

# EXPERT SYSTEMS STRATEGIES™

The Monthly Newsletter for Managers and Developers of Expert Systems, from Cutter Information Corp.

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## MARKET ANALYSIS

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### WHERE DOES THE U.S. EXPERT SYSTEMS MARKET STAND NOW?

Once again we have decided to begin the year by trying to provide our readers with an overview of what happened during the past year and then to project what we think will happen in the year ahead.

As in the past two years, we have used a less than scientific methodology. We have asked vendors to give us information on their sales, their customers, their number of employees, and the applications they believe their products are being used for. We have talked with selected companies that are using expert systems and asked them what they used in 1989 and what they plan to do in 1990. We have checked notes that we took in conversations during the past year, called a few people to ask discreet questions, and checked the various documents that try to estimate the size of the market, report companies sales, etc. Then we put all the data together and massaged it until it seemed to be

more or less consistent. We don't believe that any specific number is correct, but we are confident that the overall picture is reasonably correct. (When we obtained more specific information about numbers we used in the past, we usually found that we erred by being a little high.)

We are late with this issue in large part because many vendors who were quick to cooperate in the past were very reluctant to do so this year. This partly reflects the fact that the companies are increasingly dominated by marketing people rather than technical people. And, it partly reflects the fact that 1989 was a worse year for several vendors than they had expected.

We have promised anonymity to our sources in the process of gathering our data, so we will not discuss very many specific numbers. Instead, we will simply estimate the overall size of each niche, and the relative position we believe the major players occupy.

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### The Expert System Market in 1989 and in 1990: An Overview

Overall, we believe that the expert systems market enters 1990 in the best shape its been in during the last three years. Broadly speaking, there are two aspects to the market. There are the companies that buy expert systems products and develop expert systems to accomplish their corporate goals, and there are the expert systems vendors: companies that sell hardware and software to help people develop expert systems.

#### The Users

The companies that buy and use expert systems products have been steadily growing more confident during the last three years. They have pur-

chased expert systems products; they have built a few systems; they have found that the technology works. Their MIS folks have been skeptical (most still are), but as new products that work on mainframes have been introduced and as more people learned about the practical details of expert systems development, the companies have systematically increased their commitment.

We currently estimate that the expert systems are being used by the following industries in the following proportions:

Manufacturing	34%
Defense and other governmental agencies	24%
Finance	18%
Other business and industry	11%
Education	8%
Corporate R&D	5%

Our sample is relatively small, and the confusion about how to classify certain applications is so great, that these numbers must be considered only approximate. Even within categories there are big differences. Computer manufacturers have been particularly active in expert systems development and we have included them in manufacturing. Within the financial industry, insurance companies are very active, brokerage firms are active, and banks are still only mildly active. In both finance and manufacturing, we have avoided trying to determine whether the expert systems applications were actually related to core business functions, or were used for generic overhead functions. (An expert system used to manage a chip fabrication production line would perform a core business function; a system used by the same company to assist managers in analyzing personnel problems would perform an overhead function.)

Industries that fall into the "other business and industry" category that have a considerable interest in expert systems include transportation, energy, and communications. There is also a rising interest among retailers.

In 1988, successful expert systems applications reached the point where anyone really interested could convince themselves that the technology worked and was here to stay. There are now

several hundred working, mid-sized to large strategic applications and several thousand small to mid-sized systems that are accomplishing more modest tasks (like help desks and equipment troubleshooting). Nineteen eighty-nine saw the introduction of the first large multi-user expert system, a trend that will accelerate rapidly in 1990 as systems developed in 1989 are fielded.

Nineteen eighty-nine was the year that companies began to standardize on the tools they would use to integrate expert systems technology throughout their organizations. It was also the year that companies began to worry about systematic methodologies they could use to train their programmers to identify and develop expert systems.

### The Vendors

On the other hand, the ranks of expert systems tool vendors were thinned in 1987 and 1988. Several companies went out of business, while others realized their strategies were not working and began re-sizing and re-coding in an effort to survive. These were the years that the Lisp vendors realized that only a very few companies were going to want to buy their tools.

In 1989, mainframe tools triumphed. Vendors that hadn't thought you could run expert systems on mainframes suddenly decided to develop a mainframe version, while the companies that had focused on mainframes all along did very well.

From the perspective of both the users and the vendors who are now correctly positioned, 1990 will be a good year. The ramp-up for corporate-wide use of expert systems is just beginning, however, and 1991 and 1992 promise to be even better.

### Who Sold What

We'll consider what happened in 1989 by first considering what happened within various niches, and then we'll try to pull it all together.

### Hardware Companies

While Lisp machine, language, and most tool vendors went through a tough time during the last three years, the major hardware vendors who are selling equipment to the companies that are actually using expert systems have been doing OK. The conventional hardware vendors enjoyed significant hardware sales (which they attribute to expert sys-

tems) and they expect more in the years ahead. Indeed, given how relatively slow hardware sales have been in the last two years, conventional hardware vendors such as IBM, DEC, and Sun now see expert systems as one of the more promising ways to sell more hardware in the 90s.

We expect that the hardware being used primarily for expert systems development and implementation is being sold by the following vendors in roughly the following proportions:

Various PCs running MS-DOS (IBM and clone makers)	20%
Macintoshes (most equipped with TI or Symbolics Lisp chips)	5%
PCs and Unix workstations running Unix	15%
DEC hardware running VMS	15%
IBM mainframes running MVS	15%
Lisp workstations from Symbolics and Texas Instruments	20%
Other	10%

Some of the hardware being used may have already been in place (e.g. the mainframes) but most companies have or will be acquiring new hardware as they continue to expand their expert systems development efforts, and if present trends hold up, they should be acquiring them from the companies listed above.

The Lisp workstation figure looks high at 20%, we believe most of those workstations were purchased before 1989 and that the use of Lisp workstations will decline steadily over the next two to three years.

We think that some companies (including the military, NASA, and the aerospace companies that service them) will continue to acquire Lisp workstations for high-end applications, but we predict that most of the companies using Lisp-based software will begin running Lisp on a Lisp co-processor or on DEC hardware. (The military will probably move toward Lisp-chips embedded in other hardware.)

SUN sold about 60% of the Unix workstations being used for expert systems development. SUN claims that it derives about 5% of its revenues from the AI market and that AI is its second largest market in Europe.

In 1989 companies began deploying expert systems on mainframes so multiple users could access the systems simultaneously. We expect that multi-user applications will expand rapidly in the next few years, and that the overall use of mainframes will increase accordingly.

No companies reported applications running in OS/2, but we expect that that is a result of our sample size. In any case, we believe this will change in the next few years as OS/2 begins to replace DOS at more companies.

### Language Vendors

Some high-end users are working directly in Lisp on Lisp machines, on DEC hardware, on Unix workstations, and on Macintoshes equipped with Lisp co-processors. In addition, anyone who is using a Lisp-based expert systems building tool needs to have Lisp resident on their hardware. A few people in the U.S. are still experimenting with Prolog. Thus, there is a continuing niche for symbolic language vendors.

The dominant commercial vendor is Lucid, whose Lisp is on most commercial platforms. (A new fast version of Lucid Lisp was just announced for DEC hardware, adding DEC to the already impressive list of hardware vendors supporting Lucid, including IBM, Sun, HP, Apollo, and NCR.) In addition, KEE, the best selling Lisp tool, is written in Lucid. Clearly, Lucid is going to survive.

Lisp is used extensively in schools. However, much of it is Gold Hill's Golden Common Lisp. So, Gold Hill can also survive by selling Lisp and tools to the university market. Franz Lisp, Quintus Prolog, and Arity Prolog are all still selling interpreters and compilers as well. None of these companies has become as large as its founders had hoped, but they all seem to have found some level at which they can survive.

Lisp will not go away. It is a powerful and very flexible language that is just right for rapidly prototyping very large and complex systems. Several different companies in 1989 went out of their way to tell us that they expect to be doing more work in Lisp in the future. The latest versions of Lisp are much faster and easier to manage than the versions of only a few years ago. As more and more students move from school, where they

learned Lisp, into companies, Lisp will grow slowly and continue to occupy a highly specialized niche. (The same is also true, to a much lesser degree, of Prolog).

### Tool Vendors

The expert systems tool market changed quite a bit in 1989 and some of the changes caught us off guard:

#### Small PC/Mac Tool Vendors

We define small PC and Mac tools as tools that sell for from \$100 to about \$1000.

Many small PC vendors have disappeared in the last two years. Of those that remain, Paperback Software's VP-Expert occupies an overwhelmingly dominant position. VP-Expert has now sold some 60,000 copies, which means it doubled its sales in 1989. A large portion of the VP-Expert sales went to schools, but VP-Expert is also the most popular small PC tool in the corporate environment.

As we write this, the trial between Paperback Software and Lotus over VP-Planners's alleged infringement of VP-Planner on Lotus 1-2-3's interface is taking place. Assuming Paperback Software survives this challenge and continues to improve VP-Expert, it should be able to hold on to the low end of the expert systems tool market for the foreseeable future.

Information Builders' Level5 is clearly the second best-selling small PC tool, and it certainly sold several thousand units.

We always have trouble classifying Level5. The PC version is priced as a small tool and it has about the same capabilities as most of the small tools — rules and backward chaining — but it is associated with Focus and there are versions of the tool running on DEC machines and on IBM mainframes. In addition, Level5 has fea-

tures that facilitate its integration and assure easy database access. Where Paperback Software is really mass marketing VP-Expert, we expect that most of Information Builders' sales are to companies who acquire site licenses.

Other tools that companies are using to develop small systems include 1st-Class, Exsys, KnowledgePro from Knowledge Garden, and Crystal from Intelligent Environments. TI's Personal Consultant Easy is still being used, although it is less common now than a year ago.

With the exception of VP-Expert, which is priced and sold as a mass-market commodity (and Level5, which we'll consider later when we consider workstation and mainframe vendors), the other small tool vendors are either hurting or face the prospect of very modest growth.

Figure 1 shows our estimates of the small PC tool sales in 1987, 1988, and 1989. Last year we projected that small tool vendors would sell 70,000 units in 1989. Obviously the small tool market has not grown as fast as we expected.

Paperback Software sold the great majority of units sold in 1989. The income the small tools market received was lower than expected both because fewer units were sold and because VP-Expert sells for only \$249 (often discounted to much less).

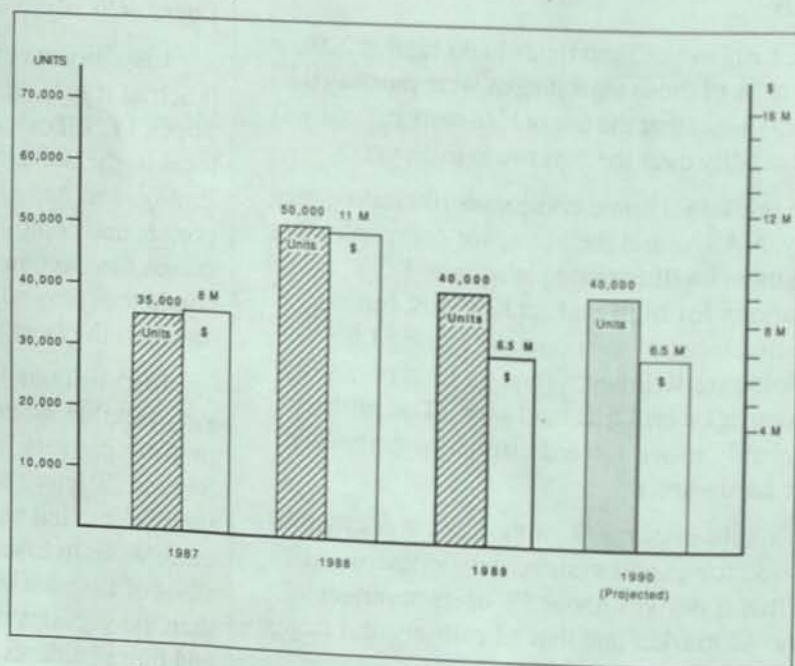


Figure 1 — Small PC and Mac Tool Sales in 1989

We expect that Paperback Software, having the momentum it has, will continue to sell well in 1990, but we anticipate that the overall market for small tools will be about the same in 1990 as 1989. Educational institutions and individuals who want to experiment with expert systems account for most of the sales. These sales will continue, but they're probably not going to experience much growth in the coming year.

Another factor that limited the growth of the market for small tools was the relative lack of Macintosh sales. Human Intellect Systems' Instant Expert (\$69) is probably the best selling tool for the Macintosh. Information Builders introduced a Mac version of Level5 in 1989, but apparently there isn't much of a market for expert systems tools among Mac users.

We expect that some of the smaller tool vendors will merge with other companies during 1990. Some of these tools would provide the right vertical marketing company with a great foundation on which to develop a series of problem- or application-specific tools. A training company could take one of these tools, modify its interface, and create a whole series of highly specific tools to help trainers (who are generally not programmers) develop manuals, small equipment repair aids, etc.

We keep expecting small, reasonably priced PC tools that are specialized for specific applications (like manual development, or small help desks, etc.) to appear. So far they haven't. Thus, the people using the small PC tools are mostly "Lotus-literate" programmers or students who are using the tools as a way to learn about expert systems technology or are using them to develop small applications.

In our opinion, there are real opportunities for the small tools that help non-programmers accomplish specific tasks. The current crop of tools, including VP-Expert, are still too difficult to use to attract this audience. Hence, as companies standardize, they will increasingly use tools they acquired under site licenses, and the market for the various standalone, generic small PC tools will decrease.

#### **Mid-Sized, PC/Workstation Tool Vendors**

We define these tools as products that run on PCs, Unix workstations (i.e. SUN), or DEC hardware. These tools range in price from \$2,500

to \$25,000, but most sell for between \$5,000 and \$8,000.

Last year we assumed that 4,500 mid-sized PC/workstation tools were sold in 1988. We realize now that some of the units we included in that figure were, in fact, European sales. We now estimate that the total PC/workstation tools sold in the U.S. in 1988 actually totalled some 3,500 units, and the sales income generated by mid-sized tool sales was \$23.5 million.

We projected that 1989 mid-sized tool sales would climb to 7,000 units. We now believe that, in fact, there were about 4,500 mid-sized tools sold in 1989. We believe the vendors made about \$30 million on such sales. Clearly the market didn't grow as fast as we projected.

What is much more interesting is who sold the most mid-sized tools in 1989 — Aion Corp. We did not anticipate this, nor did the managers to whom we talked in early 1989 about their plans for the year. Apparently companies decided to standardize in 1989, and, having made that decision, they decided to buy PC tools that were compatible with the mainframe tools they intended to buy. Since many companies chose Aion's ADS for their mainframe tool in 1989, they also chose to cut site licenses with Aion. In considering who sold the most units, we only considered developmental versions of tools. Aion led in developmental versions sold, but they also sold a phenomenal number of delivery or runtime licenses, mostly in conjunction with site licenses. A telling bit of information: the Texas Instruments instructors at TI's Information Systems Center, who formerly taught internal courses on how to use Personal Consultant Plus, now teach TIers how to use the PC version of Aion's ADS.

Other important vendors selling in this market include Neuron Data (Nexpert Object), AI Corp (KBMS), Software A&E (KES II), Inference Corp. (ART/IM), and Information Builders Inc. (Level5 for the VAX). AI Corp introduced a DOS version of KBMS in mid-1989. We expect that the same logic (i.e. that companies that have standardized on a mainframe tool will buy PC versions of the same tool) will hold in 1990 and that companies choosing the mainframe version of KBMS will also push KBMS PC sales up rapidly. Inference Corp.'s Unix workstation version of ART/IM enjoyed sig-

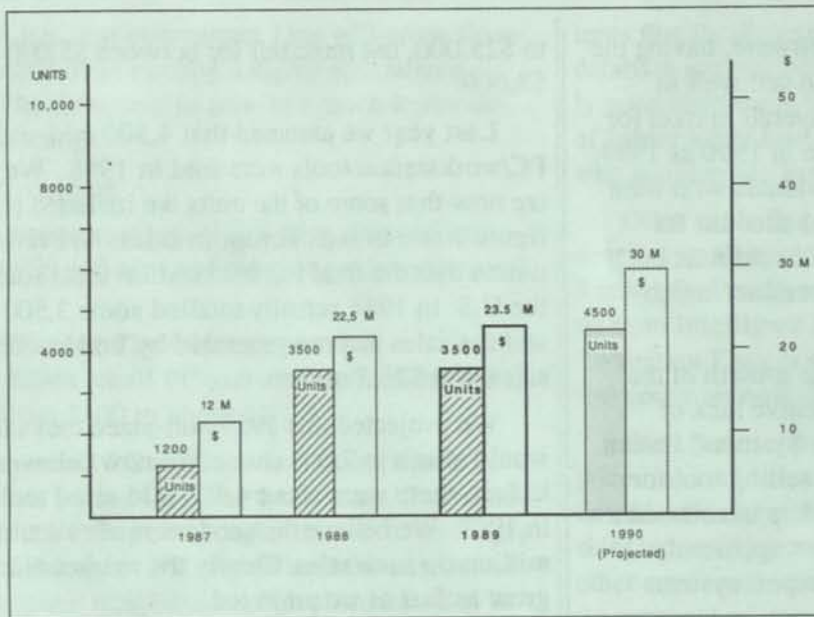


Figure 2 — Mid-size PC, VAX, and Unix Workstation Tools Sold in 1989

nificant sales in 1989, presumably because companies who are considering using ART on the mainframe want to explore its potential.

Information Builders Inc. didn't play a large role in the mid-sized tool market in 1989, but it will probably play a larger role in 1990. In mid-1990, Information Builders is set to introduce their new tool, Level5 Object. Unlike Level5, which is a backward-chaining simple rule tool, Level5 Object will be a powerful hybrid tool with high quality user and developer graphics. The PC version will be priced at around \$1,000. If the tool is as good as the demos and sells for \$1,000, it will set a new price/value standard for the industry and put both the small PC vendors and most of the mid-sized tool vendors under considerable pressure.

In effect, the mid-sized/workstation niche, as an independent market niche, is disappearing (at least in the U.S.). Companies clearly want to field expert systems on mainframes and they are committing to mainframe companies. Once committed, they are using the PC tools sold by those companies rather than buying mid-sized tools from vendors specializing in selling tools for \$5,000 to \$8,000.

The exceptions, at the moment, are companies that want to develop and field their applications on VAX hardware. We expect that Nexpert Object may still be the best-selling mid-sized tool for DEC hardware, but it must be getting some com-

petition from DEC's VAX Decision Expert and will soon get some more from DEC's Epitool. That's an important exception, of course, because DEC equipment is being widely used in manufacturing — the industry that is buying most of the expert systems software at the moment.

AI Corp has just introduced a DEC version of KBMS and Aion has committed to developing a DEC version in the future. Thus, at some point in the near

future, even those operating on DEC hardware will have the option of buying tools that not only run on a DEC, but on an IBM as well.

Some new vendors entered the mid-sized market in 1989. The most interesting tool is probably Meta Knowledge's Kappa. Still, given what we have just said, new vendors that start out on the PC and then try to add platforms until they finally get a mainframe version are going to have a very hard time.

It's probably too late for any small to mid-sized company to try to introduce a new generic tool. The market wants integration, and there are some good vendors in the market that are offering exactly that. It will be very hard for a small company to compete by offering a tool that just runs on a single platform when there are vendors that have tools running on PCs, Unix workstations, VAX machines, and IBM mainframes.

We expect that the mid-sized tool market will grow modestly in 1989. With the benefit of hindsight, we expect that most of the mid-sized sales will be to companies that have standardized on a mainframe tool and then buy PC or DEC versions of that tool to use in training and in the development of expert systems.

### Mainframe Tool Vendors

The mainframe vendors sold about 175 units and made \$11 million on tool sales in 1988. We projected that they would sell 400 units and make \$25 million in 1989. In fact, we believe they sold about 237 units and made about \$22 million selling mainframe tools.

We just described the sharp increase in market share that Aion achieved in the PC/workstation market. We expect that in 1990 the PC versions of Level5 Object and KBMS will also enjoy considerable sales. We had not anticipated this, although clearly we should have. Many companies have apparently decided to go with mainframe tools but, logically enough, they have begun by acquiring only one or a few mainframe versions of the tool, and then have proceeded to acquire a large number of PC versions of the tool. This strategy allows their developers to begin learning about the technology and to create and test applications without forcing the company to spend the larger amounts of money required to make the tools available on the mainframe.

It seems that companies are committing to mainframe delivery, but are holding off on purchasing the software required for that delivery until it is needed. In other words, mainframe tool sales will lag behind the sales of the PC versions of the mainframe tools.

Accordingly, even though mainframe tool sales fell below what we expected this year, we believe the mainframe tool market is in very good shape. We predict that mainframe tool sales will easily reach 400 by the end of 1990, and will accelerate even faster thereafter as companies develop the applications that require the mainframe software for delivery.

Clearly, the dominant mainframe

tool vendor in 1989 was Aion. Equally clear is the fact that almost everyone who is considering buying ADS is also considering KBMS. The fierce competition between these two companies will continue unabated through 1990 and probably for several years thereafter. (We will be reviewing Aion's ADS and AI Corp's KBMS in the next issue of the newsletter.)

Nineteen ninety will witness the introduction of Information Builders' Level5 Object and IBM's TIRS. In addition, Inference Corp. will probably play a larger role as a result of its recent deal with Arthur Andersen Consulting (See Trends).

In 1989, we saw the triumph of the mainframe approach to expert systems. From now on, with the exception of relatively specialized vendors like Paperback Software, the Lisp vendors, the domain- or problem-specific vendors, and perhaps one or two tools that are very effective on DEC VAX systems, any company that does not have a credible mainframe version of their product will not be able to play a significant role in the expert systems tool market. The competition in the mainframe market should be very fierce in 1990.

IBM probably didn't make much money selling expert systems tools in 1989, but it was very active. In addition to continuing to work on ESE and KnowledgeTool, they began selling IBM/KEE and, much more important, they announced their

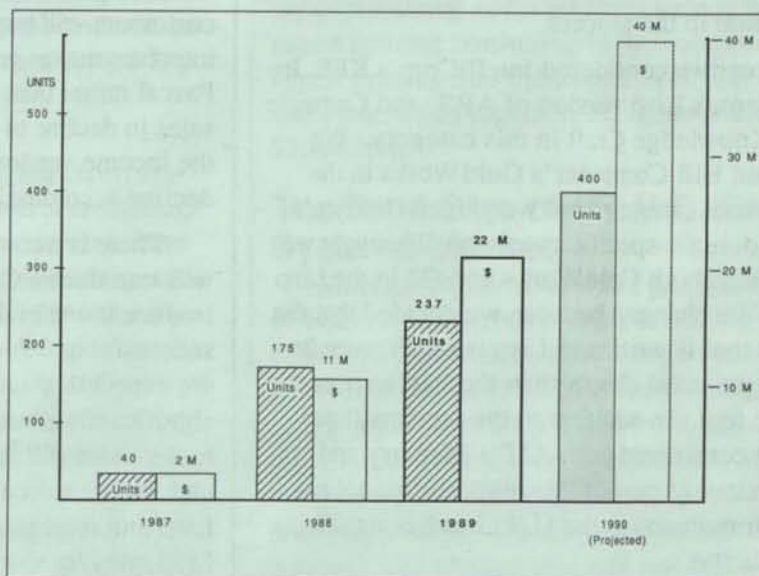


Figure 3 — Mainframe Tool Sales in 1989

AD/Cycle with a knowledge-based systems component. In the context of its AD/Cycle announcement, IBM also announced that it will begin selling a new hybrid tool with impressive graphics, called TIRS. We expect TIRS will quickly replace all three of IBM's early offerings and become the first tool that IBM sells in any significant numbers. (That TIRS is limited to mainframes and OS/2 machines will limit its sales, but there are enough people who want to buy from IBM and have been waiting for a credible tool, to guarantee that IBM will play an increased role in the tool market in 1990.

#### Lisp Tool Vendors

In 1988 the large Lisp vendors sold about 900 units and made about \$20 million on tool sales. We projected that they would sell 1100 units in 1989 and make about \$23 million on tool sales. In fact, we believe that 970 Lisp-based tools were sold in 1989 and that the vendors made about \$22.5 million in the process.

Last year we considered IntelliCorp's KEE, Inference Corp.'s Lisp version of ART, and Carnegie Group's Knowledge Craft in this category. We placed Gold Hill Computer's GoldWorks in the mid-sized tool category and we placed Gensym's G2 in the domain-specific category. This year we have included both GoldWorks and G2 in the Lisp category. We changed because we decided that the fact that a tool is written in Lisp is much more important to potential clients than the hardware or the size of the tool. In addition to the vendors listed above, we considered both AIT's Mercury and DEC's Epitool as part of this market. Epitool has just been introduced in the U.S., but has significant sales in Europe.

