring good things to life.*

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General Electric Corp. developed an expert system to identify common metals and alloys. The user is asked to supply information on density, color, hardness and simple chemical tests that can be performed by non-metallurgists in a non-laboratory setting. If sufficient information is available, the system will positively identify the metal or alloy. If there is not sufficient information, the system will provide a list of possible metals in order of likelihood.

# EXSYS Case Study

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## Planning and Design of Agroforestry Systems

*United Nations University*

The goal of the Agroforestry Expert System (UNU-AES) is to assist land-use officials, research scientists, farmers and individuals. Use of the system maximizes benefits gained from applying agroforestry approaches to land management for sustainable production of food and fuel wood supplies by farmers.



Agroforestry studies promote land use in which woody perennials are grown on the same land as agricultural crops and/or animals either in spatial arrangement or in sequence. The woody components interact ecologically and economically. Alley cropping is a type of agroforestry in which leguminous trees are planted in rows with food crops cultivated between them. Pruning minimizes shade, provides nitrogen-rich foliage, recycle nutrients and can provide fodder, mulch, and firewood thereby integrating crops and animal production.

The knowledge base in the system utilizes annual rainfall, number of rainy days, total rainy seasons, elevation, slope, soil texture, soil fertility, soil reaction data, and socioeconomic characteristics. Agroforestry practices such as fallows, plantation crop combinations, home gardens, soil conservation hedges are also considered. The expert system operates on portable computers, which enables demonstrations and use in developing countries. Though it handles very complex data, the application is simple enough so that end users can run the program and perform sensitivity analyses with minimum training time. The system displays customized screens, allows interface calls to external databases and programs, and has an explanation facility to assist the system user.

# EXSYS Case Study

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## Electronic Legal Assistant

*The Georgia Magistrate Court Judges Training Council,  
State of Georgia Department of Information Systems  
and Communications, Georgia College*



The Georgia Magistrate Court Judges are composed of elected judicial representatives from each of the counties in Georgia. The representatives vary in their formal legal training, which ranges from limited experience in judicial areas to advanced degrees in jurisprudence.

The electronic legal assistant was designed to assist magistrates in determining whether the known evidence supports the issuance of either a criminal arrest warrant or bad check citation. The purpose of the program is to help legal professionals in areas of limited law familiarity, capturing worthwhile knowledge, improving job performance and increasing the quality and uniformity of an existing procedure.

The program makes use of extensive hyperlinks and varying degrees of "the reasons why", for questions and statements. Graphics and color are also a predominant part of the user interface. The program runs on PCs and online. Another version was prepared to accommodate the variety of workstations available to the Georgia Magistrate Court Judges.

For more information, contact: Dr. Barbara Jeanne Clinton, J. Whitney Bunting School of Business, Georgia College, Milledgeville, GA 31061



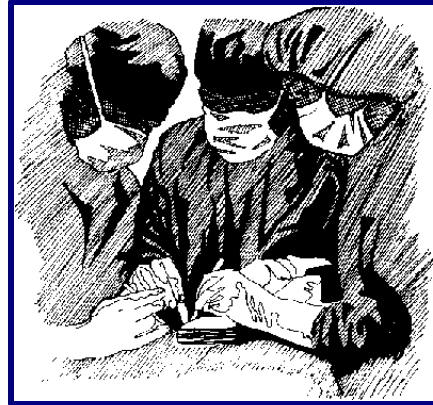
# EXSYS Case Study

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## Respiratory and Anesthesia Monitoring

*Rader, Crowe, and Marcott*

*CAPS* combines a pattern-recognition module with an expert system to characterise and analyse each segment of a capnogram. A capnogram is a carbon dioxide wave form produced by monitoring patient respired gases during surgery. The analysis of the capnogram is used by the expert system to generate a probable diagnosis and to recommend a therapy or equipment adjustments.



# EXSYS Case Study

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## Work Zone Safety Interactive Video Trainer/Advisor

*Federal Highway Administration/Virginia  
Transportation Research Council*

The Federal Highway Administration and Virginia Transportation Research Council implemented an expert system to assist highway engineers in selecting appropriate traffic control and management strategies for highway construction and maintenance zones. It is used as:



- ◆ An interactive training course for work zone safety procedures
- ◆ A source of information for specific work zone safety issues
- ◆ A work zone planning and design aid

Due to the expert system's flexibility, it is combined with the presentation capabilities of an interactive videodisk training system. The use of the videodisk technology enhances the expert system by providing the user with high quality video images. This visual information can aid the user in analyzing and diagnosing problems and in understanding the recommended solution.

The training system presents the traffic control devices available and the basic procedures for selecting and using these devices. It also incorporates established principles to be used in the design, installation and maintenance of traffic control devices and heuristics for applying these principles to a particular situation. The course is divided into a series of expert system modules and lessons, which allows the training to be tailored to individual needs. Questions spread throughout the course require the user to actively participate in the training and are governed by their responses. A proper response allows the user to continue with the training, while incorrect response results in correction prior to proceeding with new material.

# EXSYS Case Study

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## Severe Thunderstorm Prediction

*National Oceanic and Atmospheric Administration*

An expert system was developed by NOAA to assist in the prediction of severe thunderstorms in the area of northeast Colorado and adjacent states.

A large body of meteorological data is collected constantly and available to meteorologists through computer systems such as PROFS (Program for Regional Observing and Forecasting Services). Such programs provide a meteorologist with the data needed to develop a good weather forecast. However, often there is a limited time frame in which to make a prediction and some problems, such as severe thunderstorm prediction, require highly specialized and complex knowledge.

To address this problem, an expert system was built to help use the data available to predict severe thunderstorms. The system makes calls to external programs to handle the necessary complex mathematical calculations. The system can make predictions on thunderstorm likelihood and severity. In testing, the expert system has performed well in predicting storms provided that full data is available.



# EXSYS Case Study

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## Configuration of Computer Integrated Manufacturing Cells (CIM)

*Rockwell Automation/Allen-Bradley*



Allen-Bradley is one of the major manufacturers of Computer Integrated Manufacturing Cells (CIM Cells). The company has fielded this system worldwide and it is used extensively by their sales force. CIM cells are a highly advanced form of automated machining equipment. The CIM cell is capable of re-configuring itself under computer control to produce a wide range of different parts in lots of 1 to 10,000 or more. The flexibility and speed with which differing parts can be produced make CIM cells one of the most advanced production technologies available.

A CIM cell is extremely complex, utilizing many different types of sensors, controls, cutters and peripheral equipment. There are hundreds of components that can be included in a CIM cell, and many possible configurations will not function properly. Configuring a CIM cell involves determining that all components are compatible and that the system is complete. This used to require a human expert with extensive experience, and take a full day.

A large expert system was built that now configures a CIM cell in minutes. The system backward chains extensively and uses external programs for data input, and obtaining current prices of equipment. A sales person can input information to the configuration using a large customized "fill-in-the blank" type screen. The system then checks the configuration and asks the user for additional information as needed. Once the CIM cell is configured, the system looks up prices of the selected components and prints a detailed quotation, using the Report Generator. The report can then be incorporated into a sales proposal and given to the customer.

# EXSYS Case Study

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## In Vitro Fertilization Cycle Stimulation

*University of Vienna, Austria*

Nothing says “mission critical” like the precise timing for cycle stimulation needed in infertility diagnosis and treatment. Below are the results from an expert system that was presented at the World Congress of In Vitro Fertilization and Embryo Transfer.

The following factors were built into the system

- ◆ Cycle day
- ◆ Urinary luterinizing hormone (LH)
- ◆ Yesterday’s and today’s serum-estradiol (E2)
- ◆ Yesterday’s and today’s progesterone (P)
- ◆ Increase of E2 and P
- ◆ The number and size of sonographically measured follicles.



The system displayed the correct choice in over 90% of cases after extensive testing. It is the opinion of many doctors that this expert system presents a valuable tool to simplify routine procedures in IVF programs. It is also used as a teaching instrument for residents. This system dramatically speeds up decision-making processes for treatment.

# EXSYS Case Study

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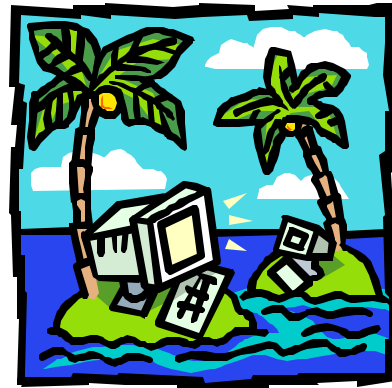
## Tree Selection Based on Environmental Conditions

*Rubber Research Institute of Malaysia*

An expert system was developed by the Rubber Research Institute in Malaysia to recommend specific rubber tree clones for plantations based upon the specific conditions of that plantation. The complete system includes the expert system, presentation graphics of environmental condition maps, and information on the

various types of clones. A critical aspect of system design was for the system to be run by end users with no training. It was designed to be used by the plantation growers themselves and is made available to plantations without electricity on **battery powered laptops**.

The Institute has found that the selection of the proper clone is the single most important factor in enhancing production. System recommendations can be compared to clones actually in use. The system incorporates graphics and other data assists in presenting a complete explanation of why a particular clone is suitable.



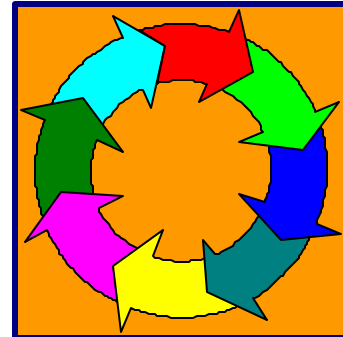
# EXSYS Case Study

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## Mechanical Equipment and Systems Diagnosis

*An Engineering Company*

Several expert systems were developed that contain the knowledge of seasoned mechanical engineers and equipment troubleshooters. For this reason, such systems are valuable in helping operators and maintenance personnel find the sources of mechanical and electrical equipment malfunctions both quickly and accurately. These systems help diagnose and locate problems in electrical, mechanical, or fluid systems.



The *Rotating Equipment Vibration Advisor* for example, is an expert system for rotating equipment including centrifugal pumps, industrial fans, steam turbines, electric motors, and compressors. The system helps interpret a machine's vibration patterns derived from standard vibration analysis. It uses these patterns, together with observed symptoms, to arrive at an accurate diagnosis of equipment problems. The system:

- ◆ Works with interactive user input
- ◆ Reads vibration-measurement-data files
- ◆ Derives data from vibration-analysis instruments

*PumpPro*, a generalized centrifugal pump diagnostic expert system, is distributed to over 400 client installations. The system is used for problem-solving and maintenance personnel training. *PumpPro* contains rules for identifying the symptoms and causes of pump problems, and suggests remedies. The system also includes extensive tutorials on subjects that may be unfamiliar to pump maintenance personnel, but is important to problem identification and solution.