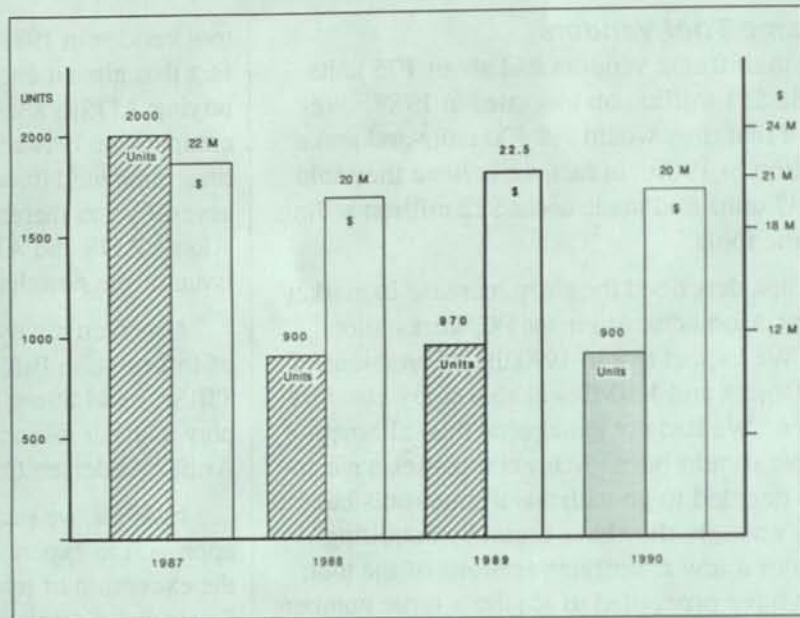


Figure 4 — Lisp-based, Hybrid Tool Sales in 1989

Clearly IntelliCorp's KEE is still the best selling Lisp tool and almost everyone agrees that it defines the top of the entire expert systems market in terms of features and functionality. Inference has switched most of its attention to selling the C version of ART and Carnegie Group is concentrating on consulting and on problem-specific tools. AIT's Mercury (fast database access) and Gensym's G2 (real-time applications) are currently attracting buyers with specialized needs, and DEC's Epitool is about to test the proposition that customers will buy a Lisp tool if the programming interface makes you think you are programming in Pascal rather than Lisp. We expect Lisp tool sales to decline to 900 units in 1990, and we expect the income vendors earn on Lisp tool sales to decline accordingly.

There is a continuing rumor that IntelliCorp will introduce a C-based tool in 1990. If they do introduce it within the first half of 1990 and it is as successful as Inference Corp.'s C version of ART, we expect that overall Lisp tool sales may decline significantly, since, in effect, the last major Lisp tool vendor will appear to be moving out of Lisp and will be refocusing its sales effort on the non-Lisp tool market. That might mean a few more Lisp sales for some of the more specialized vendors, but it will probably be the final blow to generic Lisp tools. There will continue to be a



small market for problem- or application-specific tools written in Lisp. However, most of the people who want to work in Lisp will probably work in the language itself.

### **Problem- and Application-Specific Tool Vendors**

There were a number of domain-specific tools introduced in 1989. Carnegie Group added Service Maintenance Planner, Text Categorization System, and Cost & Manufacturability Guide to their earlier diagnostic specific tool, TestBench. TI, which also sells TestBench, added Line Balancer, Technicians Assistant, and a variety of airline planning and scheduling applications that it developed in its Symbolic Spreadsheet product. TI is eager to tailor any of these applications to help solve any transportation company's needs. IntelliCorp introduced KLUE. DEC announced XSAFE and started marketing AI WARE's CAD/Chem product. Syntelligence sold a copy of Syntel, its tool for developing financial applications. These products range in price from a few hundred to one million dollars.

Last year we estimated that 100 problem- or application-specific tools had been sold and that the vendors had made some \$3 million. We projected the sale of 200 units in 1989 and revenue of \$6 million. We believe that more than 200 units were sold, but we are very unsure of the money that vendors made in the process. For our summary calculations we take the very unreliable figure of \$6 million and project an equally unreliable \$12 million for 1990. In most cases, these sales blend into consulting and these figures have to be regarded as particularly suspect.

### **Application Vendors**

The early vendors who tried to sell expert systems off the shelf failed to make a go of it (although Syntelligence is still trying). At the moment, there are many small to mid-sized expert systems applications being sold. Most are modest in size and very narrowly defined. We have not tried to estimate the number sold or the money being made in the process. Later this year we will publish a catalogue of expert systems for sale. We'll try to make a reasonable estimate of the market at that time.

### **Consultants and Software Houses**

Companies like Cimflex-Teknowledge and Carnegie Group have really transformed themselves

into software development shops that specialize in expert systems development. IntelliCorp and Inference Corp. will probably follow in the next couple of years. In addition, some of the small expert systems tool vendors are making most of their money from consulting and will probably be absorbed by software development groups in the coming year.

Almost all of the expert systems tool vendors earn a considerable amount of their money from expert systems consulting (which we have tried not to count as a part of their tool revenue). TI, for example, is earning far more money selling consulting services than it is selling tools. As a general rule, you can add 35% to 40% to the tool income of an expert systems vendor to reflect the income that vendor is earning from consulting. (There are only a few significant exceptions — Neuron Data and Aion, for example.)

In addition, established software development groups are doing lots of work in expert systems. The largest is clearly Arthur Andersen Consulting (see Trends), followed probably by Coopers & Lybrand and Arthur D. Little. In addition, most of the other major software development groups are doing at least a little work in expert systems consulting. There are likely a number of groups doing specialized work for the military that we don't know about.

We don't have any hard estimate of the money the conventional software houses made by doing expert systems consulting or by incorporating expert systems into their other work, but we assume that, taken together, the figure must be over \$20 million.

## **The Total Size of the U.S. Expert Systems Market**

Nineteen eighty-nine was a good year for users of expert systems, but it was a confusing year for vendors. In retrospect, 1989 was part of the transition that began in 1987. The transition was not simply away from Lisp-based tools, as some thought, but toward tools that could be based on mainframes and hence be simultaneously delivered to multiple users. The C-based standalone workstation tools had trouble this year just as the Lisp-based tool vendors did in 1987 and 1988. The only

expert systems tool vendors who really look good right now are those that have the same tools on all of the major platforms, including the mainframe.

Aion and AI Corp are in the best position. Information Builders Inc., Software A&E, Inference Corp. and Neuron Data are all still in the market, but each will be playing catch-up in 1990 as they try to improve their tools capabilities and their mainframe credentials to match the two leaders. We only expect a couple of them to really make it.

IBM and DEC are both limiting their tool offerings by limiting the platforms on which their products will run, but IBM could be a very serious contender in 1991 if TIRS turns out to be as nice as it looks and companies really begin to shift from DOS to OS/2 (TIRS doesn't run in DOS).

Last year we tried to put a dollar figure on the total expert systems market and then on the total AI market. This year we thought that there was too much information we didn't have, so we decided to take a pass.

We have calculated the total income of tool vendors in 1989 and projected it for 1990. The numbers are presented in Table 1.

We expect that the best-positioned vendors will expand their PC/workstation sales next year and begin to get the mainframe sales that this year's sales have, in effect, set in motion.

If you really want information on the broader market and can afford to pay for it, you should buy Ovum Ltd.'s new report *Knowledge-based Systems: Markets, Suppliers and Products*. (\$995, \$1035 outside North America) It arrived just as we

Table 1 — U.S. Tool Vendor Income in 1989

In Millions of Dollars	1988	1989	1990 (Projected)
Small PC/Mac	11	6.5	6.5
Mid-Size	22.5	23.5	30
Mainframe	11	22	40
Lisp-based	20	22.5	20
Domain Specific	3	6	12
<b>Total Product Income</b>	<b>67.5</b>	<b>80.5</b>	<b>108.5</b>
Consulting Income (@ 30% of Product Income)	20.3	24.2	32.6
<b>Total Vendor Income</b>	<b>87.8</b>	<b>104.7</b>	<b>131.1</b>

were completing this newsletter and we examined it closely to see how Ovum's assumptions matched our own. We have a few disagreements; we think they overestimate the role of Symbolics and AI Corp and don't give enough weight to Aion and IntelliCorp. Moreover, they say VP-Expert sales have faded, which is clearly wrong. (It's as if they gathered their information on the East Coast and didn't spend enough time in Palo Alto). Ovum's figures are about twice ours; we expect they didn't take into account the discounts the vendors are offering and the effect of site licenses on income. Still, we know how hard it is to come up with reasonable information on the various parts of the AI market and this report seems to us worth quite a bit of study if you are interested in vendor income estimates.

In addition to a complete analysis of the U.S. market, the Ovum report has the best analysis we've seen of the expert systems market in Europe.

For more information about *Knowledge-based Systems: Markets, Suppliers and Products*, contact Cutter Information Corp., 1100 Massachusetts Avenue, Arlington, MA U.S.A., 02174; (617)648-8700, Fax: (617)648-8707

## PREDICTIONS

## WHAT WILL HAPPEN IN 1990

## How Did We Do in 1989?

Before we begin to make predictions for 1990, let's take a look at what we predicted for 1989.

1. *Lisp machine vendors and Lisp-based generic tools will all but disappear in 1989. Lisp-based problem- or domain-specific tools will do better, but...*

We said this last year and still predicted that some 1100 Lisp-based generic tools would be sold. We estimate that about 979 units were, in fact, sold.

Although Symbolics is showing a profit, it has switched its energy toward software and TI is maintaining a very low profile these days. We think we were right on this one.

2. *C, Mac, and mainframe tools will dominate the news in 1989.*

As noted above, nothing much happened on the Mac, but C and mainframe tools certainly dominated the news. We'll take a mostly right on this one.

3. *Several new problem- and domain-specific tools will be introduced.*

We were certainly right on this one.

4. *The hottest subject in 1989 will be object-oriented programming techniques. All of the tool vendors are scrambling to introduce or improve their capabilities. Object-oriented techniques make developing expert systems faster and easier. Rule-based tools provided most of us with an introduction to expert systems, but hybrid tools are now rapidly becoming the standard for expert systems work.*

This was certainly correct. ADS now has objects and Information Builders' Level5 Object (formerly called Level5 (Release2) is in beta testing and about to be released. We talked to several companies about standardization during 1989 and no one was considering a tool that didn't have (or was about to have) objects. Everyone now realizes that objects are necessary for many high-end applications.

In addition, the object-oriented conferences were very hot in 1989. Many programmers who know little or nothing about expert systems are rushing to learn about OOP.

5. *The Mac tools introduced in 1989 will be really impressive and will raise the standard for what we expect for the small PC tools.*

Human Intellect Systems Instant-Expert Plus (introduced in 1988) remained the most interesting small tool on the Mac. Hyperpress' Intelligent Developer was interesting but needed more work. The same goes for Logic Programming Associates' (and Quintus Computer Systems) Flex. IBI's Level5 for the Mac is a very professional tool, but not very exciting. Paperback Software failed to deliver its Mac tool, as did Gold Hill. Little's Cameo (in Hypercard) is interesting, but not commercially available.

The Mac is being used by Lisp programmers in conjunction with either a TI or a Symbolics Lisp co-processor to run larger Lisp-based tools like ART or KEE, but those are hardly small PC tools.

We missed on this one. So far, the Mac isn't playing a very interesting role in the world of small expert systems.

6. *Nexpert Object will dominate the workstation tool market in 1989, but will probably start to face some real competition from tools that have about the same capabilities and interface but cost closer to \$800.*

Nexpert Object no longer dominates the mid-sized workstation tool market, Aion does. It hasn't gotten any \$800 competitors, but it will when Level5 Object comes out at \$1,000 in mid-1990. We were wrong on this one.

7. *The major marketing battle in 1989 will be fought between ADS and KBMS. Aion will try to add object-oriented capabilities while KBMS will concentrate on getting its tool to run as fast as ADS-HPO.*

We were right on here. Aion did add objects and AI Corp did manage to get KBMS to run a lot faster. And they certainly did battle in the offices of many companies that are trying to decide which tool to buy.

8. *The overall market will grow slowly as companies continue to try to sort out how to integrate expert systems techniques with their current practices.*

We were right on this one. Actually the market grew a little faster than we expected because companies began to standardize and several site licenses were sold, but we still think this prediction accurately reflects the overall market in 1989.

9. *Consultants and vertical market VARs will do very well, since companies will turn to them both for assistance in training their own personnel and for developing high-value tailored expert systems applications with high price tags.*

We believe that we were right on this one, too.

10. *The research community will continue to show a lot of interest in neural nets, but there won't be very many commercial applications.*

Right again.

11. *Interest in and applications of natural language will be more pronounced in 1989 than in previous years, driven primarily by the introduction of KBMS with its Intellect interface.*

There certainly was a growing interest in natural language in 1989. Natural language vendors showed up in numbers at the AAAI convention (IJCAI in Detroit) for the first time.

Most of the natural language activity was incorporated in expert systems applications or focused on front ends for databases. MCI International, for example, developed a system that scans incoming messages and sorts out time-critical money orders. They have sold the system to several banks.

Natural language hardly begins to rival the interest in expert systems, nor is it worth the effort for most expert systems applications, but it is slowly and surely growing. We'll take a right on this one too.

We admit that our 1989, predictions were pretty general and rather conservative, but we're still

pleased to say that we got 8 right, 1 mostly right and only 2 wrong. Buoyed up by our success in 1989 we have decided to be more specific and less conservative in predicting what will happen in 1990. We'll be really happy if we get 75% of our 1990 predictions right.

## What We Predict for 1990

1. 1990 will be a good year for people promoting expert systems within corporations and for the few expert systems tool vendors who are positioned correctly.

In spite of tight money and continued confusion about hardware, operating systems, and networking, corporations will invest in expert systems because they are directly related to solving hard, strategic problems; increasing productivity; and improving quality; all key corporate concerns.

Fortune 500 companies will continue to standardize on tools and buy site licenses, which will make the winning expert systems tool vendors stronger, while eliminating the less successful vendors from the market.

Most corporate MIS groups are only beginning to be won over to expert systems, so 1990 won't see really large numbers of systems deployed or integrated in the way that DEC has. We believe 1991 and 1992 will be even better years, as MIS people realize just how many problems they can ameliorate or solve with expert systems techniques.

In other words, the AI winter is over, the weaker vendors have been weeded out or are dying, and the vendors who have successful products are about to enjoy some prosperous years. The people within corporations who have been championing expert systems are about to become respectable prophets, as MIS groups slowly but surely realize that expert systems technology will be an important key to success throughout the 1990s.

2. The term "expert systems" is about to disappear. By the end of 1990, almost everyone will be saying "knowledge-based systems" (KBS). We certainly admit that "expert systems" suggests the wrong thing; (it refers to a specific role that only a small minority of the systems ever played) and that "knowledge-based systems" puts the emphasis on the technology, where it belongs. (The only proper alternative would be inference-based systems.)

"Expert systems" has held on primarily because the media have used the term in popular articles. As the hype around expert systems dies down (and the popular computer press focuses on OOP and neural networks), corporate analysts and programmers will prefer to talk about the technology using a more accurate term.

We'll have a hard time adjusting; "expert systems" just comes tripping off our tongue, but we'll try. (We may even change the name of the newsletter.)

3. Throughout 1990, the main marketing news will continue to be generated by Aion and AI Corp, although later in 1990, IBM's TIRS will begin to give both companies some modest competition.

By the end of 1990, Aion will be the most successful expert systems vendor, with sales topping \$30 million.

4. Level5 Object will be very well received and will effectively drop the price of a good, hybrid mid-sized tool to \$1,000.

5. The Lisp-based hardware and tool vendors are still in for a rough time.

IntelliCorp will introduce a C version of KEE. KEE will remain the best of the Lisp-based tools and the preferred choice of high-end developers, but IntelliCorp will be forced to shrink since it is still too large for its limited niche. Symbolics will try to shift from hardware to software, but they will have trouble and they too will probably also find themselves trying to shrink their overhead.

TI will increasingly focus on doing Lisp development in the context of highly targeted consulting. They will focus on introducing a SPARC II chip with Lisp-like capabilities and then position themselves in the Unix world.

Gold Hill will need to shrink some more and will probably increasingly focus on supplying Lisp software for universities.

The Lisp companies that survive will follow TI, Teknowledge, and Carnegie Group and become specialized software development houses. They will de-emphasize software sales and focus on helping clients develop strategic software applications.

One or more of them will be purchased by larger software houses who want to add an expert systems capability to their portfolio of consulting capabilities.

At least one major Japanese or European software house will enter the U.S. market by acquiring one of the Lisp vendors to get a foothold in sophisticated software development in the U.S.

The use of Lisp will continue to grow throughout the decade. The demand for Lisp-based products and consulting services during 1990, however, will be less than the supply being offered by the various Lisp vendors.

6. DEC and IBM will both play a steadily increasing role in the expert systems market. They will both continue to benefit from the growth of expert systems-driven hardware purchases.

DEC will play a larger role in the short run by helping manufacturing companies develop an overall strategy for using expert systems and integrating them throughout the company.

IBM will play a greater role in the longer term by continuing to work on its tool offerings until it gets a winner — probably in the context of their AD/Cycle.

Both companies will continue to play a limited role in the tool market in 1990 because both companies are still trying to use their tools to force companies to commit to their hardware. Most companies, however, will insist on buying tools that run on several different platforms, including mainframes, PCs (in DOS and later in OS/2), VAX machines, and Unix workstations.

7. Neural network applications will increase and you will hear more about them as they get integrated into existing expert systems building tools. Neural networks will still remain a research subject and not a commercial technology throughout 1990.

8. Object-oriented programming will continue to be a hot topic throughout 1990. Many programmers who know nothing of expert systems will get excited about using C++, Object-oriented CASE tools and Object-oriented databases. (By the middle of the decade, C++ will be the dominant OOP language and will begin to replace C.)

Most of the OOP folks don't know much about expert systems. They stress rapid prototyping but don't understand inferencing or the use of heuristic rules. In 1991 and 1992 there will be a real opportunity for expert systems people within corpora-

tions to help the OOP folks develop a methodology based on what they (the expert systems people) have learned about developing object-based programs and managing rapid prototyping efforts.

By 1992 or 1993, the best of the OOP tools will incorporate some inferencing and will be positioned as CASE tools. Some of them will probably be developed by the same vendors who are now selling expert systems tools.

We regard OOP as a spin-off of AI, or at least a kindred technology, and will devote an increasing amount of attention to it as it matures. We haven't tried to estimate the financial size of the OOP market in this issue, but we will take a crack at it later in the year.

9. Problem- and application-specific tools will continue to be introduced. No one tool will have a large impact because each will be specialized for very specific niches, but they will certainly create consulting opportunities for companies that will increasingly consider themselves software consulting firms, as Texas Instruments' Knowledge Engineering Group has done.

10. While the early vendors of expert systems applications were unsuccessful, there is a growing number of vendors, mostly selling expert systems that run on PCs (see the Trends article on Ask Dan) or applications that are highly specialized, such as DuPont's Packaging Advisor or

Beckman's PepPro, that are doing quite well. The successful products all emphasize that they perform a job well and de-emphasize the technology that underlies the product. No one wants to buy a tax program simply because it's an expert system — they want to buy a tax program that's more powerful, flexible, and easier to use than its rivals.

(We'll be publishing a catalogue, *Expert Systems for Sale*, in 1990. We don't expect people to buy expert systems from a catalogue, but we want to show just how large and diverse this specific subset of expert systems applications has become. We haven't tried to put any financial numbers on application sales in this issue, but we'll come up with an estimate as we develop the catalogue, and we predict that it will be a more impressive number than most will expect.)

11. The hot expert systems topic of 1990 will be a systematic methodology. There will still be some market for consultants and trainers who want to talk about "What Expert Systems Are" but the most successful consultants will be those who can help companies train conventional programmers to recognize opportunities, build expert systems, and integrate with existing corporate systems.

If someone develops a methodology that rests on a structured approach to developing hybrid systems (the successor to the top-down structured programming systems based on data flow diagrams), corporations will beat a path to their door.

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## TRENDS AND NEWS BRIEFS

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### Arthur Andersen Consulting and Inference Corp. Sign an Agreement

Just as we were going to press, we received an announcement that Inference and Arthur Andersen Consulting have signed an agreement whereby Andersen will have access to Inference's expert systems tools for use in its system integration business. The agreement also provides for Inference to assist Andersen in application development. Inference estimates this agreement will produce between \$5 and \$10 million in revenue over the next three years.

This agreement will go a long way to ensure that Inference is seen as a vendor who can supply tools that run on PCs, Unix machines, VAX hardware, and on IBM mainframes.

It also lends support to our contention that conventional software consultants will want to acquire the consulting skills that are currently possessed by companies like Inference, IntelliCorp, and Carnegie Group.

## Ask Dan, Now Andrew Tobia\$' Tax Cut

For the last two years we have recommended Ask Dan, a PC-based expert systems application that helps individuals and small business prepare their taxes. (We weren't alone in this — *Business Week* rated Ask Dan #1 for two years in a row, as well.) The important thing about this program is that it doesn't put a lot of emphasis on being an expert system; it just does the job better than the competing (non-expert) programs. The interface is really excellent — it reproduces the IRS forms and allows you to fill out the forms, open windows to get advice, and eventually, print out your returns.

For those who are interested, Ask Dan is now being distributed as part of the Andrew Tobia\$ series under the name TAX CUT. If you have been using Ask Dan, Tax Cut will seem completely familiar. If you use the Tobia\$ Managing Your Money software, Tax Cut will work with the data from that program.

Tax Cut is available from MECA Ventures, Inc. and is available in most software stores. List price is \$79.95, but Egghead Software has it listed for \$45.

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## CALENDAR

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### North America: 1990

FEB 13-14. **Integrating the Enterprise: Issues in Modeling & Coordination.** Pittsburgh, PA. Sponsor: Center for Integrated Manufacturing Decision Systems, Robotics Institute, Carnegie Mellon University. Contact: Betsy Herk, CIMDS, Carnegie Mellon Univ., Pittsburgh, PA 1521; (412)268-3078.

FEB 28-MAR 2. **IntelliCorp Users' Group and Technical Conference.** San Francisco, CA. Contact: IntelliCorp, 1975 El Camino Real West, Mountain View, CA 94040-2216. (415)965-5500.

MARCH 5-9 **6th IEEE Conf. on AI Applications (CAIA-90).** Santa Barbara, CA. Contact: CAIA-90, IEEE Computer Society, 1730 Mass. Ave. NW, Washington, DC 20036-1903. (202)371-1013.

APRIL 2-5. **IPC/Process Control/Expert Systems Conference & Expo.** Detroit, Michigan. Contact: Engineering Society of Detroit, Regional Conference Center, 24 Frank Lloyd Wright Dr., Suite C500, Ann Arbor, MI 48105; (313)995-4440.

APRIL 10-12. **Conference on Advanced Computing for the Social Sciences.** Williamsburg, VA. Sponsor: Oak Ridge Nat. Lab. and U.S. Census Bureau. Contact: Lloyd Arrowood, Oak Ridge Nat. Lab., P.O. Box 2008, MS 8165, Oak Ridge, TN 37831; (615)575-8700. (A general conference but with a significant focus on ES this year.)

APRIL 15-18. **Application of AI VIII.** Orlando, FL. Sponsor: SPIE. Contact: Mohan M. Trivedi, Univ. of Tenn., Elect. and Computer Eng., Ferris Hall, Knoxville, TN 37996-2100; (615)974-5450.

MAY 1-3. **2nd Annual Conference on Innovative Applications in AI (IAAI 90).** Washington, D.C. Sponsor: AAAI. Papers on applications are evaluated by committee and must be submitted by Dec. 12, 1989. Contact: AAAI, 445 Burgess Drive, Menlo Park, CA 94025. (415)328-3123. Fax: (415)321-4457.

MAY 7-11. **Fifth AI Systems in Government Conference.** Washington, DC. Sponsors: IEEE and MITRE. Contact: Dr. Vincent Hwang, AISIG90, MITRE, MS W429, 7525 Colshire Drive, McLean, Virginia 22102; (703)883-7501.

MAY 16-18. **Third Conference on AI in Petroleum Exploration & Production.** College Station, TX. Contact: Tsai-Bao Kuo, Conf. Co-chair, CAIPEP, Petroleum Eng. Dept., Texas A&M Univ., College Station, TX 77843-3116; (409)845-2962, Fax: (409)845-1307.

MAY 22-23. **5th Conference on AI for Space Applications.** Huntsville, Alabama. Sponsors: Univ. of Alabama, IEEE and NASA. (unclassified papers) Contact: Univ. of Alabama in Huntsville, Div. of Continuing Education, Tom Beville Center 285-C, Huntsville, AL 35899. (205)895-6372.