# EXSYS Case Study

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## Control Panel Layout Design Aid

*An Engineering Company*

An expert system has been built that aids in the design of control panels. The system is also useful in performing human-factors engineering evaluations of proposed design changes to existing panels. The benefits extend well beyond initial design. The system ensures an optimized control panel layout, which results in fewer costly operator errors, and consequently, in safer plant operation. It can also evaluate future retrofits in the context of the existing database model and compare design alternatives, ensure consistency of color, mimic, and other plant specific guidelines.

The expert system incorporates human-factors design guides and checklists, as well as specialized knowledge about the display of information, the operation of controls, operator decision-making, and the complex interactions between operators and the processes they oversee.

The system interfaces directly with a 3-D CAD system. Proposed designs are entered graphically into the CAD system, through a relational database. The flexible user interface accesses the database allowing the expert system to evaluate the design. The system examines component specifications and proposed layouts, generates reports, determines the adequacy of the proposed designs, and recommends any necessary changes. The benefits are improved quality and accuracy of the design process without expensive iterative analyses.



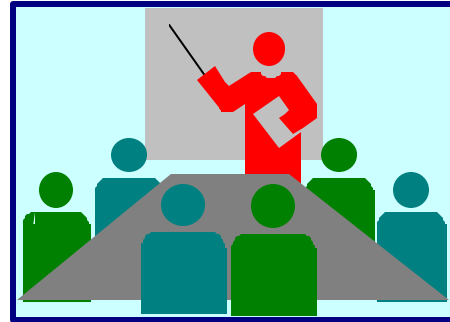
# EXSYS Case Study

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## Individual Development Plan Advisor

### *Human Technology*

An individual development plan (IDP) is a formal statement of short and long range employee career goals and the developmental objectives to reach those goals. It specifies the combination of developmental assignments, classroom training and other learning activities planned to enhance job-related knowledge and skills.



The IDP Goal Advisor is an expert system which assists the supervisor in deciding the goal(s) for development planning. The system has two stages. Stage 1 produces possible goal(s) for:

- ◆ Development planning
- ◆ The need for performance improvement planning
- ◆ Where to begin solving the problem
- ◆ The need for retraining
- ◆ Career goals
- ◆ The relevance of a selected training program

The system coaches the user through consideration of each issue building a cumulative understanding of the most appropriate focus for development planning. The system then produces a summary of the recommendations.

The second stage evaluates the goals from the perspectives of organizational policy, resources and the ability of the employee to succeed. This includes consideration of organizational policy on proposed development goals or the mix of development goals, and the availability of funding to support pursuance of those goals.

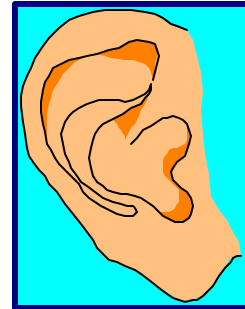
# EXSYS Case Study

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## Pediatric Auditory Diagnostics

*Vanderbilt University*

A diagnostic expert system named *AUDEX* was developed that can interpret infant auditory brainstem response (ABR) data. Identification of hearing loss in the pediatric population poses a difficult diagnostic challenge to the audiologist. Developmental age, gestational age, and chronological age are considered when interpreting test data used in the diagnoses. Also, adjustments must be made if an infant is premature or developmentally delayed. These considerations require a certain level of expertise in the domains of electrophysiological and behavioral pediatric testing.



The authoring of the expert system required a professional in the domain of audiology. The system user provides history information, absolute and interwave latency values, waveform threshold values, and tympanometric data. The diagnostic system then provides the user with the following information:

- ◆ Hearing sensitivity classification based on click or tone burst thresholds
- ◆ Type of hearing loss, (i.e.: conductive, sensorineural or mixed)
- ◆ Auditory brainstem status (i.e. normal or abnormal)
- ◆ Certainty factors associated with each of these conclusions
- ◆ The user is allowed to query about what rule it is trying to affirm and how it reached certain conclusions

Five certified audiologists with extensive experience in ABR measurement with young children were utilized for testing purposes. They were instructed to use the system after they completed ABR assessments and made diagnoses. Cases that included children between the ages of 34 weeks and 3 years of age who had a full range of degrees and types of hearing impairment were run. A total of 73 were analyzed and in the final evaluation, and the expert agreed with the computer diagnosis for 100% of the cases. The system also benefits in audiology training programs.

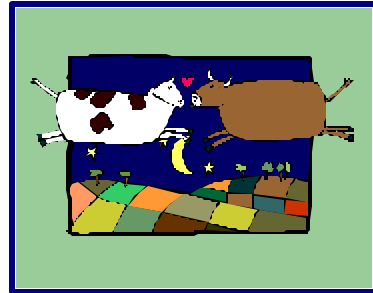
# EXSYS Case Study

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## Cross Breeding System Increases Gross Margin by 50%

*Woolangbar Agricultural Institute, Australia*

Beef farmers in response to changing market conditions and to improve production efficiency can use planned cross breeding from two or more breeds. With an appropriate choice of breeding system and breed combinations, gross margins can be increased by up to 50% in some environments. In the well over \$3 billion Australian beef industry, an increase of only 5% is worth \$180 million.