JUNE 21-23. **Second International Conference on Software and Knowledge Engineering.** Skokie, IL. Sponsors: Univ. of Pittsburgh and Inst. for Information Industries, Taiwan. Contact: Shi-Kho Chang, Comp. Sci. Dept., Univ. of Pittsburgh, 322 Alumni Hall, Pittsburgh, PA 15260; (412)624-8490.

JULY 15-18. **Third International Conference on Industrial and Engineering Appl. for AI and ES.** Charleston, S.C. Sponsors: ACM. Contact: Moonis Ali, Univ. of Tenn. Space Inst. MS15, Tullahoma, TN 37388; (615)455-0631.

JULY 29 - AUG 4. **AAAI Conference.** Boston, MA. Contact: AAAI, 445 Burgess Drive, Menlo Park, CA 94025; (415)328-3123.

SEPT 10-12. **Managing Expert System Programs and Projects.** Washington, DC. Sponsor: IEEE Task Force on ES. Contact: Dr. Randall Shumaker, Program Chair, Navy Center for Applied Research in AI, Code 5510, Naval Research Lab., Washington DC, 20375.

OCT 21-25. **ECOOP-OOPSLA'90.** Ottawa, Canada. Sponsor: ACM. Sponsor: ACM. Contact: ACM, 11 W. 42nd St, New York, NY 10036; (212)869-7440.

NOV 4-9. **Fifth Knowledge Acquisition for Knowledge-Based Systems Workshop.** Banff, Canada. Sponsor: AAAI. Contact: John Boose, Adv. Technology Center, Boeing Computer Services, 71-64, P.O. Box 24346, Seattle, Washington, U.S.A., 98124. Phone: (206)865-3253.

NOV 8-10. **Users.PRL (The Level5 Users Group Conference).** Cocoa Beach, Florida. Contact: Users.PRL, P.O. Box 312, Ramsey, NJ 07446.

**International: 1990**

MARCH 6-8. International Conference on Neural Networks. Lyon, France. Contact: Solange Dubeauclard, 1030 N. Glenhurst, Birmingham, MI 48009; (313)647-7833.

MAY 7-11. Fourth International Symposium on Knowledge Engineering. Barcelona, Spain. Sponsor: Rank Xerox, Faculty of Computer Science, Madrid Polytechnic Univ. Contact: Jose R. Chelala Lopez, Gen. Secretary, 4th Int. Symposium of Know. Eng., Alvarez de Baena, 3-2, 28006 Madrid, Spain. (91)419 7740. Fax: (91)410 0121.

MAY 14-16. Commercial Expert Systems in Banking and Insurance. Lugano, Switzerland. Sponsor: Swiss Re. Contact: Istituto Dalle Molle di Studi sull'Intelligenza Artificiale, Corso Elvezia 36, CH-6900 Lugano. (41)9151 8660 Fax: (41)9151 7748.

MAY 28-JUNE 1. Avignon 90 (Expert Systems & Their Applications). Avignon, France. Sponsors: ECCAI, JSAL. Contact: Jean-Claude Rault, EC2, 269-287 rue de la Garenne, 92024 Nanterre Cedex, France. (33.1) 4780 7000, Fax: (33.1) 4780 6629.

JUNE 25-29. 4th European Knowledge Acquisition for Knowledge-based Systems Workshop (EKA W-90). Contact: Bob Wielinga, Social Science Informatics, University of Amsterdam, Herengracht 196, 1016 BS Amsterdam, The Netherlands. (31) 20 525 2160.

JUNE 27-29. ACM Conference on Lisp and Functional Programming. Nice, France. Contact: Gillies Kahn, INRIA Sophia — Antipolis, 2004 Route des Lucioles, 06565 Valbonne Cedex, France. (33) 9365 7801.

AUG 6-10. ECAI90 (European Conference on AI). Stockholm, Sweden. Sponsors: Swedish AI Society and ECCAL. Contact: Stockholm Convention Bureau, Box 6911, S-102 39 Stockholm, Sweden. (468) 23 0990. Fax: (468) 34 8441.

OCT 25-26. 1st Japanese Knowledge Acquisition for Knowledge-Based Systems Workshop (Part 1). Kyoto, Japan. Sponsors: Hitachi, Ltd. and Kansai Inst. of Information Systems. Contact: Riichiro Mizoguchi, Inst. of Scientific and Industrial Research, Osaka Univ., 8-1 Mihogaoka, Ibaraki, Osaka 567, Japan. (06)877-5111 (ext. 3540)

JULY 2-6. Second International Conference on Economics and AI. Paris, France. Sponsor: AFCET. Contact: J-L Le Moigne, GRASCE, Unvi. Aix Marseille III, 3, ave. Robert Schuman 13628 Aix en Provence, France.

JULY 9-13. IBERAMIA 90 (Second Ibero-American Conf on AI). Morelia, Michoacan, Mexico. Sponsors: Centro Regional de Enseñanza en Informatica (Spain). Contact: Iberamia 90, Atn. Srita Ma. Antonieta Alvarez Perez, Apartado Postal 70302, C.P. 04510, Mexico, D.F.

SEPT 25-27. Sixth International Expert Systems Conference & Exhibition. London, England. Contact: Learned Information, Woodside, Hinksey Hill, Oxford OCl 5AU, United Kingdom. (0865) 730 275, Fax: (0865) 736 354.

OCT 29-31. 1st Japanese Knowledge Acquisition for Knowledge-Based Systems Workshop (Part 2). Tokyo, Japan. Sponsors: Hitachi, Ltd. and Kansai Inst. of Information Systems. Contact: Hiroshi Motoda, Adv. Research Lab, Hitachi Ltd., Kokubunji, Tokyo 185, Japan. (0423) 23-1111. Fax (0423)26-0880.

**A Personal Note**

I have agreed to write a manual for ObjectVision, a graphical object oriented programming environment that generates C++ and Turbo Pascal 5.5 code. The product was developed by Brian Sawyer with whom I co-authored my latest book, *Creating Expert Systems for Business and Industry*. I will end up having a financial interest in the success of the ObjectVision product. This product does not compete with any expert systems-building product — it is a CASE tool for object-oriented programmers.

In the past, I have held a few shares of stock in the various publicly held expert systems companies to make sure I got their financial reports (I hold none at the moment). In addition, I have given lectures, presented training programs designed around specific tools, and helped some expert systems tool vendors develop introductory expert systems training programs. But I have never had any significant financial interest in the success or failure of any company or product I have reviewed.

I have already mentioned ObjectVision (before I had any financial interest in the company) in the newsletter and will undoubtedly mention it again as I review object-oriented products in the year ahead. Whenever I mention ObjectVision or any of its direct competitors I will remind you that I have a financial interest in ObjectVision. I hope this way of handling a potential conflict of interest will be acceptable.

Paul Harmon

**EXPERT SYSTEMS FOR SALE**

Harmon Associates is in the process of developing a catalogue of all of the expert systems that we know about that are being offered for sale. If you sell an expert system, or know of a company that does, we would appreciate hearing about it.

Please contact Paul Heidt, Harmon Associates

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# EXPERT SYSTEMS STRATEGIES™

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Editor: Paul Harmon

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## TOOL REVIEW

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### AION'S ADS AND AICORP.'S KBMS

Many companies are planning to standardize on tools and, for most companies, that means choosing between the two most popular mainframe tools: Aion's ADS (Version 5.1) and AICorp.'s KBMS (Version 404). We have been studying both tools over the course of the last six months in an effort to provide readers with a comparison of the two tools. (We actually examined version 403 of KBMS, but 404 was demonstrated and is just now beginning to ship, so we'll talk about 404 features as well.)

#### Aion's ADS

Aion Corp. was founded in 1984 by Harry Reinstein, who is the chairman of the board and CEO, and Lawrence Cohn, who is Aion's president and COO. Both men had previously worked for IBM for 23 years. (We checked with Larry Cohn, and Aion is pronounced "a-on," not "i-on.")

In 1985 Aion introduced the Aion Development System (ADS) for the IBM PC. In August of 1986, it introduced the first mainframe version of ADS (for MVS). So, although Aion is a newer

company, it has been selling mainframe tools two years longer than AICorp.

Aion has probably sold about three times as many mainframe development licenses to date worldwide as has AICorp. Aion has 185 employees. The company is privately held.

#### AICorp.'s KBMS

AICorp. was started in 1975 by Larry R. Harris, who is the founder and guiding technical person. AICorp. introduced its first product, Intellect, in 1981. Intellect is an AI-based natural language frontend for databases. The system enables business users to access and analyze corporate data in plain English. Some 600 copies of Intellect have been sold for IBM mainframes. There are also DOS and PS/2 versions.

In 1988 AICorp. introduced the Knowledge Base Management System (KBMS) for the mainframe. In 1989 it introduced versions of KBMS for the PS/2 and for DOS.

The current president and CEO is Robert N. Goldman (formerly the president of Cullinet). AICorp. has two major products, Intellect and KBMS, and 125 employees. The company is privately held.

#### ADS and KBMS

We'll compare and contrast the two tools relative to the basics: (1) knowledge representation, inference and control; (2) developer interface; (3) user interface; (4) system interface and integration; (5) management, training and support; and (6) costs. Then we'll give an overall summary.

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## Knowledge Representation, Inference and Control

### Aion's ADS

The original version of ADS was a descendant of the Emycin work at Stanford. The first versions of ADS (through Version 5.0) were structured rule tools. Rules could be divided into contexts (Aion calls them states) and formed into a hierarchy. Although the tool would occasionally forward chain, its overall flow was always backward. ADS extended the Emycin paradigm in a number of interesting ways. For example, a developer could put procedural steps at the beginning of each state and create messages to the users that incorporated variables that would automatically initiate backward chaining.

The minimum structure necessary for an ADS system is a single state with a goal and some rules. For each rule you write, you need to define each of the parameters (attributes) included in the rule. If you wished, you could write a small ADS system with a single state, a backward-chaining goal as the only step, and then include rules and parameters. This system would function more or less like any of the many small, backward-chaining rule-based diagnostic systems developed in tools like VP-Expert, Personal Consultant Easy, or Level5. Aion is no longer emphasizing this approach, but companies that want to allow lots of non-programmers to develop small applications will find this a very nice feature of the tool.

Aion introduced ADS Version 5.1 in the spring of 1989. It added a powerful, independent, forward-chaining inference engine, a complete and more or less independent object-oriented programming capability, and pattern-matching rules. (See Figure 1)

With the introduction of ADS Version 5.1, Aion has focused primarily on training developers to create

hybrid systems in which:

- ◆ Knowledge is modeled in one or more class object hierarchies.
- ◆ Most reasoning is accomplished by using pattern-matching rules.
- ◆ The ADS state tree is used to organize the overall flow of the application and to introduce procedural steps when appropriate.
- ◆ Methods are used to allow the developer to maintain and update the information in the object hierarchies.

ADS rules support AND, OR, ELSE, and IFELSE. ADS also supports confidence factors. ADS provides a number of ways to resolve conflicts about which rule will fire next. Each rule is assigned a numeric priority which can be changed dynamically. The order of forward-chaining rule firing can be controlled by specifying such things as depth- or breadth-first search. Backward-chaining rules can also use a cost system. The system determines cost by calculating the difficulty of inferring the conclusion of the rule (based, for example, on how many IF-clauses in the rule remain to be proven).

The screen pictured in Figure 2 illustrates the syntax required to write a rule in ADS. In addition

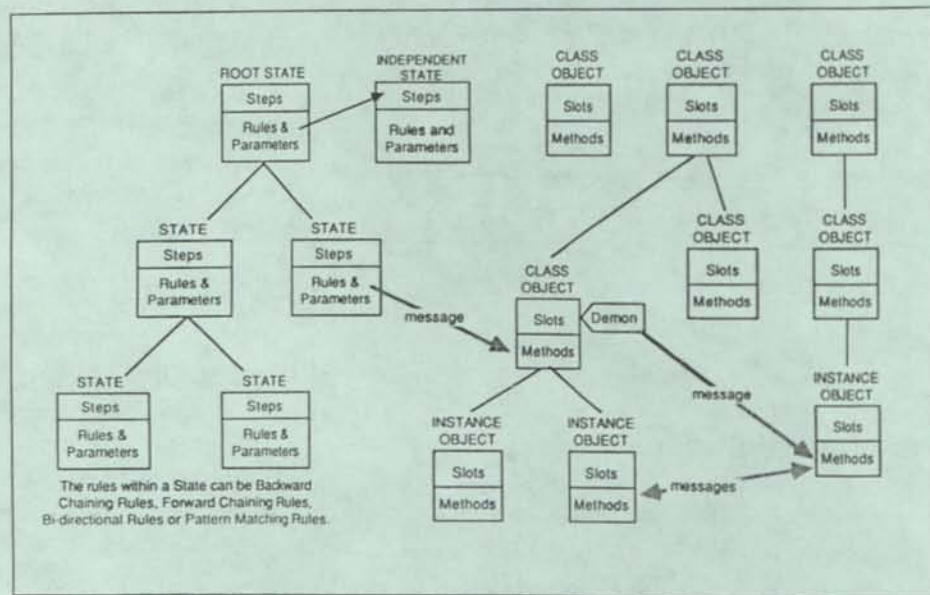


Figure 1 — Overview of ADS components

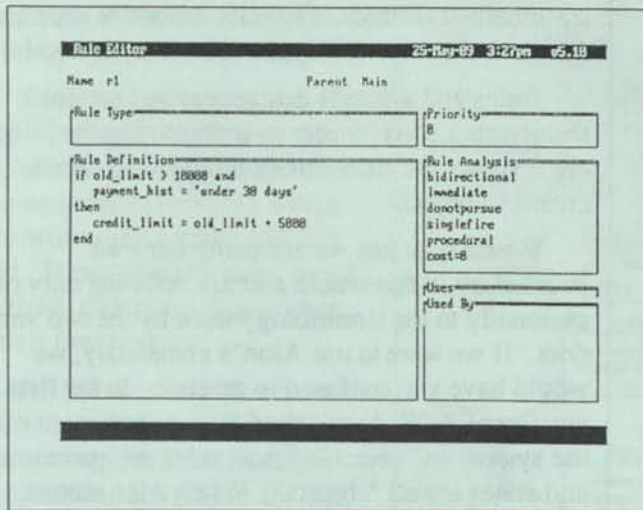


Figure 2 — ADS Rule Editor Screen

defaults for each case, but the developer can always control the processing in some more specific manner. In addition, the developer can indicate in the agenda whether the module will employ depth- or breadth-first chaining.

Note that the rule written in the rule editor does not incorporate variables in place of attributes. If it did it would require a slightly different syntax (e.g., it would begin with IFMATCH rather than IF). Pattern-matching rules (ADS calls them "generic rules") are used with ADS's object-oriented programming capabilities, since variable parameters function by binding and unbinding on different instances of objects (see ESS Vol.5, No.12 for a detailed explanation of this).

In addition to entering a rule, the developer must define each attribute (parameter) used in any rule. Defining an ADS parameter determines the type of values the developer can associate with the parameter, the defaults, and the source of the value for the parameter. If the source of the value is to be a user, then the developer provides a question to ask the user. If the source is to be a database file, the developer indicates the file name. Later, the developer must write specific code to access the database file and retrieve the information needed by the parameter. More code is required if the database is to be modified as a result of anything the system does.

The overall organization of an ADS application is provided by the state hierarchy. Each state

in the tree contains a set of steps (called agenda statements) and a set of rules. The agenda statements constitute a procedural sequence of actions that ADS attempts to execute in order (e.g., message passing, creating reports, calling other states). Any of these statements can initiate forward or backward chaining.

Assuming the system is going to have objects, the developer must include explicit agenda statements or write rules whose THEN-clauses send messages to initiate activity within the object-oriented portion of the system.

All states descended from the root state have entry conditions. If the system tries to enter a state and fails to meet the entry conditions, the system moves on to other states at the same level or returns to the parent state. Conclusions reached when a system is in a particular state are removed from working memory when the system leaves that state, unless the developer has arranged to store the results at a higher level in the state tree. Thus, by structuring the state tree properly, the developer can design quite a bit of procedural and memory efficiency into an ADS application.

In addition to the states making up the state hierarchy, other independent states can be created. These can be used as sub-routines that can be invoked as often as needed from anywhere in the knowledge base.

Rules within states can invoke other independent states or send messages to objects. Whenever a rule invokes an independent state or object, processing is shifted there until the task is completed then it returns to the location from which it started.

To begin an ADS application, the developer enters the root state of the state hierarchy. All other activity follows as it is either called by a specific agenda statement, or called when a rule references another state or sends a message to an object.

The ADS object system allows the creation of hierarchies of class objects and provides for the creation of instances of class objects. Each object can contain slots and methods. Methods are proce-

dural statements that manipulate the data contained in an object's slots. To determine or change data associated with any slot, the developer sends a message to an appropriate method attached to the object containing that slot. The method then checks the slot, modifies the data in the slot, or returns a value to the source of the message (which could be a rule or a method attached to another object). In this way, ADS respects the important OOP principle of encapsulation, which holds that the slots of an object, should be the private property of the object and should only be accessed indirectly by methods. ADS does not enforce encapsulation, but we hope that most developers will respect it. When encapsulation is respected, then objects can be reused and maintained with much greater ease since their core data and functionality are not directly incorporated into any specific routine.

ADS also supports demons, methods or rules that are attached to either objects or to specific slots. A demon fires whenever the slot or object to which it is attached is called, accessed, or altered.

An ADS object can only inherit from a single parent. All slots and methods are inherited. Inherited slots cannot be deleted, but the developer can override inherited constraints and values associated with the slots. In addition, the developer can special-

ize inherited methods. Defaults cannot be changed dynamically when the application is being used.

Rules and methods can access and reason about either class objects or instance objects. Figure 3 shows the ADS screen a developer uses to create an object.

Please note that we are using our own vocabulary in this article and are referring only occasionally to the terminology used by the two vendors. If we were to use Aion's vocabulary, we would have you confused in no time. In the first version of ADS, Aion called every component of the system an "object." Thus, rules and parameters and states are all "objects." When Aion moved from version 5.0 to 5.1, it had an opportunity to get rid of this awkward convention, but didn't take it. So now ADS has "object objects."

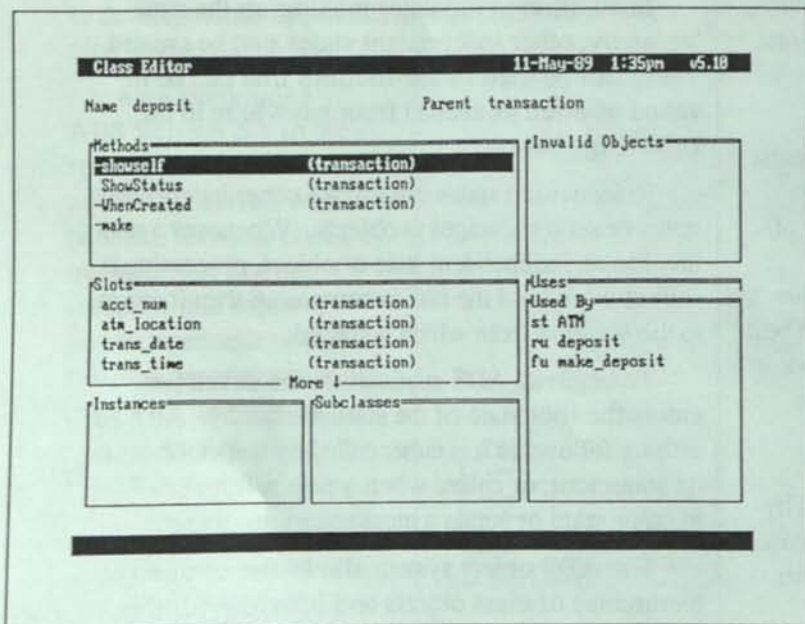
### AICorp.'s KBMS

As ADS has Emycin as an ancestor, KBMS is an offspring of OPS5. The syntax is entirely different from OPS5, but the overall design certainly bears a family resemblance. In addition, KBMS incorporates the experience that AICorp. gained from working on Intellect over the years. An overview of KBMS components is shown in Figure 4.

Essentially, KBMS is a forward-chaining rule-based system embedded within a limited object-oriented environment but supplemented with 4 GL and natural language capabilities. Unlike ADS, which is really a collection of different techniques that one can use or ignore, KBMS is a highly integrated system.

Before you can create a rule, you must create one or more objects that have the attributes that will be referenced in the rule (in exactly the same sense in which you must create variables in C before you can create procedures.

One enters a KBMS application via an agenda which is a list of steps that KBMS attempts to execute in order of priority. The steps reference rule packets, and the entire process is driven by the KBMS inference engine. As with ADS, a KBMS developer can structure the program by creating procedural steps



© AION Development System

Figure 3 — ADS Screen Used to Create and Edit Objects

which are executed when you enter or exit the rule packets.

Each rule packet contains rules that are listed within the packet in order of priority. The rete network determines which rule within any packet will fire first. If two or more rules could be fired, then order determines which fires first.

KBMS uses the rete network to organize the rules. Essentially, the rete network identifies rules whose IF-clauses (LHS) are the same, and arranges all rules into a network so that, for any given set of values, you always know which rules are eligible to fire. When you fire a rule, you establish new values and the rete network must then be updated. KBMS partitions the rete network so that the system considers only the rules within a packet being used, and updates only that portion of the network as new values are established. This, in turn, means that all rules that conclude a value for the same conclusion must be in the same packet.

There is a special packet containing demon rules — rules that fire automatically — whenever its IF-clauses (LHS) are true.

The agenda can forward- or backward-chain among packets. Within a packet, however, all of the rules are executed in a forward-chaining manner. (There are no backward-chaining rules in KBMS in the sense that one is accustomed to them in backward-chaining tools like Level5 and VP-Expert. KBMS doesn't automatically generate questions, for example.)

In developing a KBMS application, you want to limit the number of rules per packet. Forward-chaining rules are much more difficult to control than backward-chaining rules, and one way to limit the potential problems is to limit the number of rules in each packet. You must also be very careful of the order in which the rules are placed within a packet. If you place a looping rule at the top of the list within a given packet, the system will never get past it to the other rules in that packet. This

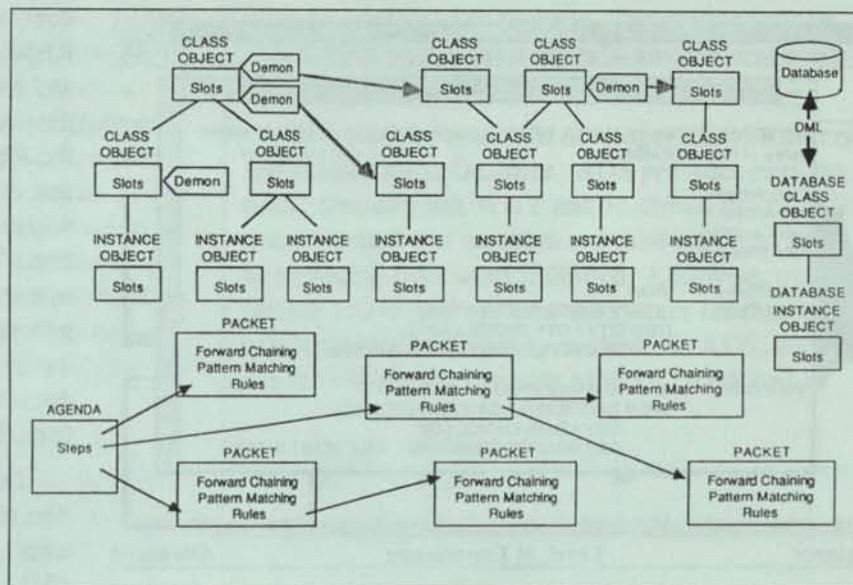


Figure 4 —An Overview of KBMS

means that any significant KBMS application will have a large number of packets and the developer must give considerable thought to which rules go in which packets.

The attributes of each rule reference objects. If multiple instances of an object exist, KBMS rules automatically do pattern matching. No special syntax is needed since all KBMS rules are both forward-chaining and pattern-matching rules. This means that one of the most complex aspects of knowledge-based programming (pattern-matching) is essentially transparent when you are using KBMS.

KBMS rules support AND and OR. Rules can be prefaced by Boolean operators thus: If ANY..., If x NOT y..., If EXISTS w...

Figure 5 shows a KBMS screen that one uses to enter rules. (This particular screen is taken from the OS/2 Version 404 of KBMS. It illustrates the screen in Presentation Manager with other graphical information in the background.)

KBMS objects contain slots but they do not have procedural methods. Demons can be associated with objects that will fire when some value is changed. These demons will check the values of other slots, altering the values of those other slots when appropriate. However, one of the many features of an OOP system is the ability to inherit methods and modify or specialize the proce-

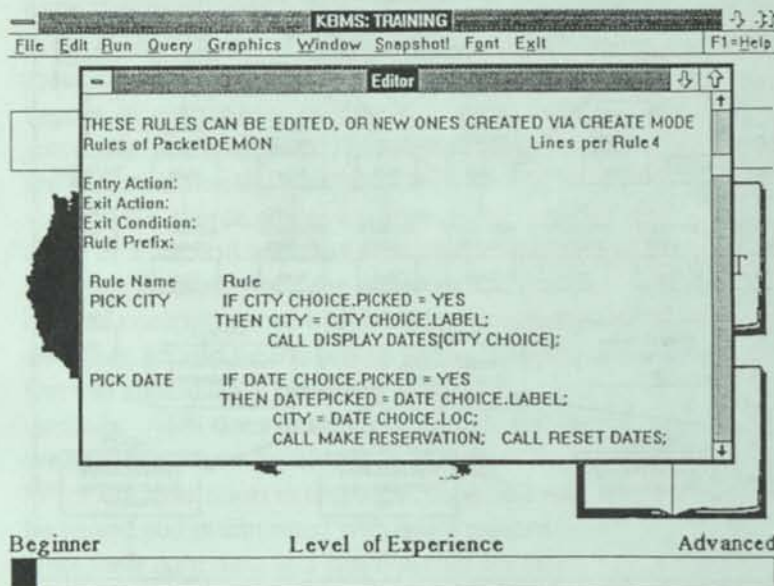


Figure 5 — KBMS rule entry screen.

dural logic in the derived objects. KBMS totally lacks this ability. In addition, KBMS violates the encapsulation principle by allowing one object to directly access and modify the slots of other objects. (Most object-oriented programming theorists would argue that a system with objects but without class methods, method inheritance and method specialization, or message passing should not be called an "object-oriented" system.)

KBMS supports hierarchies of class objects. It also supports multiple inheritance, meaning that any particular object can inherit slot information from more than one parent. The developer must specify priority in cases where an object might inherit contradictory information from two different objects. Multiple inheritance is a useful feature when you are developing systems that have graphics, since you can have a single object inherit knowledge from one parent and a graphic image from another. Figure 6 shows the two KBMS screens a developer uses to create objects.

In addition to regular class objects, KBMS supports two special kinds of objects. The first is called a database object, which is created whenever a

developer identifies a database file. KBMS determines the fields in the file and converts them into slots in the database object. Thereafter, whenever the KBMS application is loaded, the content of the database object is available within the virtual space of the application. When a KBMS pattern-matching rule references a database object, KBMS generates code (DML) that goes to the database, searches for the pattern, and does the joins required to obtain the information desired.

Other programs write code to bring data from the database into the expert systems application. With KBMS, it's as if all the data in the database is always available within the expert systems application, since KBMS can automatically and transparently generate any code needed to carry out pattern-matching and joins on the contents of the database file.

The database objects cannot be incorporated into hierarchies of other non-database objects. Moreover, you can't attach some demons to database objects. If you wanted to do this, you would need to bring data into KBMS and incorporate it into knowledge objects.

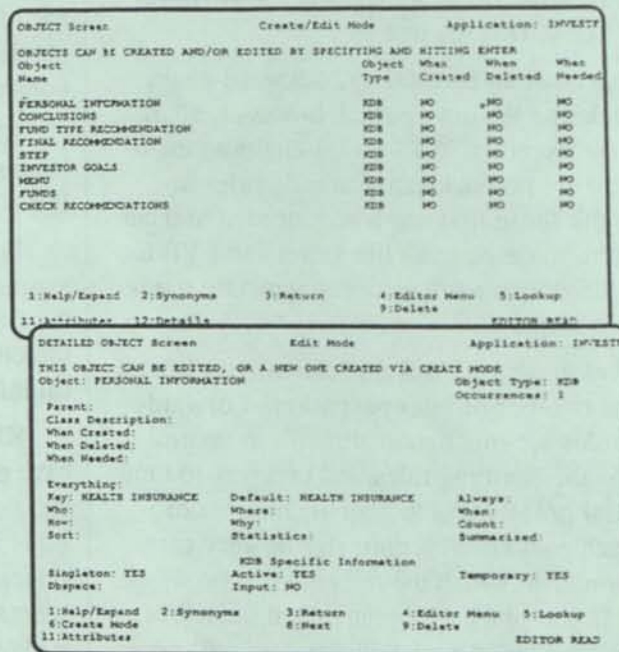


Figure 6 — KBMS Screens used to enter and edit objects

While an OOP theorist might argue that KBMS object system has deficiencies, AICorp. would argue that its 4GL approach to objects renders them much more useful for the kinds of applications with which most expert systems developers are concerned. The KBMS approach makes its systems especially easy to port. Once you develop an application and specify the files to be obtained, you can move the application from one platform to another, and the KBMS system will still generate the code necessary to get information from the database.

The second special type of object KBMS supports is a remote object. This object can use AI/SQL, LU2, or LU6.2 to automatically access another KBMS system on another computer.

Both Aion and AICorp. claim that they can handle hypothetical reasoning problems. Each provides the developer with A\* and other search techniques, but both tools fall far short of the hypothetical reasoning capabilities that one finds in the Lisp-based tools.

### Developer Interface

Both systems provide menu-driven screens for to use in developing the system. Each allows developers to avoid using the screens and enter code directly, if desired. The ADS screens include several windows that make it easy to move about within a screen, while KBMS screens are more typical of a mainframe environment. With the introduction of KBMS 404 in Presentation Manager, KBMS has jumped ahead, although the data entry within windows still looks like it did in the 403 mainframe version. But with the pull-down menus provided by Presentation Manager, you can move about KBMS and access Intellect with much greater ease.

The main menu screens for ADS (5.1) and KBMS (403) are shown in Figs 7 and 8, respectively.

In ADS, the developer must begin by identifying a root state. Thereafter, the developer can write rules, define parameters, or create objects in whatever order he or she prefers. In KBMS, the developer must begin by specifying the objects to be referenced by any

rules he or she wants to write. The developer can expand the object hierarchy, add demons, and move rules into packets more or less freely.

Both tools provide the developer with browsers and various trace facilities. ADS provides explanations. One can ask WHY and be shown the rule that generated the question and then trace the line of reasoning backward if desired. Likewise, one can ask HOW and see how the system reached the conclusions it has already reached. In ADS, each rule is written in a separate window. ADS has a

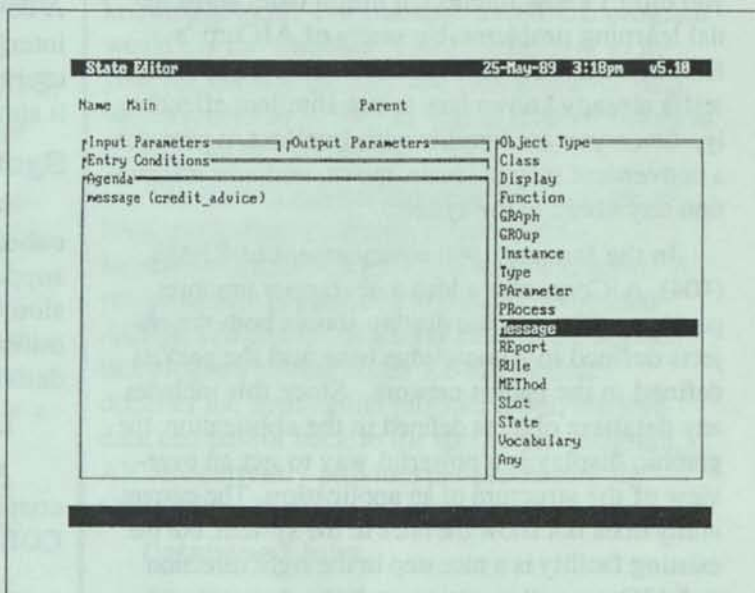


Figure 7 — ADS Main Menu Screen

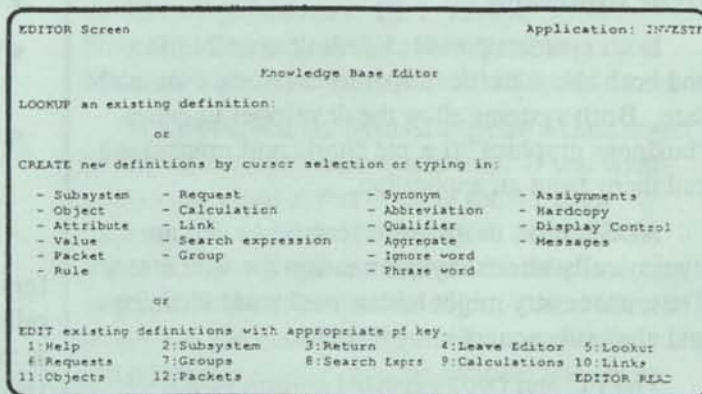


Figure 8 — KBMS Main Menu Screen

good text editor that can be used to copy and move text.

KBMS does not support HOW or WHY explanations. In KBMS, you can write several rules in a single window. Unfortunately, KBMS lacks a real text editor, so although you can move rules, you cannot copy strings.

KBMS provides the developer with the ability to use its natural language interface, Intellect. This can be used to query the application (e.g. "What are the bindings for this rule?"), update the knowledge base, and debug the knowledge base. If you didn't know Intellect, it might offer some initial learning problems, but many of AICorp.'s KBMS clients are also Intellect clients, and their staffs already knows how to use Intellect effectively. Once you are familiar with Intellect, it provides a convenient way to locate, move, and edit information anywhere in the system.

In the January 1990 enhancement of KBMS (404), AICorp. also added a developer graphics package. The graphic display shows both the objects defined in a knowledge base and the packets defined in the packet network. Since this includes any database objects defined in the application, the graphic display is a powerful way to get an overview of the structure of an application. The current utility does not show the rules in the system, but the existing facility is a nice step in the right direction and AICorp. will surely expand it to show rules at some point in the future.

In ADS, you view state and object hierarchies as indented text outlines.

### User Interface

Both systems provide a default user interface and both allow the developer to tailor the user interface. Both systems allow the developer to create "business graphics" (i.e. pie charts and graphs) and call them from an application.

ADS allows users to create screens that are dynamically altered by information the user enters. Thus, user entry might initiate backward chaining and alter subsequent entry boxes.

The PC and OS/2 extended edition of KBMS have active graphics. Using the KBMS graphics development utility, a developer can create simple graphics or cut and paste bitmapped graphics onto

the screen. Then he or she can designate areas of the graphics that are "active." Thereafter, when a user moves the cursor into that area or clicks a mouse in that area, the system registers the input. In this manner, a user can interact with an application graphically, moving things on the screen and then observing what the system does. In fact, the developer can literally drag items around on the screen to facilitate solving problems in which he or she needs to place units (say courses) within a broader context (say a monthly schedule). This is a very nice, easy-to-use feature that allows the developer to quickly create interesting interfaces. A developer can, for example, create a graphic user interface linked to database objects that allows the user to get information from a database and modify it simply by manipulating icons on the screen.

### System Interface and Integration

ADS has a separate delivery environment called AES (Aion Execution System). KBMS also supports both a development and a runtime version. In both cases, the runtime or delivery version minimizes the space and memory required when delivering an application.

#### Language

ADS is written primarily in Pascal, though it contains components written in Assembler, C, and COBOL.

KBMS is written in C.

#### Hardware and Operating Systems

ADS runs on the following hardware/operating systems:

- ◆ IBM PC/DOS, PS/2:OS/2
- ◆ VAX/VMS (Aion's intention to be on VAX has been announced but no date has been given)
- ◆ IBM Mainframe VM/CMS, MVS/XA, MVS/TSO, MVS Batch, MVS/ESA, MVS/CICS, MVS/IMS/DC, and MVS/IMS Batch.

In addition to the basic ADS version, Aion offers a High Performance Option (HPO) that compiles an ADS application to run at significantly greater speed. When HPO is used, confidence in HOW and WHY are not supported.

Aion has committed to keeping its products SAA and AD/Cycle-Repository compliant.



KBMS runs on the following hardware/operating systems:

- ◆ IBM PC/DOS, PS/2:OS/2
- ◆ VAX/VMS (KBMS is scheduled to be available on a VAX in the second quarter of 1990)
- ◆ IBM Mainframe VM/CMS, MVS/XA, MVS/TSO, MVS/CICS, MVS/IMS/DC, and MVS/IDMS/DC.

There is no compiled version of KBMS. Multi-user central server support is only available in MVS.

AICorp. has also committed to keeping its products SAA and AD/Cycle Repository compliant.

### Location of the Inference Engine and Communication with Other Regions in MVS

ADS typically runs within the address space of the user interface. For example, under MVS/TSO and VM/CMS, the inference engine is loaded into that address space. For IMS/DC and CICS processing, the inference engine runs in a separate multitasking MVS address space. It communicates with other regions by means of VTAM LU6.2. The ADS inference engine can be embedded directly within the IMS message processing region when inferencing is done as a sub-routine from a user application.

The KBMS inference engine is located in its own region of MVS. It communicates with other regions by means of LU6.2 or on SPC. Since KBMS incorporates database objects into its virtual space, however, much of the communication is handled by means of sub-routine linkages.

### Size of the Inference Engine and Memory Required When Using the Application in MVS and on a PC in DOS

ADS takes up two MB on a PC and at least three MB minimum on a mainframe.

KBMS takes up two MB on the PC and at least two MB minimum on the mainframe.

### Re-entrant Behavior

ADS and AES are completely re-entrant. Knowledge bases themselves are treated as data and so are not re-entrant. However, when a knowledge base is compiled using the HPO product, rules and logic are compiled into re-entrant code and bundled with the re-entrant runtimes of the AES execution system. The result is a completely re-entrant

knowledge base with specific data elements residing in dynamically acquired storage to maintain re-entrancy.

KBMS lets the operating system handle re-entrancy.

### Embeddability

ADS can be embedded and called via the Application Programming Interface (ADSAPI). This interface is language independent and supported on all platforms. No pre-processor is needed to enable this facility. ADSAPI also allows calling from a knowledge base to an external program and it allows an external program to invoke an ADS knowledge base. For example, a COBOL program would use the standard 'CALL' statement to invoke the knowledge base and pass whatever data values it needed to pass as well as receive values in return from the knowledge base.

The KBMS application program interface allows application programs to call KBMS knowledge bases and pass data back and forth. A pre-processor is provided to convert embedded AI/SQL commands to KBMS calls in the application program source code. KBMS modules decipher the application program input, retrieve data, and pass it back to the application program. AICorp. currently provides pre-processors for COBOL and PL/1.

### Database Links

Whenever you define an attribute (parameter) in ADS, you are asked to identify its source. If you identify the source as a database, you are expected to write KDL code to access, search, and update the database in an appropriate manner. ADS can access the following databases: DL/I, VSAM, QSAM, DB2, SQL/DS, Oracle/SQL, IBM Database Manager, Teradata DBC/1012, d:BASE, and Lotus.

In KBMS, you are required to create a class object for any attribute you want to reference. If you want the data contained in that object to come from a database, you create a database object. KBMS will automatically examine the database file referenced and create the slots for the database object. Later, when it is accessed, the database object will automatically generate DML code to go to the database and obtain appropriate information. KBMS can automatically access the following databases: IMS, DB2, VSAM, SQL/DS, IDMS, Ada-base, and Terradata. (In addi-

tion, KBMS can access KBMS database objects themselves.)

### Runtime Speed

Aion has developed its own network for compiling its forward-chaining, pattern-matching rules. The network allows ADS to compile the rules via its HPO system.

KBMS uses a rete network to prepare its forward-chaining rules and its objects for efficient processing. AICorp. has put considerable effort into getting its rete network to run very fast.

We do not know of a benchmark comparison of equivalent applications written in each tool that establishes which performs best in a CICS or IMS environment.

### Cooperative Processing

Both ADS and KBMS support cooperative processing. Thus both systems allow a company to store large databases and knowledge bases on mainframes which can be accessed by PCs where the actual interaction with the end user is managed. Moreover, if appropriate, a separate knowledge base can reside on the PC.

### Management, Training, and Support

The management at both companies is excellent. Unlike some of the earlier expert systems tool vendors that were guided primarily by technical people, both Aion and AICorp. are run by professional managers with years of experience in the mainframe world.

Both companies are adequately capitalized and both are committed to and capable of developing and supporting their products during the next several years, when they will need to grow and evolve rapidly.

Both firms offer training courses. We have attended the first course offered by each company. Neither course provides a good foundation to guide the new programmer in selecting good applications, and both courses tend to degenerate into long lists of the features available in their respective tools. Both courses are well taught and well documented.

The basic ADS course is five days long. The instructors provide participants with an overview of each of the different programming paradigms

available in ADS. This means that significant time is given to backward-chaining, rule-based programming, forward-chaining systems, object-oriented programming, and pattern-matching rules. There is an awful lot to learn, and it must leave some participants rather confused.

The basic KBMS course is three days long. Participants learn to develop forward-chaining, rule-based systems. Objects are mentioned, since you can't write rules without them, but nothing is said about representing hierarchical knowledge structures or using OOP for anything other than in support of rules. If you substitute the word "parameter" for "object," the current KBMS course is like the old three-day ADS (Version 4.1) course that focused entirely on teaching backward-chaining, rule-based systems. The way the KBMS course is currently taught, it could just as well be a course in OPS5 programming, except that you are using a very friendly tool with some powerful 4GL capabilities.

The integration of forward-chaining and pattern matching in KBMS is so well done that you get to the end of AICorp.'s three-day class understanding the basics of that rather complex concept without ever realizing you were learning something difficult.

Both companies say they have changed their courses since we took them, and both companies offer advanced courses we have not taken.

Both Aion and AICorp. offer support, although neither one really has a group of consultants available to actually help clients undertake large, long-term projects.

Both companies have established users groups that have regular meetings

### Costs

Both firms package their products in a wide variety of ways. Prices for units can therefore be misleading. Both stress site license sales. In addition, both companies sell development versions and delivery versions of their tools.

In general, a single unit of the developer version of ADS for MVS will cost \$85,000 and a PC DOS version of ADS will cost \$7,000.

A single unit of the developer version of KBMS for MVS will cost from \$90,000 to \$160,000. A PC DOS version of KBMS costs \$5,000. KBMS prices include a single Intellect database interface. If a company wants interfaces to more databases, prices will increase accordingly. Since many companies acquiring KBMS systems already have Intellect and the interfaces for several databases, a copy of KBMS could cost them less.

### Some Applications

Two examples of multi-user, mainframe-based expert systems illustrate the potential of these tools.

MCI Telecommunications used AICorp.'s KBMS tool to develop Pricer, a system that generates precise estimates of service costs for customers, taking into account the constantly changing maze of tariffs. The system was developed from conception to beta in four months. The system is now fielded and supports some 600 MCI salespeople. The system typically handles two transactions per second and 15 concurrent transactions.

KKB Bank in Germany, with the help of Insiders, used Aion's ADS to develop a system called Ramses. It provides staff officers in some 300 branches of the bank with advice on how to analyze personal investment needs.

The ability to develop new applications quickly on PC versions of the tool, to port the applications easily to mainframes, and maintain them at a central location while simultaneously making them available to users throughout an organization will finally convince corporate MIS professionals that knowledge based systems have an increasingly important role to play in the world of corporate computing.

### Future Directions

Aion has announced that a Version 6.0 of ADS will be available in the third quarter of 1990. Aion says the new version will include a graphical user interface, the ability to generate data manipulation statements automatically and to read and write data, and a source level debugging facility for rules and functions. ADS 6.0 will offer fully CUA-compliant support for Presentation Manager. Aion has also announced the extension of its cooperative processing option to include OS/2.

Aion already has project development tools incorporated into Aion 5.1. It has announced its in-

tention to expand its project development capabilities into a full-blown CASE environment that will provide life-cycle development, maintenance and management tools. Aion has already said that an application testing and maintenance tool that will collect all input and output from a consultation and manage it for regression testing will be available in the third quarter of 1990.

At the same time, the company has announced a series of end-user development tools — tools to help developers quickly develop specific kinds of applications. A service aid tool and a procedure validation tool are the first of these being considered.

AICorp. has consistently been more conservative about announcing its plans. The company prefers to announce new products only when it is actually ready to deliver them. AICorp. has said that it plans to enhance its OOP system, connect to other databases, make KBMS available on VAX in VAX Windows, and develop techniques to compile additional portions of its delivery system. The company also says it intends to improve the graphical depiction of KBMS knowledge bases.

### Summary

ADS and KBMS are both very strong tools. There are real differences between them; each has some marked strengths and some comparative weaknesses. If I were a corporate executive trying to decide which tool I'd choose as a standard, I would have a very hard time deciding between the two. I will try to summarize and then offer some general advice.

### Knowledge Representation, Inference and Control

KBMS is essentially a forward-chaining, pattern-matching, rule-based tool with an unconventional object-oriented programming capability. Its object-oriented system does not provide the kinds of methods and message passing one usually expects with OOP systems, but instead provides for database objects, which in turn makes it very easy for developers to incorporate database files into applications without writing access code. It would be hard for a non-programmer to use KBMS to develop a small diagnostic application. You might also run into difficulties trying to develop very com-

plex applications in KBMS because you would be bumping into the limitations of its OOP capabilities.

ADS is a true hybrid tool with backward-chaining and forward-chaining rules, bidirectional chaining, and pattern-matching rules. It has a state hierarchy and an independent object-oriented programming environment that includes class methods, method inheritance, and specialization and message passing. A non-programmer could easily use one small piece of ADS to develop a simple, backward-chaining diagnostic system. At the same time, ADS' complete OOP capabilities assure that you could develop very complex applications as well.

In our opinion, if you just consider the knowledge representation, inferencing and control capabilities of the two tools, ADS provides the sophisticated developer with more power and more flexibility.

#### Ease of Use

Aion has the problem faced by all large hybrid vendors; they have to explain how to use a system that is large and complex. In effect, they have to teach new users to program in three or four different modes, depending upon the application. ADS does not provide a graphical overview of the knowledge base, and you are forced to create explicit connections between ADS and the databases from which you need to obtain data.

By contrast, AICorp. has a simpler, better integrated paradigm. Moreover, it has integrated its knowledge and inferencing capabilities with a powerful natural language system, a database system that automatically and transparently generates DML code, developer graphics that provide the developer with an overview of the object hierarchies and packet networks, and recently, with active images running in a Presentation Manager environment on OS/2.

Each tool makes some things transparent and easy, while making other things more difficult. On the whole, we think KBMS is easier to learn and to use than ADS.

There is a fundamental philosophical difference between the two products that is evident in many aspects of the two tools. ADS provides several paradigms that the developer must figure out how to use. There is a great deal of power and

flexibility in ADS, but you must know what you are doing to take advantage of it. KBMS generally provides less power and flexibility, but the development process is simpler, more integrated, and more transparent.

#### So Which Do You Buy?

If I had to choose today, and not consider what each tool might be like in nine months, I'd emphasize the following:

If I wanted a tool that non-programmers could use to develop simple systems, I'd favor ADS because it has backward-chaining rules and its very easy to use a single portion of ADS to develop a small system quickly.

If I wanted a tool that skilled programmers could use to develop and maintain a complex planning and scheduling application, I'd favor ADS, because its object-oriented environment is stronger.

If I wanted to train a large number of programmers to develop mid-sized systems, my decision would be much harder. Both ADS and KBMS allow you to develop systems that incorporate knowledge in object hierarchies and use pattern-matching rules to reason about the knowledge.

KBMS certainly makes the initial development process less painful by providing a more integrated approach, automatic database access, and natural language, although developers may run into more problems in the long run as they encounter subtle control issues. If my applications required access to lots of data, I would consider KBMS' approach to database access a major plus. If my programmers had already used Intellect, that would be another strong argument in favor of KBMS. If I needed to put graphical simulations on the screen, I would choose KBMS.

If I wanted to develop or deliver on DEC hardware, I would certainly favor KBMS. KBMS will be available on VAX equipment in the next quarter and Aion hasn't even announced a date for a VAX version of ADS.

ADS takes more time to understand and requires more effort to connect to databases. On the other hand, once you have made the effort, you have more control over the tool. If you want to do serious object-oriented programming, clearly ADS is the tool to use. By the same token, if you want to mix proce-

dural and inference-based programming, clearly ADS offers you a lot more options.

When you take the longer view, it's clear that both companies are very well managed and adequately capitalized, and both are very sensitive to what their potential clients want. It's a safe prediction to say that both companies will soon enhance their tool to eliminate many of their existing weaknesses. Aion will improve its integration, clean up the vocabulary problems, add SQL generation, and developer and user graphics. AICorp. will expand its object-oriented environment by adding class methods and message passing. It will surely expand KBMS' graphical programming capabilities and add some features to improve mainframe integration.

In other words, if you favor either one of these tools, but wish that it had one or two features that the other tool has, chances are those features will be added by the end of 1991. The competition between these companies is fierce, both products are good, and both are being rapidly enhanced. It just isn't an easy choice.

### Other Options

One final note. We've focused this review on ADS and KBMS because these two tools clearly dominate mainframe sales at the moment. They are the two tools being examined by almost every company that is considering standardizing.