Effective cross breeding strategies require an expert knowledge of genetic variation between breeds in traits such as growth rate, maturity, ease of calving, calf survival, disease resistance, milk production, temperament and fertility. The task is further complicated by the interaction of genetic and environmental factors and by management constraints.

This knowledge, captured in an expert system X-Breed, is used to improve the most sought after traits while avoiding a negative effect on other desirable traits. X-Breed was built to assist professional livestock advisors in their task of planning a cross breeding strategy for beef farmers. The system guides the user through an “expert” consultation resulting in a number of ranked recommendations that provide a cross breeding strategy for their farm. The expert system is made up of data sharing modules, which selects the breeding system and makes calls to other data sources for tasks that are outside its domain. A blind validation test showed that X-Breed performed at a level equal to that of a domain expert and significantly better than seven out of eight professional advisors.

# EXSYS Case Study

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## Construction Method and Labor Cost Diagnostics

### *Construction Contractor*

Arc welding is used by various segments of the construction industry and has become an integral part of almost every steel structure. An expert system was developed that provides cost analysis to help contractors and fabricators in bidding, control and productivity analysis. The system is not only practical for cost estimating, but can be used to study the effect of varying important parameters such as labor rate, labor efficiency, operating factor, and material costs on the total cost.



The system consists of two main modules: The first selects an appropriate welding method based on job characteristics. The second estimates the welding costs based on the selected welding method and the input values supplied by the user. The system can also be used by steel fabricating establishments for preparing detailed project estimates and performing sensitivity analysis to evaluate the impact of varying specific parameters on final welding costs.

The expert system covers many welding processes such as:

- ◆ Manual
- ◆ Semi-automatic
- ◆ Machine
- ◆ Automatic welding

Project characteristics considered for determining a suitable weld process include:

- ◆ Welding indoors versus outdoors
- ◆ Weld size
- ◆ Quality and appearance
- ◆ Position of work
- ◆ Joint penetration
- ◆ Availability of automatic welding system
- ◆ Dispersion of weld locations

Labor cost, material and consumable cost, and equipment and power cost information were also included in the spreadsheets used by the system.

The expert system explains why it asks questions and also describes its decision-making process. For example, it explains what is meant by a high versus average quality weld, or what is the relationship of weld penetration with the plate thickness and its effect on welding. System users can evaluate the impact of various factors on the total costs.

# EXSYS Case Study

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## Customized Diagnostic System for Unusual Hardware



*MicroDimensions, Inc.*

An expert system was developed to help technicians diagnose hardware/software problems in a machine vision system. What makes this project especially interesting is that there was a constraint that the expert system run on the same hardware as the machine vision programmer. This was a board with no keyboard, only light pen input, no disk drive, and a screen size of 64x24 characters. Most importantly, there was no operating system in the normal sense. Needless to say, it was a very unusual computer to port to.

Clearly, off the shelf software could not be used for this project. EXSYS staff worked with the company to produce a custom version of the runtime that could run on this hardware. The port was completed by cross compiling on a specific PC model. Routines were written that simulated an operating system for the calls made by the expert system. Due to the easy portability of the code, this project was accomplished very rapidly.

Development of the rules was on a PC with both the inference engine and rules permanently stored in memory. Input was handled by an external program, which drew the keys needed by the expert system on the screen with selection by light pen. The system has been highly successful.

# EXSYS Case Study

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## Detecting Insider Trading

### *American Stock Exchange*

The American Stock Exchange is a self-regulating organization responsible for monitoring market activity in a number of investment areas of the AMEX, including equities. The equity surveillance department receives information on unusual activity from a number of sources. This department performs an initial screening of referrals to determine whether or not to investigate further.



The Market Surveillance expert system is designed to support analysts in making recommendations on whether to open an investigation of suspected insider trading. The user makes an inquiry to a database of stock price history, which is transferred, to a PC via an IRMA board. The analyst then uses a spreadsheet with menus and macros to determine a period of interest for investigation. A custom interface reads the data and provides a format for rapid user input similar to a questionnaire. The spreadsheet provides data to the expert system, which then provides the appropriate questionnaire. The expert system asks a few additional questions and gives the user two scores. One score is the probability for opening an investigation, and the other for not investigating.

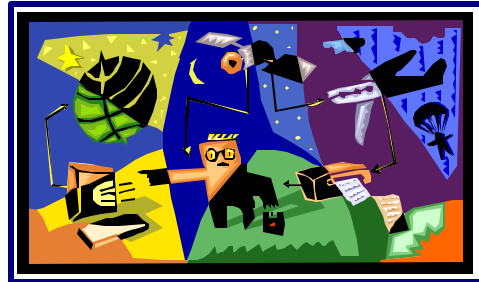
The entire system runs from a batch file. At the end of a user session, the system prints the results and saves the data and rule set on a diskette, which is then filed with the investigation folder.

# EXSYS Case Study

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## Connecting an Expert System To a Simulation of a Complex Manufacturing System

*California State University*



In industry today there are complex packages running and managing manufacturing floors. This project merges an expert system with simulation into one package. The expert system's powerful reasoning logic can prevent lateness of orders, increase productivity and performance of Flexible Manufacturing Systems (job-shop), while keeping the equipment working at an optimum level (maximum utilization of machines).