It's easy to imagine that the picture will change in the course of 1990 as other companies improve their mainframe offerings. Inference Corp.'s ART for the mainframe will get more attention, as will Information Builder's Level5 Object when it becomes available on the mainframe. Neuron Data and Bell Atlantic Knowledge Systems may develop credible mainframe offerings and IntelliCorp might turn KAPPA (see Trends) into a mainframe tool.

And then there's IBM. TIRS is scheduled for release this summer. If IBM sticks with its intention to limit TIRS to the OS/2, that will limit its

customers somewhat, but it will still play a larger role in the mainframe market than either ESE or KnowledgeTool have played. Moreover, IBM won't stop with whatever version of TIRS it offers this year. It intends to embed inferencing into some SAA facility, and knowledge-based system structures into its AD/Cycle Repository.

The battle for the ideal tool for expert systems development on the mainframe has just begun. Today's choices, for all their difficulty, are probably a lot simpler than those MIS managers will face in two to three years.

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## TRENDS AND NEWS BRIEFS

## IntelliCorp Buys MegaKnowledge

In the last issue we predicted that IntelliCorp would introduce a C version of KEE this year, and we still expect that they will. In the meantime, as we go to press, IntelliCorp has announced that it has acquired MegaKnowledge, the small Boston company that developed KAPPA.

According to IntelliCorp's press release:

"The intent of the acquisition is to allow IntelliCorp to investigate the use of MegaKnowledge technology for possible inclusion in future MS-DOS products and internal projects.

"The agreement is valued at approximately \$2.5 million in cash and stock, a portion of which will be paid at closing and a portion distributed over a three to four-year period. The principal shareholders in MegaKnowledge will become employees of IntelliCorp."

We have not personally examined KAPPA, but we looked at demos at IJCAI last August and had a long talk with the developers. At the time, we remarked that:

"The most interesting new mid-sized tool introduced at the show was MegaKnowledge's KAPPA, a PC tool with almost all of the power of a Lisp workstation tool. If you are considering paying \$5,000 to \$10,000 for a PC or workstation tool written in C, be sure to check out KAPPA before making your decision.

"This tool has all of the features that the other vendors didn't quite get right — it has great graphics, is written in C, runs in Microsoft Windows, and is all integrated into a single, easy-to-use package. It runs on 286-386 machines with 640K of RAM... The PC version costs \$3,500..."

After surveying sales in the mid-sized tool market at the end of 1989, we more or less wrote MegaKnowledge off. The mid-sized workstation and mainframe markets seems to be merging and it looks as if only vendors that can offer tools that run on PCs, workstations, and on mainframes are going to be very successful in 1990. We figured

that MegaKnowledge was probably too new and too small to be able to develop Unix and mainframe versions of KAPPA while simultaneously mounting the kind of marketing campaign they would need to sell enough product to survive.

IntelliCorp is currently the largest and most successful vendor of expert systems-building tools. Its income from the sale of KEE in its fiscal 1989 year (which runs from June 1988 to June 1989) was \$16,859,000. The company also earned \$5,104,000 from consulting and \$1,866,000 in interest on the money it has sitting in the bank (which it got from its public offerings). In January of this year, IntelliCorp reported that its revenues for the most recent quarter (its second quarter) were \$6,099,000, a 20% increase over the \$5,082,000 it earned in the same period in 1988. (Intellcorp's stock has been going up on the strength of these results and perhaps because of its recent acquisition as well.)

Even though the market for Lisp tools has been slow for several years, IntelliCorp has continued to sell KEE and consulting, and has made more money than any other tool vendor. We predicted that Aion would pass IntelliCorp in earnings in 1990 and that there would be continued consolidation within the Lisp market. KEE is well established as the best of the Lisp tools, however, and would probably benefit, in the short run, from the demise of some of the other Lisp vendors.

If IntelliCorp can establish a presence in the conventional tool market that matches its presence in the Lisp market, it could certainly change the entire structure of the expert systems market in 1990. To do this they would need to extend KAPPA (or KAPPA and some C-based tool yet to be announced) into a line of tools that run on mainframes, VAX equipment and Unix workstations. If Intellicorp uses KAPPA to establish itself in the conventional tools market (and prices it right), it could very well alter the market and its role in the market very significantly.

KAPPA is a very well thought-out tool. It seems to have more functionality than Nexpert Object, and it has a much better developer interface than either ADS or KBMS. With IntelliCorp's money, technical know-how, and marketing clout behind it, KAPPA could turn into a tool that would allow IntelliCorp to compete in the emerging

workstation/mainframe market against such companies as Aion and AICorp.

In other words, IntelliCorp could become a significant player in both the Lisp and the conventional tool markets and might even come to dominate both. It's certainly an interesting possibility. We'll let you know as soon as we find out exactly what IntelliCorp intends to do with its new acquisition.

## IBM Drops KEE and IBM Common Lisp

IBM has decided to stop marketing KEE/370. IntelliCorp will provide support and enhancements for the few customers who bought KEE/370 from IBM, and IBM agreed to fund some of the enhancements that IntelliCorp will make to the tool. IBM also decided to stop marketing its IBM Common Lisp, and turned support of that product over to its developer, Lucid.

We have never understood why IntelliCorp or IBM thought anyone would want to run Lisp or KEE on a mainframe, and apparently IBM finally reached that same conclusion. This does not mean that IBM is giving up on expert systems, of course. It simply means it intends to focus its expert systems efforts on products like TIRS and the knowledge based systems component of the AD/Cycle, which are more likely to gain IBM sales, and to position them for the future.

## MCC Begins to Sell Shares in Its Tool Development Efforts

When people first became concerned about expert systems in about 1985, many focused on the Japanese 5th Generation Computing effort. The fear that this effort would allow the Japanese to rush ahead of the U.S. in artificial intelligence prompted many programs both here and in Europe. One of the major U.S. efforts was the formation of the Microelectronics and Computer Technology Corp. (MCC) which is located in Austin, Texas. MCC is a joint venture of several U.S. companies charged with developing technology that will prove useful to its sponsors in the long term.

MCC initially required companies to take a full membership in the effort, at a cost of some \$3 million. In late 1989, MCC decided to unbundle membership fees and services, allowing companies to participate in specific programs for more modest sums.

Membership fees for specific programs range from \$175,000 to \$600,000. For the program-specific fees the company is given royalty-free rights to tools created and information gathered in the course of the program effort. In addition, individuals from member companies will have the opportunity to spend time at MCC and work with its

impressive staff members as they work to solve the key issues involved in bringing the next generation of AI products to market.

Several projects now underway at MCC might be of interest to companies who have previously regarded MCC's aims as too broad or expensive for their needs. The Object Oriented and Distributed Systems Lab, for example is working on OODBMS products. Texas Instruments, which had resisted full membership, has decided to sign up for the database project.

Of more interest to most companies involved in expert systems, however, is the work of the AI Lab headed by Elaine Rich.

Within the AI Lab are three separate projects: (1) an effort aimed at developing a common sense knowledge base that can be used with large expert systems, (2) a project focused on developing a number of very high quality natural language tools, and (3) a project focused on expert systems-building tools, called the Reasoning Architectures Project.

Apple Computer was one of the first companies to join MCC under the new arrangement. Apple signed up for both the common sense knowledge base project and the natural language project.

For those primarily interested in commercial expert systems, however, the Reasoning Architectures Project will probably prove most attractive. This program is exploring how best to design tools to create and manage knowledge-based systems. So far, the project has developed Proteus, a Lisp tool written in Kyoto Common Lisp (which means that the product can be compiled to C).

Proteus was developed as an experimental tool. Thus, it lacks the user interface facilities that most large commercial Lisp-based tools have. On the other hand, Proteus probably has the best truth maintenance facilities available (which it acquired from early work with Prolog). This makes the Proteus inference engine better at solving large design and scheduling problems than most of its commercial cousins.

At least one of the early MCC shareholders has already benefited from the Proteus research. NCR

developed a domain-specific product, Design Advisor, on top of Proteus which has proved very valuable.

In the next round of work, the AI Lab plans to continue exploring distributed reasoning and truth maintenance (to see how to develop a tool that can combine small independent knowledge bases) and making Proteus into a better core around which its members can build their own tools. It also plans to integrate Proteus with neural net technology. If the lab does the same thorough job here that it did on Proteus itself, it will probably come up with a very clean and powerful tool for manufacturing applications.

Companies already doing serious research into expert systems and neural networks or those who are just getting involved would benefit from participating in this MCC project. If you have the money, it's certainly worth exploring.

For more information, contact:

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## Index Group Survey Finds Expert Systems Are Hot

Each year the Index Group, Inc. does a survey of European and North American senior information systems executives to find out what their chief concerns are. In addition, it asks the executives to indicate what new topics or technologies are "hot."

In its 1990 survey of 243 executives, Index Group found that the top concern of IS executives was "Reshaping business processes through information technology." (In 1989 it had been "using IS for competitive breakthroughs," which fell to 8th place this year.)

The list of new developments were rated from 1 (no interest), 2 (may investigate), 3 (investigating), to 4 (in use or in pilot). This year's list of hot new developments reads:

- 3.6 Network management;
- 3.4 Computer security products;
- 3.3 Transparent PC-to-host interface;
- 3.2 CASE tools;
- 3.0 Distributed relational DBMS;

- 3.0 Expert systems;
- 2.8 Data repositories.

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# EXPERT SYSTEMS STRATEGIES™

The Monthly Newsletter for Managers and Developers of Expert Systems, from Cutter Information Corp.

Editor: Paul Harmon

## EXPERT SYSTEMS DEVELOPMENT

### THE SHIFT FROM RULE-BASED PROGRAMMING TO HYBRID DEVELOPMENT

Probably the most important technical change in expert systems development during 1989 and 1990 is the migration from rule-based, backward-chaining tools and systems to pattern-matching rule and object-based hybrid systems. This trend is occurring for two reasons. First, as developers move from smaller prototypes to mid-sized systems, they want the power and the clarity that the

hybrid tools offer. Second, good hybrid tools are now available in conventional languages.

#### Clarity and Power

When developing an expert system, you should be concerned with four things:

- ◆ Representing facts and relationships between facts;
- ◆ Representing heuristic knowledge that will allow new facts to be inferred from existing facts;
- ◆ Controlling the procedural flow of the consultation; and
- ◆ Creating an effective user interface.

In a simple rule-based tool, you represent both facts and heuristics as rules. Some rules establish facts and relationships, while other rules make inferences. In addition, most procedural control also gets embedded in the rules. Still other rules handle control issues. Consider the following set of rules:

```
Goal = recommendation
Rule1
If   type = VHS and
     heads = 4 and
     freeze_frame = yes and
     earch = yes and
     price = low
Then recommendation = VCX_1000.
```

```
Rule2
If quality_scanning = important
Then heads = 4.
```

```
Rule3
If   type = VHS and
     heads = 4 and
     freeze frame = yes and
     search = yes and
     price = medium
Then recommendation = Record_Mate99.
```

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```

Rule4
If   type = Beta and
     heads = 3 and
     freeze_frame = no and
     search = yes and
     price = low
Then recommendation = XMovie_Beta.

Rule5
If   type = VHS and
     heads = 5 and
     freeze_frame = yes and
     search = yes and
     price = high
Then recommendation = Super_Viewer_2.0.

Rule6
If   recommendation = UNKNOW
Then DISPLAY "Sorry, but no recommendation is
           available."
     recommendation = not_available.

Ask type: "What kind of VCR do you need?"
Choice type: VHS, Beta
Ask quality_scanning: "How important is
                    scanning quality to you?"
Choice quality_scanning: important, unimportant
(etc...)

MULTIVALUED: recommendation
    
```

This is a very simple knowledge base for a backward-chaining application to help a customer select a VCR system. In this application, all of the facts are either represented in rules or in statements added at the end of the rule set (e.g., "Choice type: VHS, Beta" indicates that "type" can take either of two values: VHS or Beta.) The heuristic is also captured as a rule. Control information is captured in the goal at the beginning of the rule base that initiates backward chaining, and in the sixth rule (a control rule) that determines if a recommendation has been reached. If no recommendation has been reached, this rule ensures that a statement to that effect is provided for the user.

Let's imagine that instead of representing this knowledge base in terms of backward chaining rules, we represented the factual knowledge as objects and then used rules for processing.

Having talked with our expert salesperson and gathered a number of unstructured rules like those above, we'd create a class object. The class object's name would be VCR and it would have five attributes or slots: type, heads, freeze frame, search, and price. Each of these slots would have multiple values, thus:

```

Class: VCR
Parent: (none)
Instances: VCX_1000, Record-Mate99, Movie_Beta,
           Super_Viewer_2.0.
Slots: TYPE: VHS, Beta
       HEADS: 3, 4, 5
       FREEZE_FRAME: yes, no
       SEARCH: yes, no
       PRICE: low, medium, high
    
```

Next we would create four instances. All we would really have to do is give the instances names; they would inherit the slots. Then we would have to assign specific values to the slots, thus:

```

Instance: VCX_1000
Parent: VCR
Slots: TYPE: VHS
       HEADS: 4
       FREEZE_FRAME: yes
       SEARCH: yes
       PRICE: low.

Instance: Record_mate99
Parent: VCR
Slots: TYPE: VHS
       HEADS: 4
       FREEZE_FRAME: yes
       SEARCH: yes
       PRICE: medium.

Instance: XMovie_Beta
Parent: VCR
Slots: TYPE: Beta
       HEADS: 3
       FREEZE_FRAME: no
       SEARCH: yes
       PRICE: low.

Instance: Super_Viewer_2.0
Parent: VCR
Slots: TYPE: VHS
       HEADS: 5
       FREEZE_FRAME: yes
       SEARCH: yes
       PRICE: high.
    
```

We would also need to add one simple heuristic:

```

Rule1
If quality_scanning = important
Then heads = 4.
    
```

In other words, there isn't much inferencing involved in our problem; it's mostly just factual information. All of the factual information would be saved as a class object and four instances of that class. We would also need to create some procedural commands. Let's assume that we had an agenda with steps. It would read:

```

AGENDA
step1 ASK: "What kind of VCR do you need:
           VHS or Beta?"
    
```

- step2 ASK "How important is scanning quality to you?"  
 step3 ASK "Do you want to be able to freeze a frame?"  
 step4 ASK "Do you need search ability?"  
 step5 ASK "What price do you want to pay: low, medium, or high?"  
 step6 FORWARDFIRE Rule1  
 step7 DISPLAY Names of all valid instances

If we wished, we could use object-oriented programming and add methods to our object to eliminate the rule and most of the agenda steps.

There is a sense in which a small backward-chaining system is easier for a newcomer to create — you simply write rules. As the system starts to get bigger, however, the small rule base becomes more confusing. You start having rules with all kinds of different attributes, and you need to begin writing rather complex control rules. Moreover, since inferencing takes time and memory, the system slows down as more rules are added.

At some point, the hybrid approach becomes much simpler. You can represent the factual knowledge as objects. Objects have the advantage of mapping directly to things in the real world. There really are VCR objects; the expert salesperson knows exactly what you mean when you talk about different kinds of VCRs having different characteristics.

As the number of objects grows, you can create hierarchies that show the logical relationships between different types of objects. The objects maintain clarity about the facts being represented in the knowledge base, and they make it easy to edit the factual structure of the system.

At the same time, you reduce the number of rules. Moreover, since you represent specific examples as instances, you can write pattern-matching rules that can examine all of the instances of a class object, or do joins and find commonality among the instances of more than one class object. (See Vol. 5, No. 12 for a detailed discussion of pattern-matching and joins.)

In our example, if we wanted to write a rule that listed the VCRs that are VHS systems, we could write the following rule:

```
Rule2
If ?VCR is a VCR and the type of the ?VCR is VHS
Then
ADD ?VCR to list.
```

The first clause simply instructs the inference engine to bind any instances (?VCR) of the class VCR and to add the name of that instance to a list if the value of that instance's TYPE attribute is VHS. The inference engine would try this rule with every VCR instance, one after another, until it had examined all instances. Since our system has four VCR instances, this rule would fire four times and put the names of three instances on the list.

The power of pattern-matching rules alone justifies creating classes and instances in order to ensure that you can use pattern-matching rules whenever you need to. If you wanted to add this same functionality to our initial backward chaining rule base, you would have to write four rules, one for each kind of VCR in the knowledge base.

Some developers will continue to use rule-based systems; those systems will certainly remain popular with managers and technical people who are non-programmers. Most MIS programmers, however, will move to hybrid tools to get the added power and clarity of object hierarchies and pattern-matching rules.

## The New Hybrid Tools

In 1985, when most of us were just beginning to experiment with expert systems building tools, we really had only three options:

- ◆ low end PC tools that used rules and did backward chaining (M.1, Level5, Personal Consultant);
- ◆ VAX OPS5 running on DEC equipment (a forward-chaining, pattern-matching language that used rules and a limited object system); and
- ◆ the hybrid Lisp-based tools like ART, KEE, and Knowledge Craft.

Those who didn't want to learn Lisp or buy specialized hardware were largely confined to the backward-chaining, rule-based tools. Some brave souls who used DEC machines tried OPS5 (which was written in BLISS), but in 1985 OPS5 was much more like a language than a tool. Moreover, the syntax made it an awkward language, so most new developers chose to avoid OPS5.

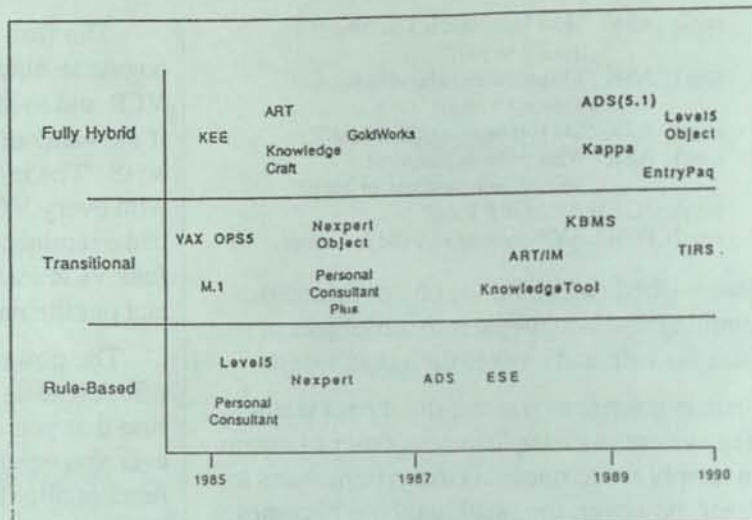
The first tools that really opened up possibilities beyond rule-based programming were Nexpert Object and Personal Consultant Plus. Un-

fortunately, their lack of pattern-matching rules that could do joins between objects, and their limited object-oriented programming capabilities constrained their users.

By 1989, however, several tools had been written in conventional languages that supported both the complete object-oriented programming paradigm and provided pattern-matching rules that could do joins between objects. Aion's ADS, IntelliCorp's newly acquired Kappa, and Information Builder Inc.'s Level5 Object (in Beta testing in 1989) all provide the power necessary to support the pattern-matching rules and offer complete object-oriented programming environments.

Figure 1 lists only a few representative tools. On the horizontal axis we have indicated when the tools were introduced. On the vertical axis we suggest whether the tools were essentially rule based, transitional, or fully hybrid. The way each tool is placed within its band does not signify anything.

For the purposes of Figure 1, "transitional" tools either lack pattern-matching rules that can do joins, or they lack an object-oriented programming environment which includes class methods and message passing, or both. Lisp-based tools are



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Figure 1 — The Evolution of Generic Expert System-Building Tools in the U.S.

shown in regular type, while tools written in conventional languages like C and Pascal are indicated in bold type. Obviously KEE and the other large Lisp tools have offered fully hybrid environments since 1985, but they have not had the impact that fully hybrid conventional tools have had in the last year or so.

As 1990 evolves and programmers become familiar with both pattern-matching rules and object-oriented programming in the latest tools, we expect the trend toward hybrid programming to continue. Indeed, by 1991 we expect that rule-based programming will be much less common among programmers than hybrid programming.

## BOOK AND TOOL REVIEW

### DEVELOPING EXPERT SYSTEMS AND ENTRYPAQ

We've read lots of books on developing expert systems (and we've even written a couple), but until now we have never known of a book we could recommend to developers that provides a step-by-step introduction to programming expert systems.

**Developing Expert Systems: A Knowledge Engineer's Handbook for Rules & Objects** by Edmund C. Payne and Robert C. McArthur (Wiley, \$34.95) is the first good book for developers who want to know exactly how to go about building a

mid-sized to large expert system. This book is bound to become the bible of knowledge engineers. Everyone who is either engaged in developing or considering developing an expert system should rush out and buy this book.

In addition, there is a tool, EntryPaq, that you can buy to supplement the book. If you have a Mac or can borrow one, buy EntryPaq as well. There's nothing else like either one of these products on the market.

Ed Payne and Bob McArthur started out at Arthur D. Little, where they were among the co-founders of ADL's original AI group. Later, Payne worked for IntelliCorp, where he led the design team that developed SIMKIT. In 1986 they formed their own company, Albathion Software. Between them, Payne and McArthur have helped develop several of the large, sophisticated systems that have been built in the last five years. In 1988 they developed AXLE, an interactive software training package that sits on top of GoldWorks and guides developers through the process of creating four expert systems. We reviewed AXLE in 1988 (Vol. 4, No. 5) and were very impressed. At the time we said that it was the only software tutoring package that could get the user beyond the toy project stage.

Now, McArthur and Payne have written a book that is just as impressive as AXLE. *Developing Expert Systems* is organized around the development of an application that looks for signs of problems, diagnoses them, and then makes recommendations for repairs. The application solves quality control problems that previously existed at a canning plant. The book begins with a discussion of the canning plant problem and then follows two consultants as they work through it in a step-by-step manner.

McArthur and Payne assume that their readers will be using a hybrid tool, and that they will want to represent the facts as objects and the heuristics as rules. Moreover, they assume that the tool will provide an object-oriented programming environment that will support the development of sophisticated user graphics. Two years ago, the approach these authors advocate would have required a Lisp-based tool like KEE or GoldWorks. Today, however, their approach is fully compatible with tools like Aion's ADS and IBI's Level5 Object.

Payne and McArthur start by evaluating the suitability of the project, then move on to scoping and defining the project. Next, they develop their initial set of rules, then the initial class objects (EntryPaq calls them "Frames"). Next, they show how the developer moves back and forth between the initial rules and the objects to refine the core of the system.

As they expand the system, they begin to explore the tradeoffs between writing more rules and using object-oriented programming (methods, mes-

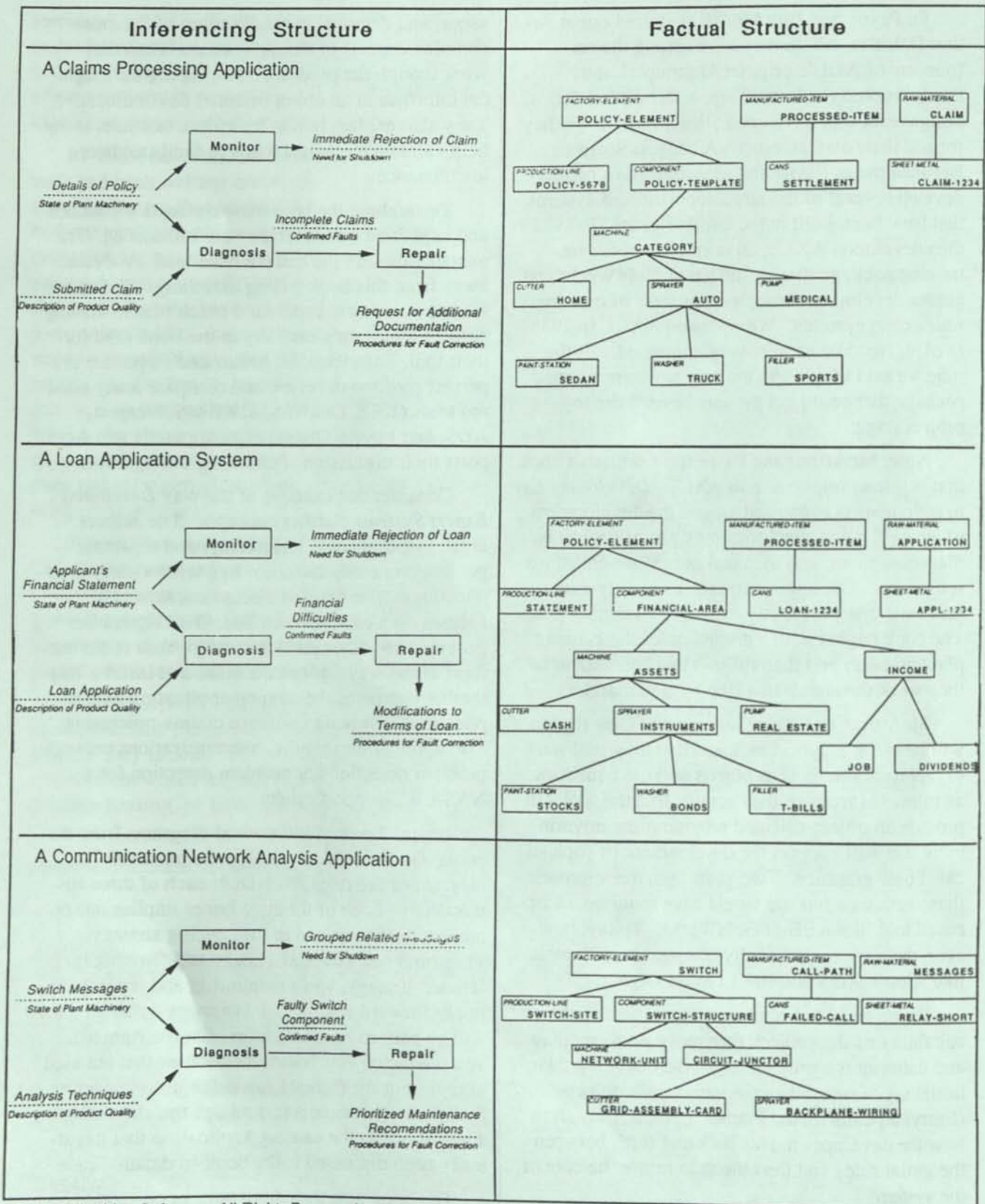
sages, and demons) to handle some of the more complex aspects of the application. Then they work through the process of developing the graphical interface in an object-oriented environment. They also explain how to develop a test suite to help validate the program and to facilitate later maintenance.

Throughout the book, new concepts are defined and explained whenever they are introduced. The explanations are the best we have read. We came away from this book feeling that things we thought we knew, we now understand much better. Having defined their terms carefully in the book (and for their tool, EntryPaq), McArthur and Payne are in a perfect position to review and compare many standard tools (KEE, GoldWorks, KBMS, Nexpert, ADS, and Level5 Object) in an appendix that supports their discussion of choosing the right tool.

Consider one example of the way *Developing Expert Systems* clarifies concepts. The authors argue that diagnosis, monitoring, and repair are generic processes that occur in a wide variety of applications. The detailed discussion, however, focuses on a canning plant line. To help readers generalize to other problems, they pause about one-third of the way through the book and insert a chapter that compares the canning application with applications involving insurance claims-processing, loan application analysis, communications network problem detection and problem detection for a NASA life-support system.

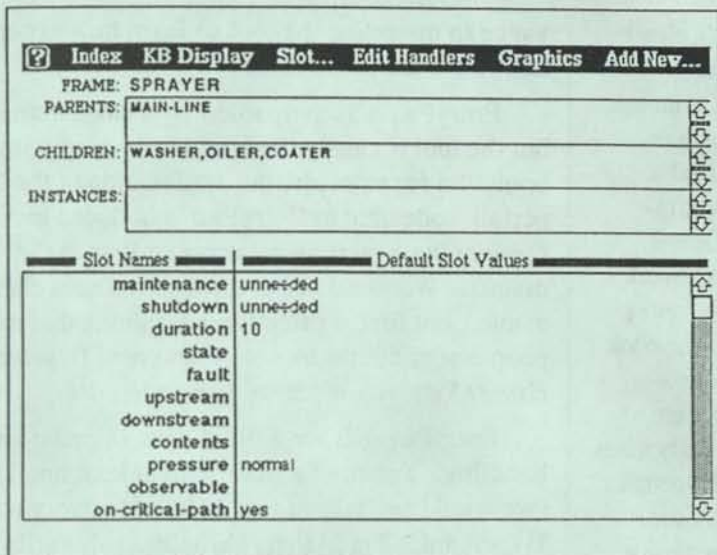
Figure 2 reproduces several diagrams from the book. On the left side you see the top level diagram of the rules involved in each of three applications. Each of the three boxes implies one or more sets of rules and an inferencing strategy. Thus, diagnosis implies a backward-chaining inference strategy, while monitoring and repair both imply forward chaining. It is assumed that all rules will be pattern-matching rules. On the right side you see the object (frame) hierarchies that are used to represent the factual knowledge used in each application. The smaller text relates the alternative applications to the canning application that has already been discussed in the book in detail.

The book also includes a very good section on model-based reasoning and on interfacing with the outside world. In addition to the tools appendix, it also contains appendices that provide a brief over-



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Figure 2 — Diagrams from Payne & McArthur's *Developing Expert Systems* illustrating how four different applications are analyzed.



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Figure 3 — EntryPaq screen for creating class objects (frames).

use to explore the development of the canning application in detail. The result was EntryPaq, a tool that runs in Hypertalk on a Mac.

EntryPaq is very impressive. We are tempted to say that it is KEE for the rest of us. Not only does it provide a reader with an inexpensive way to explore expert systems development, it could easily become the best selling small Mac tool.

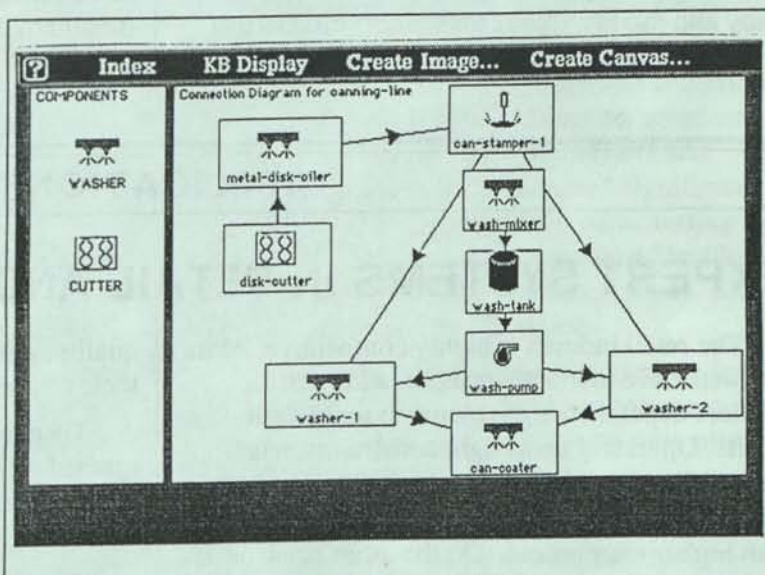
EntryPaq offers forward-chaining, pattern-matching rules, rule sets, and control over rule firing order. You can write rules in EntryPaq that do

view of Lisp, an overview of Hypertalk (the programming language of Hypercard which is used throughout the latter half of the book to illustrate programming commands), and extensive notes on the knowledge base which is built during the course of the book.

Unlike AXLE, which presented a complete introduction to both planning and scheduling problems and diagnostic and monitoring problems, *Developing Expert Systems* focuses only on the development of diagnostic, repair, and monitoring systems. The book does not cover configuration or planning and scheduling systems. Given the detail in which Payne and McArthur discuss the development of a diagnosis and monitoring application, they could not possibly cover configuration and planning in the same book. (Everyone who reads *Developing Expert Systems* will probably join me in hoping that these two will decide to write a second book that covers configuration and planning and scheduling in the same way the present book covers diagnosis, monitoring, and repair.)

In addition to writing *Developing Expert Systems*, McArthur and Payne decided to create a small expert systems-building tool that readers could

joins on the instances of different objects. It also has objects with multi-valued slots, and facets, message passing, multiple inheritance of slots and methods and demons. It provides object graphics, rule-driven menus, and graphic displays of the objects in the knowledge base. You can also create links between EntryPaq rules and Excel spreadsheets, and you can create fine user interfaces using this tool. In other words, EntryPaq offers more capabilities than most of the high-end C tools on the market.



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Figure 4 — EntryPaq screen illustrating a graphical interface.

Although EntryPaq is inexpensive, it's clearly an advanced product. A KEE programmer will feel more comfortable with this tool than someone who is just beginning to learn about expert systems. If you're a programmer and interested in learning about serious expert systems development, however, this is the way to do it. Get *Developing Expert Systems* and EntryPaq. Work through the tutorial and then through *Developing Expert Systems*, creating each example in the book in EntryPaq. You will end up with a graduate-level understanding of how expert systems are designed and developed. The system obviously relies on the capabilities of Hypertalk, and, like Hypertalk, it is slow. It would probably work well only for rather small commercial applications where time is not critical. But the tool wasn't intended for commercial systems development, it was designed to teach people how to develop expert systems, and it provides an outstanding environment for learning about the technology and for exploring and prototyping applications.

EntryPaq comes with two versions of the canning line diagnosis system created in the course of *Developing Expert Systems*. One is inside the development environment so it can be modified. The other is set up without the development environment, in the manner in which you would prepare an application for delivery.

The entire system, including the source code of the inference engine, is available to the user to study and modify. You can begin to use this tool to learn about developing expert systems, and ad-

vance to dissecting the tool to learn how expert systems tools are constructed.

EntryPaq is accompanied by a small manual, but the tool is clearly designed to be used with the book. So for example, the explanation of the Hypertalk code used in EntryPaq is included in *Developing Expert Systems* rather than in the manual. We would like to have seen a more elaborate manual, but for the price (and assuming that most people who use the tool will also read *Developing Expert Systems*), it seems quite adequate.

EntryPaq sells for \$79.95 plus shipping and handling. You need a Mac with at least one MB (we would say at least two MB) of memory and Hypercard 1.2 or higher. Albathion also sells the manual and the book together for \$100, plus shipping and handling.

EntryPaq is the most cost effective expert systems tool we've ever examined. At last, the power of the Mac environment has been fully integrated with Hypercard, inferencing, and OOP, and is priced to sell.

The instructional quality of *Developing Expert Systems* coupled with the high power and low cost of EntryPaq should guarantee that this book and tool combination become the basis of many commercial and academic expert systems training programs in the next couple of years.

To purchase either EntryPaq or the book/tool combination, contact: Albathion Software, P.O. Box 7926, San Francisco, CA 94120-7926; (800)338-0364.

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## APPLICATIONS

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### EXPERT SYSTEMS IN RETAIL AND SALES

The retail industry is highly competitive. Most products have low profit margins and most retailers depend on high volume to make their profits. Operating under tight constraints, retailers are usually slow to adopt new technology — they simply can't afford to take the risks that companies with higher margins can. On the other hand, once a new technology proves it really can help minimize overhead, improve service, or help maintain

quality, retailers move quickly to try to improve their competitive position.

Therefore, although retail companies generally ignored the early enthusiasm for expert systems, some of the large retailers are now moving to take advantage of the benefits that expert systems offer.

The primary functions that retailers have identified for expert systems include:



1. Sales Analysis and Inventory Planning;
2. Market Analysis and Promotion Planning;
3. General Management Support; and
4. Sales Support.

Today, retailers are applying expert systems to such areas as merchandise buying, employee scheduling, production planning, and problem diagnosis. These systems are particularly well suited for "intelligent retrieval" applications like market analysis and promotion planning that depend on the use of large amounts of information maintained in company databases.

Increasingly, expert systems are being used as a means of freeing management from time-consuming administrative tasks, thereby allowing more time for customer service and staff support, and for ensuring that company standards are consistently implemented.

Here are 14 examples of expert systems that are helping retailers to better meet their goals:

### 1. Sales Analysis and Inventory Planning

Buy, sell, and restock are the underlying principles of retail, but the actual decision process involved in acquiring new merchandise contains many complex variables. To avoid ending up with too many swim suits in September, a merchandiser must consider such factors as seasonality, pricing, quantity, and consumer preference when making a purchasing decision. Also, this process must be applied to not just one, but thousands of different articles.

Like any expert, the knowledgeable merchandiser obtains his or her skills mostly from experience. The introduction of knowledge-based expert systems in retail is changing the way merchandising is done.

**AREA SALES MANAGER EXPERT SYSTEM CONSULTANT.** The Broadway-Southern California Stores, a division of Carter Hawley Hale, Inc., recognizes the potential for expert systems in the area of merchandising. The Broadway has introduced the Area Sales Manager Expert System Consultant (ASMESC) into its 43 southern California owned and operated stores. Through the use of a computer-based dialogue, the application enables the company's 645 area sales managers to analyze their skills and past records in areas such as staff-

ing, sales techniques, motivation, floor layout, and product knowledge and procurement.

Serena Kokjer, corporate vice president, IMS, for Carter Hawley Hale, has described the area sales manager as "a jack of all trades, expected to manage sales associates, analyze sales reports as if they had a computer for a brain, and be able to read the minds of a very fickle public." Developed with IBM's ESE, the application captures the collective expertise of The Broadway's top area sales managers who have consistently produced the best results.

To run the system, a user first selects the area or areas to be analyzed — staffing and sales techniques, for example. Then, company data concerning monthly sales, average sales per hour, forecasted sales, and the previous year's sales, etc., are entered. The user is alerted to sources for the input data by a series of "WHAT" prompts with instructions as to exactly where they will be able to acquire this information. The user then enters into a consultation with the system through a series of questions such as, "Do you communicate regularly with your buyers?" and "How would you rate your own selling techniques?"

After going through a one or two hour consultation, the system provides a sales manager with a detailed business analysis that includes specific "management" tips targeted at what it has determined are his or her most pressing problems. In this way, sales managers are alerted to any problems they may have — for instance, the need to assign sales personnel more effectively.

The benefits of the system were realized immediately. During the three month testing program the company conducted at its Santa Anita and Fashion Valley stores, sales increased significantly. Management estimates for the initial testing period showed that, had the system been installed at that time in all 43 of the company's stores, sales would have increased by \$6 million.

Store management also noted an increase in employee productivity; as sales managers working at the test stores started spending more time planning, they became better managers.

The Broadway introduced ASMESC into its other 41 branches about a year after the initial testing took place. The company operates the system on a mainframe using a MVS/TSO environment.

However, a PC-based version has recently been installed in Carter Hawley Hale's San Francisco-based Emporium stores.

In the future, Carter Hawley Hale senior management would like to see the system deployed in all 114 of the company's stores. Dan Nowlin is executive vice president - stores for The Broadway and a firm believer in knowledge-based systems. Says Nowlin: "to justify the system, we need to see an increase of .5% over our projected financial plan ... We're way north of that already."

The success of the ASMESC has led Carter Hawley Hale to begin developing other knowledge-based expert systems. Already in the works is a system to help refine the reordering of stock items. Look for more news about expert systems in retail from Carter Hawley Hale.

**BUYER'S WORKBENCH.** Deloitte & Touche, a Seattle-based management consultant group, has developed an expert systems application that captures a seasoned buyer's expertise. Associated Grocers, a Pacific Northwest chain providing buying services to its 400 member supermarkets, is evaluating the system designed to support its buyers in making buying decisions.

Developed with Neuron Data's Nexpert Object, Buyer's Workbench translates a seasoned buyer's knowledge into a set of rules, classes, and objects that form the knowledge base for the system. The system works in conjunction with a PC-host server running on a LAN that allows access to mainframe-based DB2 data via an SQL Windows/Microsoft Windows interface.

To access the system, a buyer first retrieves a list of potential purchases (items) to be evaluated. A selected item is then highlighted, displaying pricing information that includes such "tips" as manufacturers' specials and best buys. The item is then evaluated with the "expert" knowledge via the rules maintained in the system's database.

In this manner the buyer is provided with recommendations on the commercial viability of a particular item, and can either issue or decline a purchase order. The graphical environment of Windows allows the data to be presented in an organized and easy-to-understand format.

Ben Maguire, Deloitte & Touche senior consultant and project manager for the application, noted that the Buyer's Workbench provides for several competitive advantages: "The proposed system allows a consistent approach to making buying decisions, increases productivity based on the ability of computers to rapidly evaluate large quantities of data, and extends the breadth and depth of buyers who are responsible for making decisions based on large amounts of data."

The objective of Buyer's Workbench is to allow retailers to make sound investments by more accurately predicting the success of their buying decisions. The system also enables the inexperienced buyer to draw on the expertise of a more knowledgeable and seasoned merchandiser.

For more information, contact: Blanc & Otis Public Relations, 100 Spear, Suite 425, San Francisco, CA 94105; (415)546-8080.

The Hudson Bay Company, Canada's oldest and largest retailer, is presently using expert systems in several areas.

**SALES MANAGER COACH.** Managers are using this system to conduct the review of yearly and monthly sales totals, and as a sort of "store expert" that provides advice on store management problems (for instance, the best means of recovering from an over-expenditure.)

**MERCHANDISING COACH** is being used in the buying offices for expense management and analysis of gross profit margin. The system provides helpful advice in such areas as vendor negotiation, shopping the competition, and assembling a sales department strategy for a coming year.

Both systems were developed on a PC using Aion's ADS and are now running on mainframes.

Robert Love, manager for computer-based training and expert systems development, The Hudson Bay Co., identified four significant benefits to be gained from expert systems: "consistent analysis of business, application of expert advice to all locations, greater productivity gains through better business analysis, and better use of time by management." The Hudson Bay Co. is a multinational corporation committed to providing products for many different customers in different markets.

Love believes that expert systems will continue to play an important role with his company.

## 2. Market Analysis and Promotion Planning

In the area of market analysis and planning, expert systems are being used to help consumer packaged goods companies analyze and report on scanner data. This is an application area we like to refer to as "intelligent retrieval."

**COVER STORY.** Information Resources, Inc. (IRI) has announced the release of Cover Story, an application developed to make sense of all the product sales and popularity data now generated by supermarket scanners and other sales information systems.

Market analysts spend hours of precious time collating product information from thousands of supermarkets to help direct promotion and sales of selected goods. By conducting a first analysis of market data, Cover Story allows marketers to spend more time managing their business and less time shuffling numbers.

Running on a PC, Cover Story can instantly extract key information from mainframe scanner databases and present it in an easy-to-read, desktop-published memo with illustrating graphs and tables, complete with generated text and headlines. Cover Story can report on market trends, competitors, and market share gains and losses, in the order pre-determined by a model-directed knowledge base.

IRI does not intend Cover Story to replace analysts, but rather to help them retrieve core information about a product and ensure that the right questions are asked concerning market viability.

"Cover Story mimics the way brand managers and marketing managers look at their data, allowing them to spend less time in reaching a decision," said Beth Christopher NeCamp, IRI marketing spokesperson.

The application was written in IRI's fourth generation language, Express, and can be used with IRI's own InfoScan product database, or with other syndicated scanner databases such as Nielsen Scantrack or SAMI Samsan.

Cover Story was developed by John Little, professor of management science at M.I.T., and has been in testing for one year. The system is now ready for national release and is available in

conjunction with both IRI's InfoScan and Data-Server, with just InfoScan, or by itself. Cover Story costs \$75,000 for the introductory fee, then \$25,000 for each additional year. For more information, contact: Beth Christopher NeCamp, Information Resources, Inc., 150 Clinton Street, Chicago, IL 60606; (312)726-1221.

## 3. General Management Support

The fast food industry is applying expert systems to such areas as employee and production scheduling, and customer service and staff support.

Mrs. Fields Cookies has taken a different approach to using expert systems. While other companies are focusing primarily on using expert systems in merchandising, Mrs. Fields is using a "floor level" approach. "Our primary goal," says Randy Fields, president of the company, "is to allow expert systems to free the store manager from administrative duties and paperwork, so he can better focus on his customers and staff."

In meeting this goal, Mrs. Fields has developed and deployed no less than four PC-based, expert systems applications to automate administrative tasks ranging from screening prospective employees and planning employee scheduling, to production planning and computer-aided instruction.

**INTERVIEWER** is an application that provides managers with a preliminary interview to help identify prospective employees. Compiled in Basic, the system asks an applicant a series of approximately 80 true/false and multiple choice questions for full-time, part-time, store manager, district manager, and regional manager positions. Interviewer makes interviewing more consistent, thorough, and efficient. This automated interviewer provides a preliminary screening of job applicants, enabling a store manager to determine whether or not a further interview is necessary. The system not only saves time by eliminating unnecessary interviews, but also ensures that company policy concerning employee hiring is consistently maintained.

**PRODUCTION PLANNER**, also written in Basic, is a rule-based expert system that projects production needs based on sales input for selected products. The system can be revised according to actual sales of the product over a certain time period, allowing more precise planning.

**LABOR SCHEDULER**, written in C, embodies the knowledge of the company's 10 or so best labor scheduling experts into a system of 750 to 1,000 rules. By taking into account the sales history of a particular store by product, the system enables a store manager to better assign employee tasks at any given store. The benefits are increased productivity and time saving. Before the system was introduced, district managers trained store managers to do scheduling for each store. Now the managers can better utilize their time.

**ELECTRONIC FORM PLANNER** is a system being used in the home office to do away with unnecessary paperwork.

Mrs. Fields has found expert systems so valuable, that it has created its own software division to sell its applications. The Fields Software Group numbers several well-known food chains as well as Fox Photo among its clients. As for the future of expert systems at Mrs. Fields, the company foresees another 25 projects in development over the next two years.

The use of expert systems has allowed Mrs. Fields to implement company-wide standards throughout its nearly 650 nationwide stores, and to save money by reducing training time. "But the greatest benefit we've realized from expert systems," says Randy Fields, "is the huge reduction in the amount of time our store managers spend away from their customers and staff." For more information, contact: Paul Quinn, Mrs. Fields, Inc., P.O. Box 400, Park City, UT 84060; (801)649-1304.

Wendy's International, Inc. is using an expert system to help its service representatives respond quickly to questions from staff at nearly 1,200 company-owned restaurants.

Until recently, service representatives at Wendy's Field Operations Support Center in Dublin, Ohio, had to rely on two to three months of training and on cumbersome service manuals to diagnose problems and provide solutions. The new system allows service reps to trouble-shoot problems involving such things as point-of-sale terminals, time clocks, and wireless headsets. It not only helps assist experienced reps in solving problems, but also acts as a training tool for new staff.

Bruce Stabile, Wendy's director of information systems, says, "Our productivity has increased as has the consistency in solving problems. The system will often lead the service reps from problem to solution in a matter of minutes."

The system, created with 1st Class Expert Systems' tool, 1st-Class HT, runs on IBM PS/2 Model 30 systems and was developed by members of Wendy's Professional Computing Center and selected Field Operations Support Center staff. E-KE, Ltd, Expert Systems Knowledge Engineers of Dublin, Ohio, recommended the use of 1st-Class Fusion to build the prototype and 1st-CLASS HT to enhance it with hypertext. The system took four months to develop and has been in use since June 1989. Future plans at Wendy's International call for further use of expert systems to help with a variety of management and administrative needs. For more information contact: 1st-CLASS Expert Systems, Inc., 526 Boston Post Road - 150 East, Wayland, MA 01778; (508)358-7722.

#### 4. Sales Support

Using expert systems to support sales efforts is an area that is sure to grow rapidly in the years ahead. There are two trends within this broad category: (1) using expert systems to help professional salespeople sell to corporate clients, and (2) helping the customer choose a product from a retail merchant.

First let's consider helping salespeople. The two systems we've listed are particularly interesting because they have helped the companies that developed them either to enter a completely new market (DuPont), or to expand existing sales operations to new territories (Johnson Wax).

**WAREWASH EXPERT DIAGNOSIS SYSTEM (WEDS)** is an expert system designed to assist salespeople in evaluating a restaurant's cleaning and sanitation requirements. Professional Integration Sanitary Management, a subsidiary of S.C. Johnson Wax, uses the system to assess a restaurant's cleaning problem and offer the correct machine and chemical solution.

Annette Oleson-Wiles, manager of Knowledge Engineering, said that "WEDS functions as a training aid to help familiarize salespeople, who may have little or no knowledge of restaurant cleaning requirements, with the problems involved in

evaluating any restaurant sanitization problem." This has allowed the company to begin selling restaurant cleaning products in new markets.

Developed with the Aion's ADS (5.0), the system was deployed in January 1990 and runs on PCs and laptop computers in the field. Presently, the system is for internal use only.

For more information, contact: Annette Oleson-Wiles, Manager of Knowledge Engineering, S.C. Johnson Wax, 1525 Howe St., Racine, WI 53403-5011.

**PACKAGING ADVISOR** helps users design plastic containers and then select the most cost-effective resins from which to fabricate them. When DuPont decided to introduce its line of "Selar" resins in 1987, it faced a challenge. Two other companies, one of which was considered the technical leader in resins at the time, were already firmly established in the market.

In order to establish itself as a technical leader and capture a share of the market, DuPont created Packaging Advisor, an expert system that simplifies the task of analyzing and designing food containers, and provides information on all available resins, both DuPont's and the competition's. DuPont's salespeople provided Packaging Advisor to their potential customers. This allowed packaging designers to create container specifications more quickly than before. In this way, DuPont was able to develop a customer base quickly and establish itself as a leader in resin technology. DuPont has now acquired some 30% of the U.S. resin market, and attributes much of this success to Packaging Advisor.

Packaging Advisor was developed using Information Builders Inc.'s Level 5 development tool, and runs on a PC. The system is also unique because it is the first time, to our knowledge, that a marketing campaign has been planned around an expert system.

Expert systems have also been used to help retail customers, although there are problems with providing access to the systems, since most customers are not computer literate. This area will probably expand in the next few years as computers become cheaper and friendlier and incorporate video output capabilities.

One large retailer has informed us of possible plans to develop an "Expert Bridal Registry" that would operate in conjunction with video. Other prospects might include stereo and automotive parts sales. Here are two applications that explore the possibilities:

**SOPHINA**, developed for use by Ka-oh Corp., Japan, is an expert system designed to be used by cosmetics customers while shopping in large department stores. Ka-oh Corp., a large cosmetics company, uses the system to explain, diagnose, and recommend advice on the nature of skin problems that include rough skin, sunburn, and pimples.

Sophina has a knowledge base that contains data on the skin conditions of about 160,000 different women. Using a theory of skin physiology developed at the Ka-oh laboratory, the system analyzes and explains skin conditions.

**SIMPLIFIED NEEDS ASSESSMENT PROFILE (SNAP)** is an expert system that functioned as an "Expert Sales Assistant." SNAP is particularly unique because it is the first application of an expert system to be fielded for public use.

Introduced in 1985 at Infomart, the world's first information processing center, SNAP helped first-time computer shoppers assess their computer needs. By entering into a 20 minute consultation that included such questions as: "What kind of business do you have?" and "Do you want to communicate with other locations?," SNAP was able to configure a customer's computer needs. At the end of the consultation, the customer was presented with a printed summary of the needed configuration, including a directory of dealers at Infomart that could supply the necessary items.

Although the system ceased to be used about three years ago, it was considered a success, according to Mike Weinnig, vice president of systems and services at Infomart. It appears that the system needed to be updated as more and more computer products entered the market. In all likelihood, this and the expected cost determined that the system not be upgraded. Infomart has since donated SNAP to the Boston Computer Museum.

Boeing Computer Services developed SNAP for Infomart using Texas Instrument's Personal Consultant. The system ran on PCs. For more in-

formation contact Texas Instruments, Inc., P.O. Box 2909 M/S 2222, Austin, TX.

## Summary

Expert systems are increasingly being used to solve management and store level problems. This technology can more effectively predict the outcome of decisions that increasingly depend on the manipulation of large amounts of data being churned out by MIS departments. In the process, management is finding that time saved in automating various administrative tasks is reaping benefits in the areas of better production planning, marketing and forecasting, increased employee productivity, and company-wide dissemination of knowledge.

Both Carter Hawley Hale and Deloitte & Touche have successfully integrated expert systems and databases to aid retailers in automating investment decisions. Other companies are surely implementing similar systems or will be doing so shortly.

Some companies have found expert systems to have additional "spin-off" benefits. DuPont has used its Packaging Advisor to enter an entirely new market. Johnson Wax's system has allowed the company to expand its sales of restaurant cleaning systems into new

territories. And Mrs. Fields has founded its own software division to market its applications.

The future will continue to see more expert systems being used in retail applications. The very competitive nature of the industry supports their development.

Also, several upcoming conferences will hold seminars and workshops on expert systems in retail: RETAIL SYSTEMS '90 will take place May 22 - 24, Infomart, Dallas, Texas. This conference will include several sessions on developing expert systems for retail applications. For more information contact: Thomas H. Friedman, P.O. Box 312, Newton Highlands, MA 02161; (617)527-4626, Fax: (617)527-8102.

RISCON '90, the Retail Information Systems Conference, being sponsored by The National Retail Merchants Association, will take place October 14-17 in St. Louis, Missouri. The conference agenda will include several sessions on expert systems in retail (see Calendar).

For more information, contact: John E. Chay, V.P., Information Systems Division, NRMA, 100 West 31st St., New York, N.Y. 10001; (212)244-8780.

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## TRENDS AND NEWS BRIEFS

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### GoldHill Computers Restructures

GoldHill Computers has reduced its staff to about 10 people. The reduction is a direct result of slow sales of GoldWorks. The market for PC-based Lisp tools has declined steadily over the past year. In spite of its inability to improve its sales, GoldHill intends to continue to sell Lisp for the PC and support people who have purchased GoldWorks. Celia Wolf, Gold Hill's new COO, explained it this way: "The Lisp market is growing much slower than we expected, so we've had to cut

back, like Lucid, Symbolics, and IntelliCorp have done earlier. But we're not going to go away; we're going to return to profitability just like Lucid and IntelliCorp have done. We've reduced our staff so that we can live on our cash flow and support our customers while we figure out the best strategy for GoldHill Computers in the 1990s. Our main concern right now is taking care of our existing customer base."

## Associations for Expert System Developers

Developers who are creating expert systems need someplace to meet and exchange practical ideas. On the national level this need has yet to be filled, although several groups are trying. Two that stand out are:

- ◆ The International Association of Knowledge Engineers. This group publishes a journal, *Heuristic* and a newsletter. It has an office in Washington D.C. and puts on an annual conference in October in San Francisco. (See Calendar.)
- ◆ The IEEE Task Force on Expert Systems. The task force operates within the Computer Society. This group is trying to develop an IEEE program focused on the practical problems of developers. It is working on standards and has an annual conference which is scheduled for Washington D.C. in September (See calendar.)

In addition to those focusing on developing national meetings, several active local meetings have become established. Among the best known are:

- ◆ DVAIA — The ACM Delaware Valley Special Interest Group on AI. This group sponsors local meetings and has a newsletter. It meets on the

third Wednesday of each month, September through June. For more information, contact Kathy Erkert, The Matrix Organization, 950 W. Valley Road, Suite 2602, Wayne, PA 19087; or call Elizabeth Caine at (215)561-4200, ext 268.

- ◆ SMART FS — A New York group that focuses on expert systems in the financial industry.
- ◆ BAX-F\$ — A San Francisco (Bay Area) group that focuses on expert systems in the financial industry. It produces a newsletter. Its upcoming meetings include:

March 28. Topic: IBM's TIRS (The Integrated Reasoning Shell);

April 25. A PC-Based Voice Response System; and

May 30. Demo of HyperX Expert System Shell and a presentation by Ralph Love of the Bechtel AI Institute.

All meetings run from 3 to 5 pm. For more information, contact: Blair Helsing, Bank of America, Dept #3622, P.O. Box 37000, San Francisco, CA 94137; Phone: (415)624-5080.

If readers let us know of other local expert systems meetings, we will print information about them.

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## CALENDAR

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### North America: 1990

APRIL 10-12. **Conference on Advanced Computing for the Social Sciences.** Williamsburg, Virginia. Sponsor: Oak Ridge Nat. Lab. and U.S. Census Bureau. Contact: Lloyd Arrowood, Oak Ridge Nat. Lab., P.O. Box 2008, MS 8165, Oak Ridge, TN 37831; (615)575-8700. (A general conference, but with a significant focus on ES this year.)

APRIL 15-18. **Application of AI VIII.** Orlando, Florida. Sponsor: SPIE. Contact: Mohan M. Trivedi, Univ. of Tenn., Elec. and Computer Eng., Ferris Hall, Knoxville, TN 37996-2100; (615)974-5450.

MAY 1-3. **2nd Annual Conference on Innovative Applications in AI (IAAI 90).** Washington, D.C. Sponsor: AAAL. Contact: AAAL, 445 Burgess Drive, Menlo Park, CA 94025; (415)328-3123, Fax: (415)321-4457.

\*\* MAY 6-11. **AISIG'90 (The Fifth Annual AI Systems in Government Conference).** Washington D.C., Sponsors: IEEE, Mitre Corp, George Washington University. Contact: Ms. Michelle L. Carbone, IEEE Comp. Soc., 1730 Mass. Ave., N.W., Wash. D.C. 20036-1903; (202)371-1013, Fax: (202)728-0884.

\*\* MAY 6-11. **Meeting of the U.S. Chapter of the Digital Equipment Computer Users Society (DECUS).** New Orleans, Louisiana. The DECUS AISIG will present a track on expert systems and AI, including meetings on DEC products like VAX Decision Expert, etc.

Contact: DECUS Office, 219 Boston Post Road, Marlboro, MA 01752; (508)480-3635.

\*\* MAY 9-11. **Neuron Data Annual User Group Meeting.** San Francisco, California. Contact: Neuron Data, 444 High Street, Palo Alto, CA 94301; (415)321-4488.

\*\*MAY 14-16. **Fourth Int. Conf. on Expert Systems in Production and Operations Management.** Hilton Head Island, South Carolina. Sponsor: Univ. of South Carolina. Contact: Daniel Management Cent., College of Bus. Adm., Univ. of South Carolina, Columbia, SC 29208; (803)777-6495.

MAY 16-18. **Third Conference on AI in Petroleum Exploration & Production.** College Station, Texas. Contact: Tsai-Bao Kuo, Conf. Co-chair, CAIPEP, Petroleum Eng. Dept., Texas A&M Univ., College Station, TX 77843-3116; (409)845-2962, Fax: (409)845-1307.

MAY 22-23. **5th Conference on AI for Space Applications.** Huntsville, Alabama. Sponsors: Univ. of Alabama, IEEE, and NASA. (unclassified papers) Contact: Univ. of Alabama in Huntsville, Div. of Continuing Education, Tom Beville Center 285-C, Huntsville, AL 35899. (205)895-6372.

JUNE 21-23. **Second International Conference on Software and Knowledge Engineering.** Skokie, Illinois. Sponsors: Univ. of Pittsburgh and Inst. for Information Industries, Taiwan. Contact: Shi-Kho

Chang, Comp. Sci. Dept., Univ. of Pittsburgh, 322 Alumni Hall, Pittsburgh, PA 15260; (412)624-8490.

JULY 9-13. **IBERAMIA 90** (Second Ibero-American Conf on AI. Morelia, Michoacan, Mexico. Sponsors: Centro Regional de Enseñanza en Informática (Spain). Contact: Iberamia 90, Atn. Srita Ma. Antonieta Alvarez Perez, Apartado Postal 70302, C.P. 04510, Mexico, D.F.

JULY 15-18. **Third International Conference on Industrial and Engineering Appl. for AI and ES.** Charleston, South Carolina. Sponsors: ACM. Contact: Moonis Ali, Univ. of Tenn. Space Inst. MS15, Tullahoma, TN 37388; (615)455-0631.

JULY 23-25. **International Workshop on Principles of Diagnosis.** Menlo Park, California. (Participation limited to 30 presentors. March 30 deadline for paper acceptance.) Sponsor: AAAI and Price Waterhouse. Contact: Walter Hamscher, Price Waterhouse Technology Centre, 68 Willow Road, Menlo Park, CA 94025; Phone: (415)688-6669.

JULY 29 - AUG 4. **AAAI Conference.** Boston, Massachusetts. Contact: AAAI, 445 Burgess Drive, Menlo Park, CA 94025; (415)328-3123.

SEPT 10-12. **Managing Expert System Programs and Projects.** Washington, DC. Sponsor: IEEE Task Force on ES. Contact: Dr. Randall Shumaker, Program Chair, Navy Center for Applied Research in AI, Code 5510, Naval Research Lab., Washington DC, 20375.

\*\* OCT 3-5. **Conference of International Association of Knowledge Engineers (IAKE).** San Francisco, California. Contact: Joan Scaffidi, IAKE, Georgetown Univ., P.O. Box 25461, Washington DC, 20007; (301)231-7826, Fax: (301)770-4621.

\*\* OCT 14-17. **RISCON'90** (Retail Information Systems Conference). This conference will have sessions on expert systems in retail. St. Louis, Missouri. Contact: John E. Chay, V.P., Information Systems Div., National Retail Merchants Association, 100 West 31st St., New York, NY 10001; (212)244-8780.

OCT 21-25. **ECOOP-OOPSLA'90.** Ottawa, Canada. Contact: ACM, 11 W. 42nd St, New York, NY 10036; (212)869-7440.

OCT 22-26. **Third International Symposium on AI: Applications of Engineering Design and Manufacturing in Industrial and Developing Countries.** Monterrey, N.L. Mexico. Sponsor: ITESM (Instituto Tecnológico y de Estudios Superiores de Monterrey), IJCAI, AAAI, Sociedad Mexicana de Inteligencia Artificial and IBM of Mexico. Contact: Hugo Trashima, Program Chair, Centro de Inteligencia Artificial, ITESM, Suc. de Correos "J" C.P. 64849 Monterrey, N.L. Mexico; Phone: (52-83) 58-2000, ext. 5134, Fax: (52-83) 58-0771.

NOV 4-9. **Fifth Knowledge Acquisition for Knowledge-Based Systems Workshop.** Banff, Canada. Sponsor: AAAI. Contact: John Boose, Adv. Technology Center, Boeing Computer Services, 71-64, P.O. Box 24346, Seattle, WA 98124; (206)865-3253.

NOV 8-10. **Users.PRL (The Level5 Users Group Conference).** Cocoa Beach, Florida. Contact: Users.PRL, P.O. Box 312, Ramsey, NJ 07446.

NOV 15-16. **Third Annual North Carolina Symposium on AI.** Research Triangle Park, North Carolina. Contact: Connie McElroy-Bacon, Division for Lifelong Education, N.C. State University, Box 7401, Raleigh, NC 27695-7401; (919)737-2261.

### International: 1990

MAY 7-11. **Fourth International Symposium on Knowledge Engineering.** Barcelona, Spain. Sponsor: Rank Xerox, Faculty of Computer Science, Madrid Polytechnic Univ. Contact: Jose R. Chelala Lopez, Gen. Secretary, 4th Int. Symposium of Know. Eng., Alvarez de Baena, 3-2, 28006 Madrid, Spain; Phone: (91)419 7740, Fax: (91)410 0121.

MAY 14-16. **Commercial Expert Systems in Banking and Insurance.** Lugano, Switzerland. Sponsor: Swiss Re. Contact: Instituto Dalle Molle di Studi sull' Intelligenza Artificiale, Corso Elvezia 36,

CH-6900 Lugano, Switzerland; Phone: (41) 9151 8660, Fax: (41) 9151 7748.

MAY 28-JUNE 1. **Avignon 90 (Expert Systems & Their Applications).** Avignon, France. Sponsors: ECCAI, JSAI. Contact: Jean-Claude Rault, EC2, 269-287 rue de la Garenne, 92024 Nanterre Cedex, France; Phone: (33.1) 4780 7000, Fax: (33.1) 4780 6629.

JUNE 25-29. **4th European Knowledge Acquisition for Knowledge-Based Systems Workshop (EKAW-90).** Contact: Bob Wielinga, Social Science Informatics, University of Amsterdam, Herengracht 196, 1016 BS Amsterdam, The Netherlands; Phone: (31) 20 525 2160.

JUNE 27-29. **ACM Conference on Lisp and Functional Programming.** Nice, France. Contact: Gillies Kahn, INRIA Sophia — Antipolis, 2004 Route des Lucioles, 06565 Valbonne Cedex, France; Phone: (33) 9365 7801.

JULY 2-6. **Second International Conference on Economics and AI.** Paris, France. Sponsor: AFCET. Contact: J-L Le Moigne, GRASCE, Unvi. Aix Marseille III, 3, ave. Robert Schuman 13628 Aix en Provence, France.

AUG 6-10. **ECAI90 (European Conference on AI).** Stockholm, Sweden. Sponsors: Swedish AI Society and ECCAI. Contact: Stockholm Convention Bureau, Box 6911, S-102 39 Stockholm, Sweden; Phone: (468) 23 0990, Fax: (468) 34 8441.

SEPT 25-27. **Sixth International Expert Systems Conference & Exhibition.** London, England. Contact: Learned Information, Woodside, Hinksey Hill, Oxford OX1 5AU, United Kingdom; Phone: (0865) 730 275, Fax: (0865) 736 354.

OCT 25-26. **1st Japanese Knowledge Acquisition for Knowledge-Based Systems Workshop (Part 1).** Kyoto, Japan. Sponsors: Hitachi, Ltd. and Kansai Inst. of Information Systems. Contact: Riichiro Mizoguchi, Inst. of Scientific and Industrial Research, Osaka Univ., 8-1 Mihogaoka, Ibaraki, Osaka 567, Japan; Phone: (06)877-5111, ext. 3540.

OCT 29-31. **1st Japanese Knowledge Acquisition for Knowledge-Based Systems Workshop (Part 2).** Tokyo, Japan. Sponsors: Hitachi, Ltd. and Kansai Inst. of Information Systems. Contact: Hiroshi Motoda, Adv. Research Lab, Hitachi Ltd., Kokubunji, Tokyo 185, Japan; Phone: (0423) 23-1111, Fax: (0423)26-0880.

Note: \*\*Indicates new entry

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# EXPERT SYSTEMS STRATEGIES™

The Monthly Newsletter for Managers and Developers of Expert Systems, from Cutter Information Corp.

Editor: Paul Harmon

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## MARKET ANALYSIS

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### THE SECOND GENERATION OF EXPERT SYSTEM TOOLS ARE JUST ABOUT TO ARRIVE

The first expert systems-building tools were introduced in 1983. (We're excluding OPS5 which wasn't developed to be an expert systems-building tool, although it was used in 1980 to develop DEC's XCON system.) In the years since 1983, there have been numerous developments. Tools have evolved from DEC VAX hardware, to Lisp machines, to Unix machines, to PCs, and to mainframes. At the same time, tools have evolved from Lisp-based tools to tools written in languages like Pascal, C, and PL/1. At various points along the way, vendors have claimed that their tools were second or even third generation expert systems-building tools. Now, in 1990, with the benefit of hindsight, it looks like most of the tools we have

seen to date were really only modest mutations. We believe that the next two years will witness the appearance of the real second generation expert systems-building tools.

In 1989 companies decided that expert systems techniques were valuable and that they would train their MIS programmers to use the technology. This development, in turn, led many companies to set up committees to standardize on the expert systems-building tool they would be using for the next three to five years. The trend was strongest in the financial industry, but it was also evident in the manufacturing industries. From a company's perspective, standardization means that the company only has to offer training and support for a single tool. It also means that its programmers can talk a common language and they can develop in-depth knowledge of a single tool.

From the perspective of the generic tool vendors, it means that they are either selling a tool that companies will standardize on, or they will soon be out of business. The alternative is for a vendor selling a generic tool to modify the tool and specialize in some niche market.

For the vendors who are on everyone's short list, the competition is becoming quite intense. The companies selecting tools have developed a wish list that no vendor can completely satisfy, so each vendor is working to improve its tools to better approximate the ideal tool. The checklist for a standardized tool looks something like this:

- ◆ The tool is available on multiple platforms (or at least on IBM 370s, PC/DOS, Unix, and VAX machines).

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##### MARKET ANALYSIS

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- ◆ The tool is written in a conventional language (most are written in C). It can be embedded within, or easily accessed by, conventional applications running in existing corporate environments (e.g., MVS/CICS, VMS, Unix and DOS).
- ◆ The tool provides a hybrid knowledge and inference structure, including support for both rule-based programming and object-oriented programming. The tool supports both forward- and backward-chaining and pattern-matching rules that can do joins on instances derived from independent classes of objects. It should have demons and a minimal hypothetical reasoning capability. It should support message passing as a way of communicating between objects. In addition, the tool should provide for efficient procedural control of the overall application or selected portions of it (via agendas, calls to external programs and routines, etc.).
- ◆ The tool should have graphical interfaces (probably DOS Windows and X Windows, and soon, Presentation Manager). It should also provide dynamic graphics (where the end-user can make inputs and see outputs on the screen by simply modifying a graphical image) and some graphical way of representing the knowledge base so that developers can get an overview of the knowledge and the activity of a system.
- ◆ The tool should access a wide variety of different databases. (Ideally, it should generate SQL code to make database access automatic and links portable.)
- ◆ The tool is sold by a financially stable, well-managed company that offers training and support for its products. In the best case, the company provides knowledge engineers to help users develop their own applications. And now a new consideration is being added: will the company be able to develop a second generation expert systems tool?

No tool currently meets all of these criteria, although some come a lot closer than others. The vendors whose tools come close to these criteria are being selected by standardization committees. That, in turn, means that those vendors have the money to improve their tools and make it even more likely that they will be selected in the future.

This is a familiar phenomenon and in most markets it usually leads to the survival of about three or four general vendors and a few others who are specialized in smaller niche markets. We fully expect to see this happen in the expert systems business during the course of the next two to five years. In other words, we expect that there will be only three or four generic tool vendors left by the end of 1995. And between now and then, we fully expect each successful vendor to revise and significantly improve its tool, in effect producing a second generation of much more sophisticated products.

It's ironic to see this narrowing of the market just as companies are beginning to spend a lot more money on expert systems-building tools than they have in the last few years. Unfortunately for most vendors, they are going to spend that money acquiring tools from only a few vendors. The days when the R&D groups bought one copy of each interesting tool are over. Now, companies want to standardize and train their programmers to use one, or at the most, two, tools to develop applications.

At the moment, of course, it is by no means clear which vendors will be among the top three in 1993. A good tool and a well-financed company get a vendor into the running, but they don't guarantee success. Lots of capital will be needed, and large corporations that have ignored the market until now may decide that they are ready to pick a vendor and invest enough capital to make that vendor a serious contender.

Most of the vendors are private, but we expect that most will go public in the next two years. They will simply need the money to continue to improve their tools, develop their sales and support organizations, and market their products.

### The Most Likely Survivors

Compared with this time a year ago, when the effects of standardization were just beginning to be felt, the expert systems tool market has changed quite a bit. The number of tool vendors who can hope to meet the criteria we have listed above is reasonably small. The vendors who aren't on the list now realize that they have to come up with a tool that can make that list within about 12 months, or settle for a niche market.

In our opinion, there are only a few companies that will clearly be able to meet the criteria in the course of 1990-91, and a second short list of those who may be able to do so.

The vendors that are well positioned in the spring of 1990 include:

### 1. Aion Corporation

Aion's ADS is the best-positioned product at the moment. ADS is the dominant mainframe tool and Aion has been selling lots of PC versions of the tool, besides. The current version of ADS (5.1) probably has the most complete knowledge and inferencing system available in a conventional language. More companies have standardized on ADS than on any other tool.

Aion has its problems (e.g., ADS needs graphics and a windows/presentation manager interface as well as a DEC version, and Aion needs to develop better consulting support), but it has the money and is certainly engaged in a major effort to improve the product and the company. The next version of ADS will come out in the fall, and additional versions will predictably come out in 1991.

Aion made about \$15 million selling ADS in 1989. The company is privately held and presumably will go public in the next couple of years.

### 2. IntelliCorp

IntelliCorp was one of the original "big four" and it survived the early years and established itself as the preferred Lisp vendor. Intellicorp is a public company that earned \$16.8 million selling software in its last fiscal year (June 30, 1988 to June 30, 1989). In addition, it earned \$5 million selling consulting services and enjoys a well-deserved reputation for providing high-quality knowledge engineering support.

IntelliCorp went public several years ago, and still has a substantial nest egg of capital. The company has been making a profit for over a year now.

IntelliCorp clearly has a strong hold on the Lisp market and it has the resources to expand into the conventional tools market. The company has indicated its intention to do this by acquiring Kappa, and has since said that Kappa is only the first of a new line of "second generation" tools that

it will be announcing in 1990-91. (See Trends, pg 14) IntelliCorp does not currently have a product that will guarantee its place in the runoffs, but it has the capital and the sophistication to develop one, and it seems intent on doing so.

### 3. AICorp.

AICorp. established itself as the vendor of Intellect and has been in business for some 15 years now. Its expert system tool, KBMS, was the first to establish a hybrid environment for the mainframe. KBMS has a number of very nice features, including its 4 GL/Intellect interface to databases, the ability to create database objects that generate SQL to automatically access information in database files, its dynamic graphics and its presentation manager interface.

AICorp. is competing head to head with Aion. (See the ADS/KBMS review in *ESS*, Vol. 6, No. 2.) Even though KBMS has some features that are superior to those offered by ADS, overall, AICorp. is still playing catch-up. It will have to run fast and come out with a significantly improved version of KBMS to really remain competitive. Luckily, AICorp. has money and good management, so like Aion, it will probably come out with improved versions of KBMS in the next couple of years.

AICorp. is privately held, but it is reasonable to assume that it will also go public in the next couple of years.

### 4. Information Builders Inc.

Information Builders Inc. is a well-established 4 GL company that has been selling Focus for years. In 1988 it bought Level5, (then called Insight) and began spending money to port the tool to the mainframe and to connect it to every database imaginable. At the same time, IBI started to develop a second generation tool, called Level5 Object, which is in Beta testing now and is to be released this summer. Unlike Level5, which is a backward-chaining, rule-based tool, Level5 Object will be a hybrid tool running in Windows.

The story behind the development of Level5 Object is interesting for what it says about the development of a second generation tool. The original Insight tool was developed by three guys working at home. Although the group grew a lit-