Discrete Simulation is concerned with the arrival of a process and monitoring its progress through the system. This monitoring occurs anytime a process waits in a queue for a particular facility. A typical simulation model consists of entities (jobs) that have attributes (job number, starting time, type of job, etc.). The total collection of entities and their attributes at any point in time is called the status of the system, and rules called events govern changes in the status.

Typically an order will be generated consisting of many processes (20-100 jobs at a time), by using some function of time. The processes enter the queue for a machine, process the job and then release controls of the machine. At this point, the expert system is called on to decide which job should seize the empty machine.

The rules of the expert system are based on:

- ◆ Preventing Lateness of Orders.
- ◆ Minimizing Lateness of Orders
- ◆ Maximizing (Optimize) Use of Machines

These rules use the attributes of the jobs that are in a corresponding queue of a free machine to make decisions. These attributes are read in from a file, which the simulation package has previously written to. The expert system then writes back to a file for the simulation package to use. Utilizing the EXSYS expert system with a simulation package increases performance, productivity, optimization and overall quality of the job tasks performed in the manufacturing industry.

# EXSYS Case Study

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## Equipment Selection for Highway Construction

*American Association of  
State Highway and  
Transportation Officials*



One of the most common methods used in stabilizing earth fills is to compact soil in thin layers by using compacting equipment. Choosing the most appropriate compactor under a given set of job conditions is a typical problem that construction or highway engineers face when working on highway or other earth-moving projects.

An expert system was developed that helps the construction or highway engineers choose the most appropriate compactor under a given set of job conditions. Selecting a suitable compactor is affected by numerous field variables. The expert system is well suited for formulating and organizing this type of experience-based knowledge. The system takes into consideration:

- ◆ The degree of compacting required
- ◆ Job size
- ◆ Soil type
- ◆ Plasticity
- ◆ Moisture conditions
- ◆ Breakage of aggregates

The expert system recommendations specify standard AASHTO densities to jobs, and is used as a tutorial tool for inexperienced personnel. The information provided is enhanced by scanned images of various types of equipment.



# EXSYS Case Study

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## Selecting Welding Procedures and Tests

*An Engineering Company*

Many engineering companies have built many expert systems for a wide variety of construction applications. Several systems have been developed to assist in various aspects of welding.



A personal computer based Welding Procedure Selection expert system was developed by an engineering company's construction specialists to help project supervisors identify appropriate welding procedures at field sites. The complexities of reconciling weld material types and sizes with construction policy make selecting these procedures difficult. This expert system gives welders printouts of the correct welding procedures, after simply inputting material specifications and related information. With some additional information, the system also provides time estimates and material requirements.

The Weld Defect Diagnosis expert system was developed to identify the causes of weld defects. To do this, it analyzes material types, welding procedures, environmental conditions, and personal observations of the welding area.

### Welder Qualification Test Selection System

This expert system chooses tests for welders, taking all relevant factors into consideration. Welder qualification tests, which are based on welding requirements and a complicated set of construction policies and procedures, can be very expensive. This system has significantly reduced costs at a major oil company by helping in the efficient selection of these tests.

# EXSYS Case Study

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## Real-time Process Control in a Food Processing Facility

*Nestle Foods Corporation*



Nestle Foods has installed expert systems in real-time applications at their processing facilities. Real-time readings from a plant programmable controller are collected and provided to an expert system, which performs an analysis on the process status. Messages that guide the operator in optimizing the operations are then generated.

The system operates with special interface software developed for Nestle. A special operator's screen, and extensive use of interrupts provided by EXSYS, were keys to success of the project. A model of the process was also built to support the system in the real-time analysis.

This real-time work has been extended to provide increased power and multi-tasking. A special version of the development software was built by EXSYS, with custom hooks into process control software developed by cooperative effort of IBM and selected industry leaders in process control, including Nestle. This combination of the power is ideal for monitoring and controlling a wide range of process operations.

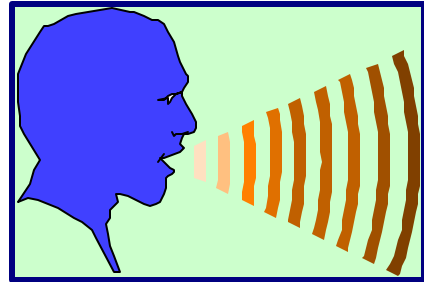
# EXSYS Case Study

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## Voice Driven Medical Diagnosis

*Medical Univ. of South Carolina  
(Used by the Family Medicine Center and its  
consortium.)*

Anemia is widely perceived as a single disease when, in fact, it is the presence of a variety of disorders that cause decreased hemoglobin concentration.. Many diseases can cause anemia and thus the skilled physician must collect and organize all the clues he can and then try to decipher the underlying cause.



Clinical Hematology Expert Support System (CHESS) was designed to assist the practicing physician in making an efficient and accurate hemotological diagnosis. The system is used and accepted by those within the medical profession who are less knowledgeable about blood disorders. For routine use, data needed to interact with the system is input through a keyboard, or a voice-recognition unit (i.e: when looking through a microscope), primarily as numbers, either of options displayed or quantitative data.

The diagnostic system's knowledge was acquired through numerous discussions with practicing expert clinical hematologists. While the intial system was first designed for anemia, erythrocytosis decision logic was incorporated to include red cell, white cell and platelet problems. The knowledge base captures the usual sequence of thought and questioning while examining a patient. The system is designed to guide the user to diagnosis in an optimal manner by minimizing the requirement for quantitative laboratory data, while at the same time, asking pertinent questions in the same sequence that an expert clinical hematologist would ask them.

The system is not only an expert diagnostic system but also an expert teaching system for medical students as well. It provides the user with the ability to ask why a specific statement is displayed, how a conclusion was reached, and shows the user the optimal sequence of questions.

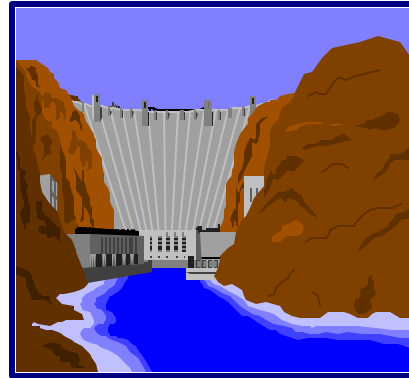
# EXSYS Case Study

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## Power Generation Scheduling

*An Engineering Corporation*

Scheduling for power generation systems involves evaluating economic optimization methods, maintenance schedules, reliability analyses, and those factors that influence load projections and generating unit availability. Conventional computer solutions focus on the algorithmic part of this process, without addressing the qualitative, judgmental issues.



The Unit Commitment Advisor expert system helps power system dispatchers with both the numerical and qualitative aspects of scheduling. Because every generation system is unique, each Unit Commitment Advisor was be customized for each client. The system uses economic optimization routines, as well as maintenance schedules, to define the best schedule.

It also employs heuristics to combine all those factors that are important in making dispatching decisions, including take-or-pay fuel commitments, minimum station generation requirements, and availability of startup and maintenance crews. This expert system illustrates the feasibility of combining traditional numerical methods with heuristic rules to solve scheduling problems.

# EXSYS Case Study

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## Time, Resource, and Taxpayer Savings



*US Department of Labor, Occupational Safety and Health Administration*

OSHA's Permit Spaces Advisor gives users interactive expert help to apply OSHA's Permit Required Confined Spaces Standard. The system interviews users about a workspace to determine whether and how it is subject to compliance. It tells the user what aspects of the standard apply to them based on their answers. The system has:

- ◆ Pop-up (hypertext) definitions of keywords and phrases
- ◆ Sets of frequently asked questions (FAQs) and official interpretation letters
- ◆ A very readable copy of the regulations, and other help

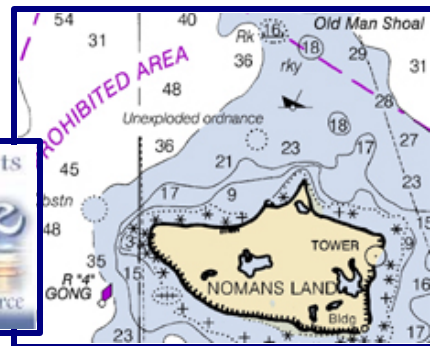
The most important direct benefit is to the employers, whose timely, accurate access to the information contributes to a safer and healthier workplace, in addition to saving OSHA regulators time, resources, and taxpayer dollars. The online Confined Spaces Advisor logs more than 400 questions each week, a workload that would have required two full-time OSHA Compliance Officers. In the first six months after its online release, the Confined Spaces Standards Advisor was accessed more than 9,000 times.

The program was developed in conjunction with EXSYS expert systems development software, and the distribution version of the program uses the EXSYS Runtime program core. Use of EXSYS products is governed by a license granted by EXSYS to the U.S. Department of Labor. The OSHA Permit Spaces Advisor, and many other expert systems, as online interactive and download versions, are available at:

<http://www.osha-slc.gov/dts/osta/oshasoft/>

# EXSYS Case Study

## Improved Accuracy in Nautical Chart Cartography



*National Oceanic and Atmosphere Administration  
U.S. Department of Commerce*

In order to increase productivity, reduce subjectivity, and provide consistency in the creation of US nautical charts, the National Ocean Service's office of Charting and Geodetic Service (Marine Branch) decided to use expert systems. The constraints were:

- ◆ The knowledge base must be in English text
- ◆ The systems had to be easy to understand so maintenance could be transferred from the contractor to government personnel
- ◆ The systems must be able to be developed by non-programmer cartographers
- ◆ Fast development time

EXSYS was selected as meeting the above parameters. It was decided to begin the project by building an expert system to address a single chart feature that was representative of the entire problem. The feature selected was overhead cabling. The system was developed in 5 months at a cost of \$50,000. Even in alpha testing it was found to be 94% accurate - 40% higher than human novice cartographers.

Acceptance of the system was excellent with many cartographers using it on their own time and providing comments. Due to the success of this system, the project now has 11 expert systems for different types of marine features. The complete knowledge base is over 6700 rules, but easily runs on a PC.

# EXSYS Case Study

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## Numerically Controlled Machine 1001 Selection

*Sandia National Laboratory*

Numerically controlled machines can be used to make a wide range of parts in complex geometries. Such tools have the ability to automatically change tools to make different types of cuts. Unfortunately, many machines, especially older ones, can only hold a limited number of tools. Consequently, the making of a cut may have to be done with a tool that is suitable, but not optimal in terms of cutting time.



*... a U.S. Department of Energy national security laboratory.*

ANVIL is a software program for making the tapes that control such numerically controlled machines. ANVIL gets some of the information it needs from blueprints, but still needs to ask the user many questions. For some parts it can take 6 hours to answer all of the questions. EXSYS Inc. worked with Sandia to develop an expert system, which greatly reduces the number of questions, and the time needed to generate ANVIL tapes.

# EXSYS Case Study

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## Forest Inventory – Quality and Quantity Analysis

*University of Georgia School of Forestry*

Traditionally, expert foresters who are familiar with forest topography and timber quality conduct forest inventories. Forest inventories are defined in mathematical procedures for obtaining statistics on the quality and quantity of standing forest timber. An expert system in forest inventory is appropriate since the best sampling method and its cost depend on several quantitative, qualitative and other intangible factors, whose influence can best be expressed as a set of rules.



This expert system considers the two most widely used forest inventory sampling procedures: Line Plot and Point Sampling, each of which can be stratified. The system recommends an appropriate sampling procedure. It also gives the plot size to be used for sampling and estimates the cost of the inventory procedure. The major criterion for selecting the sampling method is the estimated relative cost of the procedure as a function of the desired level of accuracy, and the forest topography.

The development of the expert system consisted of several discussions with doctoral students at the University of Georgia School of Forestry and several meetings with experts to elicit the knowledge and identify the pertinent factors. After the system was ready, it was successfully validated and tested by other experts in the School of Forestry. They expressed complete satisfaction with the expert system recommendations and pronounced it to be very reliable under various test scenarios.



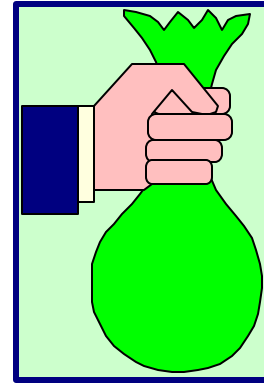
# EXSYS Case Study

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## Credit Analysis Advisor and Report System

*Financial Proformas, Inc.*  
(Now with Moody's Risk Management Services, Inc.)

An expert system was developed to support the needs of commercial lending institutions. Over one third of the top 100 commercial banks in the US and Canada along with some of the largest industrial and financial companies in the world use FAST (Financial Analysis Support Techniques) software for credit analysis. It gives a credit analyst access to the expertise of more experienced advisors, thereby accelerating the training process and increasing productivity. It also provides a complete range of traditional analytical reports on both historical and proforma basis.



The system provides complex analysis of the traditional report data. This supports the company's philosophy of utilizing the latest technology to increase the loan officers' productivity. The expert system not only provides English language interpretation of the historical financial output, but also prepares the assumptions for annual projections, and produces text output linkable to word processing software. Much of the tedious writing of analytical reports is eliminated because the system generates standard financial statement reviews.

Through periodic updates, the knowledge base is customized for a bank's current loan policy, US and local economic forecasts and interest rate projections. The system consistently and reliably interprets the relationship of these variable factors and user-defined levels of sensitivity associated with a particular financial statement.

# EXSYS Case Study

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## Environmental Compliance Support System



### *Los Alamos Technical Associates*

The environmental compliance support system (ECSS) developed by Los Alamos Technical Associates is an integrated set of tools that combine data about activities, sites, and legal or other environmental constraints. The expert system uses modern information technology capabilities, a geographic information system, a relational database, and text-search system.

The ECSS allows a manager to select candidate sites and determine which sites are environmentally optimal for each activity. It assures environmental compliance and minimizes the documentary and administrative burdens. The system was developed on personal computers to provide a high degree of platform independence.

# EXSYS Case Study

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## Seed Selection for Best Yield and Profit

*KW & Associates /University of Illinois*

Each year soybean farmers mull over a decision that can cost them yield and profit – *Which of the many soybean varieties to plant?* Location, resistance to pests and disease, and management plans are all-important, and some of these interact.

The “SOYSEED” program puts an “expert” at the farmer's elbow. The expert system gives the same recommendations an expert would, based on answers to questions, which are specifically tailored to each farmer’s situation. The program combines "expert intuition" with hard data. Farmers, farm managers and farm advisors use SOYSEED, and it serves as an experimental and demonstration program in agronomy.

SOYSEED screens 29 varieties of soybeans for suitability to a farmer's location, field conditions, farming plans, and need for pest and disease resistance. It lists varieties that are reasonable choices and their yield chances under certain conditions. The farmer can see the agronomic reasoning behind each recommendation and run "what if" scenarios to see how his preferred management affects choices. Questions are simple and limited. For example, instead of asking the farmer his "maturity group region" which determines the type of bean that can develop adequately, the program lets him show his location on a screen map of Illinois, Indiana, or the entire Midwest.



# EXSYS Case Study

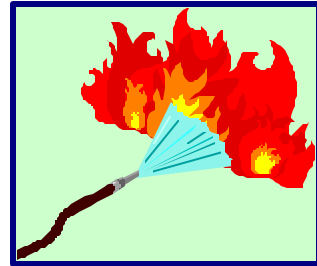
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## National Fire Code Advisor

*Dynalytics Corporation*

Dynalytics has developed many expert systems for a wide variety of applications including:

- ◆ Environmental permitting
- ◆ Design and quality control aspects of process plants
- ◆ Troubleshooting problems in complex equipment.



The purpose of the fire code advisor is to make certain parts of the national fire codes more understandable and manageable. Architects, engineers, and design people benefit greatly from quick access and interpretation of standards, which encompass gas turbine and diesel engine fuel delivery systems.

Fire codes consist of fairly rigid guidelines for many areas. By interacting with the expert system questionnaire, users can get extracts of the code which are pertinent to each installation by selecting from possible responses to questions, and providing values for size and range of applicability. As a result, the expert system edits the fire code standards and generates a listing of relevant sections. The report is specific, only provisions that are relevant to the situation under consideration are presented to the user. Aside from the tremendous savings in time, there is no risk that something is overlooked or misinterpreted in the national fire code standards.

A Fire Safety Advisor is also located on OSHA's web site at:

<http://www.osha-slc.gov/dts/osta/oshasoft/>

# EXSYS Case Study

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## Class Selection Student Advisor



Experience of educators shows that good undergraduate guidance in terms of class selection and registration process substantially helps to retain students. Advising consumes considerable time and effort of the faculty involved in the advising process. Greater needs for advising, coupled with a smaller number of faculty, has resulted in the deployment of automated advising systems in many departments. Good advising is especially important in an environment where there are many transfer students requiring individual assistance during the registration process, and where there are many full or part-time working students whose availability is limited.

EXSYS was selected for these projects because of its availability on several different types of computers and workstations; wide use for different applications in industry and business; and popularity in academic environments. The advisor suggests consecutive courses to be taken by students to ensure progress toward completing degree requirements, while taking into consideration student availability and individual interests. The advisor also suggests courses that are prerequisites for the largest number of other courses. Students can minimize the time needed to obtain a degree, particularly in the small departments that cannot offer all of its courses every semester at a convenient time.

Students run the expert systems with no training other than how to start the program. Course offerings for the next semester are always presented with the current class schedule to help students plan ahead.

The systems track student's interests, and records of taken courses. Departmental (or university-wide) databases consisting of all students records are called by the expert systems for the list of completed courses for every student. This feature is important in departments having many "transfer" students coming from nearby colleges. Courses taken by students elsewhere can be evaluated and their correlative courses can be entered into the database. The capabilities of the expert system to make fast and easy modifications each semester contributes to the adaptation of the system by other departments and colleges.

# EXSYS Case Study

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## Nuclear Weapons Security Classification



Nuclear weapons security classification guidance is defined by over 100 classification guides which state what information is, or is not, classified. It requires years of experience to be able to effectively and efficiently use the guide system to determine the correct classification of a document. Over classification can result in unnecessary expense and restriction of information; while under classification can result in the compromise of sensitive design information. To assist staff and automate the retrieval of classification policies appropriate to a particular document, an expert system was developed, using EXSYS software, by the DOE.

The expert system can correctly classify a document based upon input from a user on the contents of the document. The user is asked a series of questions about various aspects of the document. If the answers imply a potentially classified area, more detailed and specific questions are asked. The system keeps track of level (confidential, secret, top secret) and type (NSI, RD, FRD) simultaneously. Documents with multiple classified items can have the classifications combined correctly. This allows the expert system to greatly reduce the number of questions asked of the user, while making sure no areas of potential classification are overlooked.

A novice user can correctly arrive at the classification of a document in a few minutes, without having to refer to numerous classification guides. Once a classification is arrived at, the user can ask what guide topics apply and check them in greater detail.

Previous attempts at classification automation relied on very large databases on mainframes and limited trained staff. The expert system asks questions of the user rather than requiring the user to ask questions, so it can be used by novices easily. Also, the expert system can easily be run from a floppy disk on a laptop and does not require access to a mainframe.

# EXSYS Case Study

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## Equipment Selection for Highway Construction

*American Association of  
State Highway and  
Transportation Officials*



One of the most common methods used in stabilizing earth fills is to compact soil in thin layers by using compacting equipment. Choosing the most appropriate compactor under a given set of job conditions is a typical problem that construction or highway engineers face when working on highway or other earth-moving projects.

An expert system was developed that helps the construction or highway engineers choose the most appropriate compactor under a given set of job conditions. Selecting a suitable compactor is affected by numerous field variables. The expert system is well suited for formulating and organizing this type of experience-based knowledge. The system takes into consideration:

- ◆ The degree of compacting required
- ◆ Job size
- ◆ Soil type
- ◆ Plasticity
- ◆ Moisture conditions
- ◆ Breakage of aggregates

The expert system recommendations specify standard AASHTO densities to jobs, and is used as a tutorial tool for inexperienced personnel. The information provided is enhanced by scanned images of various types of equipment.

# EXSYS Case Study

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## Urodynamic Diagnosis

*University of Vienna*

Often several diagnosis are possible and the expert system lists them in order of probability. For this system, the knowledge base was developed by experts in this field who defined the rules. They added notes and references to every rule to provide an explanation of how the expert system arrived at a given conclusion. The system analyses five factors obtained at urodynamic investigation:



- ◆ Unstable bladder - First desire to void
- ◆ Maximum urethral resting pressure
- ◆ Score of a questionnaire
- ◆ Urethral closure pressure
- ◆ Standing clinical stress test

It then rates five possible urodynamic diagnosis in order of probability which include:

- ◆ Genuine stress incontinence
- ◆ Motor urge incontinence
- ◆ Sensory urge
- ◆ Mixed incontinence
- ◆ No incontinence demonstrable





**The Knowledge Automators™**

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