tle, Level5 was still supported by a small group when IBI acquired the tool in 1988.

When IBI decided to commit to a new tool that it expected to be competitive in the 90s, it created a much larger development group. That group proceeded to put over 30 person-years into the development of Level5 Object. (Such a group may be small for a companies like Lotus or Ashton-Tate, but they are large for expert systems companies, and only a very few of the original companies can afford or manage development teams of that size.) At the same time, IBI has announced a version of Level5 embedded in focus, guaranteeing them a unique place among the 4GL vendors.

The vendors who, in our opinion, are not quite so well-positioned but who are clearly in the running, include:

### 5. IBM

IBM has introduced three unsuccessful products: ESE, KnowledgeTool, and KEE 370. Any other company that lost the money IBM must have lost would have dropped out of the expert systems market by now. However, IBM is not any other company. IBM is getting ready to introduce its fourth product, TIRS (The Integrated Reasoning Shell), which we'll review as soon as we can. On the surface, TIRS appears to be more exciting than anything else that IBM has offered, and it also appears to lack some of the key features users will demand (e.g., a complete OOP capability and the ability to run on many different platforms). Of course, IBM has also announced the AD/Cycle and Repository and has included a knowledge-based section in the Repository. Everyone now assumes that TIRS and the AD/Cycle and Repository will evolve together. In effect, TIRS will probably be IBM's first successful entry into the tools market, and it will probably be followed by a second generation version of TIRS in 1991.

IBM may not have succeeded yet, but it has very deep pockets. It's hard to imagine it won't be one of the survivors in the long run.

### 6. Carnegie Group (DEC and TI)

Carnegie Group was another member of the original "big four." Its tool, Knowledge Craft, was widely regarded as the most powerful and flexible of the original Lisp tools, but it was also con-

sidered unfriendly and very poorly integrated. Somehow, Carnegie Group never got Knowledge Craft together before the market for Lisp tools declined.

Since 1988, Carnegie Group has focused on consulting (it is the premier expert systems consulting firm in the manufacturing area) and in developing a line of domain- or problem-specific tools, like TestBench and Service/Maintenance Planner. Carnegie Group is owned by companies like DEC, Texas Instruments, Ford Motor Company, and US West. These companies are interested in developing large expert systems for their own internal uses, and DEC and TI are both committed to developing domain- or problem-specific tools and applications for their customers. These companies could certainly fund the development of a second generation tool, if they felt a need for one.

### 7. Inference Corp.

Inference Corp. was one of the original "big four" and, for a while, the Lisp version of ART was a very popular tool. Inference stumbled when it tried to port ART to C. It was forced to start all over and build ART/IM from scratch. In the process, Inference lost a lot of the visibility it once had. At this point ART/IM is completed and available on all of the obvious platforms. The interface is still poor and will need a lot of work, but the product is basically sound and positions Inference for a shot at the next round.

Through all its difficulties, Inference has maintained its reputation for providing high-quality knowledge engineering support. Arthur Andersen recently concluded a multi-million dollar deal in which Andersen would use Inference tools in its consulting while Inference would provide consulting assistance to Andersen on complex projects.

Inference is owned, in part, by companies like Ford and Lockheed Corp., etc. If these companies believe in the product, they certainly have the capital to support Inference.

### 8. Neuron Data

Neuron Data got off to a fast start in 1986 by offering Nexpert Object, the first C-based tool that had a really good graphical interface and more power than most of the other PC-based tools. The company has maintained a high visibility and has

managed to port its product to a large number of workstations. It has also worked out bridges between its tool and a number of other products (e.g., Oracle).

Neuron Data has announced mainframe versions of the tool, but as far as we know, no MVS versions of Nexpert Object have been shipped. For a period of time Nexpert Object offered a lot for the money, but as time has passed the tool has begun to show its age. The tool lacks some key features (e.g., pattern-matching rules that will do joins on independent objects and full object-oriented capabilities). In addition, Neuron Data has let others sell and support its tool, and has only recently begun to develop this capability internally.

Neuron Data didn't have a great year in 1989. The market for stand alone mid-sized tools isn't growing very fast. Moreover, 1990 should be a lot tougher, since IBI has announced it will sell Level5 Object for \$995, while IntelliCorp's Kappa will be priced at \$3,500. Both of these products will go head to head with Nexpert Object. Neuron Data will probably be forced to change its pricing and will then end up making a lot less profit on the sales it does make.

At the same time, Neuron Data will need a lot of capital to upgrade its tool, to establish a more effective management structure, and to develop a real mainframe presence. On the other hand, Neuron Data has established a real presence in the market and would be a good buy for some company that wanted to enter the market and was prepared to put a lot of capital and effort into a second generation version of Nexpert Object.

## Some Niche Specialists

In addition to the vendors mentioned above, (who are, each in their own ways, a major vendor), there are several niche vendors who may survive by remaining specialists. An incomplete list of examples include:

### 9. Gensym

Gensym has developed a Lisp-based tool, G2, which is especially good at handling real-time processing tasks. There is certainly a niche for powerful Lisp systems, and one that can deal with process control could probably survive.

### 10. Paperback Software

Paperback Software has never bothered to port VP-Expert off the PC, where it remains a popular tool for beginners and for people who want to develop small systems. Paperback Software is going through lots of difficulties as it awaits a court decision on its lawsuit with Lotus. Adam Osborne, its mercurial CEO, resigned to set up a new company. He has offered to buy the rights to VP-Expert, but so far as we know, Paperback isn't selling. One way or another, VP-Expert is popular enough that someone will continue to sell the product, and it will probably continue to be a popular niche tool.

### 11. DEC's VAX OPS5

OPS5 has never been a very popular tool, but it is a highly regarded tool simply because it has been used to develop large, powerful systems like XCON, XSEL, etc. In the hands of John McDermott and DEC's Knowledge Engineering Group, VAX OPS5 is a very productive tool, and that will probably guarantee it a niche within the VAX world for some time to come.

In addition to the vendors listed above, another vendor could still emerge if a large corporation wanted to buy or develop a tool and put enough capital into the company to make it a serious contender. There are a number of vendors with interesting tools who aren't positioned quite so well. Any one of them could be a starting point for a company that decided it wanted to get in on the beginning of the second round.

## The Base From Which the Various Vendors Start

As vendors add to their products' capabilities and portability, their offerings tend to be more alike. At this point, however, it is still possible to discriminate between the various tools in terms of the niches in which they sell best. In effect, the mainframe vendors are trying to expand to workstations and PCs, while the PC and workstation vendors are trying to expand to the mainframes.

The chart in Figure 1 illustrates the overall market for computer software. On the horizontal axis, we have indicated the group within a company that the vendor would target. On the vertical axis we have indicated the platform that the vendor

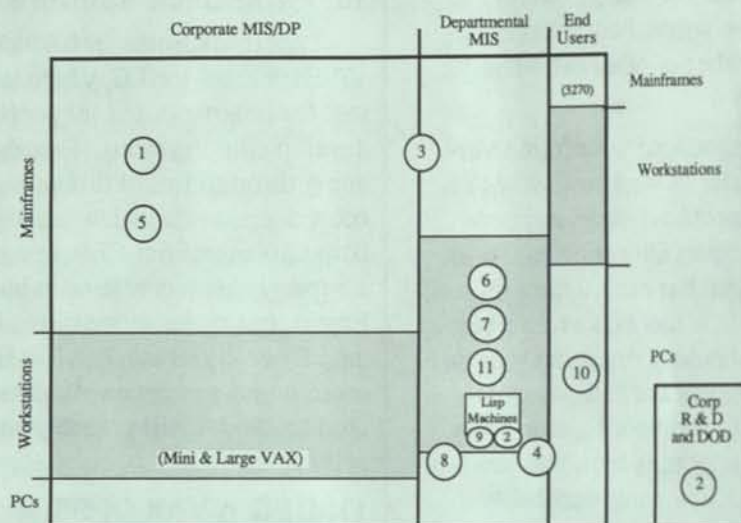


Figure 1 — The software world. Circles indicate our guess about the primary clients for each of the vendors

would emphasize. We have arranged the subdivisions to provide a very rough idea of the purchasing power of the various groups. Obviously this is our impression; vendors would claim that their tools are equally appropriate for a number of different niches, and, increasingly, they are.

We have represented each tool as a circle located at the point that we suspect each is making most of its sales. The circles are numbered according to their order and number in the text.

### Second Generation Tools

We have listed some of the criteria by which companies are evaluating tools they are considering for standardization. In addition, there are a number of other, subtle issues that will become important. Companies will want tools that run in all of their various and increasingly integrated environments. Network and integration standards that are still vague today will become clearer in the next two years, and as they do, tool vendors will be judged by how well they fit within corporate integration efforts.

At the same time, as companies become familiar with the technology, they will want to build larger knowledge bases. The current tools will all be stressed when developers start to move from knowledge bases with hundreds of rules and

objects, to knowledge bases that have thousands of rules and objects.

Companies will also want tools that can access knowledge currently stored in different knowledge bases. IBM has said that it will make some higher-level knowledge sharing possible by providing a standardized format for the storage of knowledge (rules and objects) within its Repository, and several vendors have already vowed to remain SAA, AD/Cycle, and Repository compliant. But IBM may not deliver in time, or Unix may overtake the AD/Cycle and Repository. An IEEE committee has been established to consider how to standardize knowledge base components, but it may or may not be able to offer useful guidelines. Tool vendors may very well have to offer their own solutions. Obviously, only the vendors that sell the most popular tools and have access to considerable financing will be in a position to help set standards if and when that time comes. Second generation tools will need to meet all of the criteria listed above and a lot more that are just beginning to be formulated. They will have to be very sophisticated software products that will function effectively in increasingly complex corporate software environments.

The second round is just beginning, and it will be interesting to see how the various vendors position their entries in the next 12 to 18 months.

APPLICATIONS

EXPERT SYSTEMS IN BANKING AND SECURITIES

The financial industry (at least in the U.S.) is generally divided into three parts: banking, insurance, and securities, although the lines blur a little more each day. When expert systems moved into commercial markets, financial companies followed just behind manufacturing companies in exploring the new technology, and are now among the most active users of expert systems. For various reasons, the insurance industry has been the most aggressive user of expert systems, while banks and securities firms have lagged somewhat behind. In the fall of 1989 (ESS, Vol. 5, No. 11), we considered a number of interesting insurance applications. Now, we want to consider some applications in banking and securities.

As institutions attempt to remain competitive in a world where the competition is only growing, they are increasingly turning to expert systems to solve a number of different problems, ranging from high employee turnover associated with the continuing growth of a less skilled work force, to unforeseen problems associated with data processing operations.

Our informal study of expert systems in the banking industry suggests that expert systems are being most actively used in four areas:

- 1) Lending: credit and loan evaluation;
- 2) Customer service and training implementation;

- 3) Consulting and financial planning; and
- 4) Operations.

The financial industry has always been close-mouthed about what it was using expert systems to do. Many companies still won't talk for publication. Still, we think the systems we discuss below provide a reasonably good overview of how the technology is being used. Figure 2 shows banking and Figure 3 shows securities industry expert systems applications. We'll discuss banking systems first.

**Lending: Credit and Loan Evaluation**

One of the main areas of expert systems development in the banking and securities industry is credit and loan evaluation. Credit and loan evaluation lends itself particularly well to expert

Advisory/Financial Planning	Credit/Loan Risk Assessment	Operations
Computer-based consulting system that advises mid-sized manufacturing companies on how they can increase their revenues. Used by Deutsche Bank/Roland Berger, West Germany.	AUTHORIZER'S ASSISTANT (ART) Helps credit card authorizers decide exceptional cases. Used by American Express.	AUDITOR'S ASSISTANT (ART) Used in the foreign exchange department. Checks for irregular trading patterns that could indicate improprieties. Used by Chemical Bank.
EXPATRIATE ADVISOR (KES) Provides personal finance advice to customers leaving the U.K. for more than one tax year. Used by Trustee Savings Bank, U.K.	LENDING ADVISOR (SynCore) Assists bankers with credit analysis. Helps train junior lenders for loan approval. Used by Australia New Zealand Bank Group, Integra Financial Corp., Security Pacific Bank, Wachovia Bank & Trust, Canadian Imperial Bank of Commerce.	CLINT (ADS) PC-based system used by the real estate section to determine if legal requirements for commercial property loans are in order. Used by Metropolitan Life.
		DOLS (KnowledgeTool) Adjusts tax withholdings on pensioners' checks (Approx. 250,00 per month) based on tax codes in different jurisdictions across the country. Used by Citibank, N.A.
		Training system developed using (KES) to help the bank train employees to sell debit cards. Used by Trustee Savings Bank, U.K.

Figure 2 — Expert Systems Applications in Banking

systems development because it is service-oriented and depends on the knowledge or skill of an experienced loan officer. No one trains good loan officers, individuals acquire their skills through long experience.

Expert systems are now being used to help capture and distribute the knowledge of experienced loan officers. This is proving attractive for at least two reasons. First, there is a lot of turnover in the financial industry and companies constantly face the task of training new loan officers. Given the educational level of many new employees, this is proving harder to do. Second, financial institutions want to be sure that consistent and well-defined practices are applied to ensure the quality of their loans.

### Syntelligence's Lending Advisor

While some financial institutions have chosen to develop their own systems, others have decided to purchase end-user applications. Lending Advisor, developed and sold by Syntelligence, Inc. of Sunnyvale, California, has received a lot of attention from the financial industry lately. This is especially interesting since Syntelligence has been around for a while and has had a hard time attracting much attention, in spite of the quality of its product.

We think 1990 will be the year that off-the-shelf expert systems really begin to take off, and Syntelligence just might lead the pack. The smaller banks now realize that their larger competitors are really developing and starting to use expert systems and that may encourage them to think about how they could catch up. We're certainly hearing a lot more talk of off-the-shelf systems now than we've ever heard before.

Syntelligence's Lending Advisor is designed to assist loan officers, credit officers, and bank managers in making quick and consistent credit evaluations of commercial borrowers. It is the only commercially available end-user application for automating the lending process that we know of (although several other companies will be developing similar applications shortly).

The Lending Advisor is billed as a ready-to-run, multi-user, mainframe-based application. However, most companies now implementing the system have tailored it to incorporate their own particular lending policies.

The application runs on a system consisting of a host 4381, 308x, or 309x IBM (or compatible) mainframe and is fully embeddable within existing MVS/XA, CICS, and PL/I environments. The system is accessed using PS/2 models 50 and above or PC/AT workstations, and requires the PC 3270 emulation program and DOS 3.3 or higher.

Lending Advisor sells for \$950,000, and to this date, we've identified at least five institutions now developing, or in the process of rolling out, systems. These include: Australia New Zealand Banking Group, Ltd, Australia; Integra Financial Corporation, Pittsburgh, Pennsylvania; Security Pacific Bank Washington, N.A., Seattle, Washington; Wachovia Bank & Trust, Winston-Salem, North Carolina; and the Canadian Imperial Bank of Commerce, Toronto, Ontario.

The Canadian Imperial Bank of Commerce (CIBC), a Toronto-based bank with assets of \$85 billion, is using Lending Advisor and appears to be further along the full implementation path than others. CIBC began a full rollout of Lending Advisor in January 1990, and now has about 400 lenders using the system in British Columbia and the Atlantic Maritime Provinces, as well as Toronto.

In 1987 CIBC formed Credit Management Project to review the bank's lending philosophy and determine what steps should be taken in order to enhance it. Its findings determined that an expert system, one that could be easily embedded within the existing IBM environment, would be the most viable solution. Based upon recommendations from the bank's MIS departments, the Credit Management Project decided that purchasing an end-user system was a more practical approach than developing its own system. Syntelligence's Lending Advisor was chosen because the group felt it best met the company's requirements.

The initial installation of the system began in 1989 and consisted of analyzing 167 commercial loans ranging in size from \$250,000 to over \$10,000,000. At all times, customer information pertaining to the loans remained confidential. Eighty employees participated in the initial installation: 35 lenders, 35 analysts, and 10 credit room administrators.

Even at this early stage, participants showed enthusiasm for the system, noting that it allowed ac-



count managers and officers to scrutinize and interpret a greater amount of information about a customer, thereby enabling them to make better and more informed decisions. Loan officers were particularly pleased with the ability to review credits on-line, thereby saving time and eliminating paper shuffling.

CIBC is still in the rollout phase of implementing Lending Advisor. The employee training process began with a week-long session in which Syntelligence's implementation specialists instructed employees designated as CIBC trainers. Loan officers and other bank officials who will be using the system will be required to receive on-the-job training three hours a week for a total of five or six weeks.

CIBC is already beginning to realize benefits from Lending Advisor. David Gibb, vice president of the Credit Management Project, expressed his feelings on the success of the system: "The Lending Advisor provides CIBC with a tool to deal with a big chunk of its corporate portfolio the most effective way possible — by putting discipline in the credit process and professionalism at the hands of the account managers."

Account officers and managers are seeing a reduction in the time required to approve a customer's loan. Due to the system's streamlining of the overall lending process, they are allowed to spend more time with their customers. Robin Guilbeau, an account manager, says that, "As a user of the Lending Advisor, [I feel] the system is very friendly and I don't have to think did I miss something in the analysis? The system flags all the important things and prompts me to focus in on those areas." Additional benefits of the system include a reduction in the time required to turn over an account to a new lending officer — the account information is already on-line — and reduced training time for new loan officers.

When the full rollout of Lending Advisor is completed — somewhere around mid-1990 — CIBC plans to have approximately 1,200 lenders and reviewers on-line in 80 corporate banking centers throughout Canada.

For more information, contact: Syntelligence, Inc., 1000 Hamlin Court, P.O. Box 3620, Sunnysvale, CA, 94088; (408)745-6666/(800) 624-2474.

## CLINT — Checklist For Incoming Loan Transactions

CLINT is an expert system being used in the real estate investment section of the law department at Metropolitan Life to assist in the process of identifying the appropriate legal requirements involved in making commercial property loans.

The system was developed using Aion's ADS and operates on a PC. The typical user is a paralegal or attorney who answers a set of questions that the system deems appropriate to the situation, although certain questions, such as amount and type of loan, and property location, are standard.

In determining a set of appropriate questions and evaluating legal requirements, the system takes into account not only Metropolitan Life's lending requirements, but the different local, state, and federal laws and regulations applicable to commercial property loans.

Upon arriving at a conclusion, the system displays the necessary requirements on the screen, which are then printed out in the form of a "checklist." This checklist provides a precise format that shows each requirement necessary for meeting the legal qualifications of the loan, including an accompanying column where the requirement is to be signed off upon completion. These requirements are divided into different categories, for example "Title and Survey," "Legal Opinions," "Architectural," etc., to provide a more organized format.

The primary benefit of the system is that the legal requirements concerning commercial property loans are determined more quickly and consistently. Also, the system develops a record of the transactions by saving each legal consultation. CLINT is intended for internal use only.

## Customer Service and Training Implementation

The use of expert systems in customer service is an application area that is sure to grow. Likewise, companies will increasingly use expert systems to help develop more conventional programs, such as computer-based training programs. Trustee Savings Bank (TSB), U.K., seems deeply committed to using expert systems technology. Reputable sources say the bank presently has 12 applications in use, with another

12 in the development stage. Its knowledge-based systems department is using KES and KEE to develop applications for its Apollo workstations, and KES, Crystal, and Xi Plus for PCs.

### Expatriate Advisor

Expatriate Advisor is one of the more interesting applications being used at TSB. Developed in-house using Software Architecture & Engineering's KES, TSB is using Expatriate Advisor to provide advice on foreign and domestic tax laws to customers leaving the U.K. for more than one tax year.

Bank officials say the system is quick, easy-to-use, and provides an impressive and visible customer service. To use the system, customers are first asked to complete a simple questionnaire pertaining to such matters as intended country of residence while abroad, property owned in the U.K., savings accounts, and any additional TSB products and services they are interested in.

The questionnaire is then loaded into the system which then generates a personalized six- to ten-page letter from the TSB overseas branch. In this manner, customers receive comprehensive tax advice based upon their own particular situation. The entire process, including letter printing, takes only three minutes to complete.

Bank officers say the system has proven itself particularly valuable in several ways: it has enabled the bank to increase its business from overseas customers by nearly 20%; it serves as a marketing tool by pointing out additional services a customer might be interested in (from the questionnaire); and it provides an impressive response to a customer inquiry that would take considerable time to generate otherwise.

Expatriate Advisor was introduced in May 1988.

Trustee Savings Bank has also used an expert system to develop a large computer-based training program that was used to instruct the bank's 25,000 employees across 1,250 branches in the promotion and sale of a new financial service — debit cards. Debit cards, which look like credit cards, allow creditors to access a customer's checking account immediately, rather than waiting for third-party reimbursement.

The expert system, also developed using KES, allowed the company to create its training program much more quickly and economically than if it had used conventional programming techniques. According to bank officials, the expert system dramatically reduced the amount of time needed to create the training program from "months if not years, to eight weeks."

As a result of the rapid implementation of the training program and the fact that it allowed employees to be trained on-site at their usual job location, the bank was able to significantly reduce training costs to about two to three dollars per employee. And, the additional headache of planning for the absence of 25,000 employees from their job locations was eliminated altogether.

The expert system was developed on Apollo workstations running under a Unix operating system. The training program ran on Unisys B-28 hardware.

For more information, contact: Software Architecture & Engineering, Inc., 1600 Wilson Blvd., Suite 500, Arlington, VA 22209; (703)276-7910.

### Authorizer's Assistant

Authorizer's Assistant helps American Express credit authorizers make quick decisions about authorizing purchases for cardholders who are at, or beyond, their normal limit. The system was developed by Inference Corp. using ART to help American Express reduce losses resulting from bad judgement in authorizing additional credit.

Authorizer's Assistant operates on a Symbolics Lisp machine and can access IBM mainframe databases. More than 300 credit authorizers now use the system 24 hours a day.

### Consulting and Financial Planning

Deutsche Bank/Roland Berger, West Germany's largest commercial enterprise and a worldwide banking firm, has developed an expert system to advise mid-sized manufacturing companies on how they can increase their revenues. Through the use of a computer-based consultation, the system identifies problems causing low revenue and suggests remedial actions to correct them.

The system is fielded on a portable Compaq 386 PC which is delivered to a client company by a DGM management consultant. The client fills in the tables of data and answers the questions requested by the system.

Using the input data, the system performs 20 different analyses which include market trends, organization structure, competition, sales efficiency, cross-selling, regional performance, exports, success factors, distribution methods, and new business potential. In this manner, problem areas and their causes are identified and suggestions as to possible remedial actions that could be taken and their associated/projected increase in sales are made. The system then prints this information as a 100-page report that includes charts and graphs illustrating the system's findings. The system was developed and delivered using KES on a Compaq 386 PC. Embeddability with EXCEL and CLIPPER databases allows access to industry market data, and the use of MS Windows provides for customized screen generation.

Development was primarily undertaken to help reduce the cost of providing smaller companies with management consulting. It took approximately six months and cost \$850,000. The company estimates that the application will save approximately \$200,000 a year by allowing its management consultants to spend much less time with clients during the data collection phase. Currently there are 70 users.

## Operations

Some expert systems are being used to enhance the performance of already existing operations.

### Auditor's Assistant

Chemical Bank of New York is using an expert system in its \$750-billion foreign exchange trading department to monitor trading patterns for any irregularities that could indicate such improprieties as embezzlement or kickbacks.

The system, known as the Auditor's Assistant, was developed using ART in a joint effort between Chemical Bank's advanced technology department and Inference Corp. Development time was four months and cost approximately \$175,000.

The early version of the system was used only to determine New York-based trading involving dollars and pounds. However, unlike other programs written with conventional programming techniques, the Auditor's Assistant is an expert system developed with a knowledge base that is separate from the actual rules and code. This allowed the system to be easily enhanced to include deutschemarks and yen.

### Citibank's DOLS

Citibank NA is presently using an expert system developed with IBM's KnowledgeTool to aid in the disbursement of approximately 250,000 pension checks each month.

The 100-rule expert system helps support Citibank's Disbursement On-line System (DOLS) in adjusting state and federal withholding taxes on customer pension funds.

Development of the system became necessary when, in 1986, California became the first state to pass new legislation requiring the mandatory withholding of state income tax from pension funds. Prior to this, state tax withholding had been a voluntary process with pensioners electing a specified amount to be withheld.

In order to update the system — to allow for the possibility that other states might follow California's example and pass similar mandatory tax legislation — it was necessary to create an expert system in which the knowledge base would remain separate from the rest of the program. Citibank officials say this would not be possible using conventional programming techniques.

Development time for the high-speed batch processing system was approximately six months. The system runs on an IBM mainframe and operates in an MVS/XA environment, and allows Citibank's Pension Disbursement Unit to process 120,000 pension checks a night.

### Expert Systems in the Securities Industry

Like the banking industry, expert systems are being used in the securities industry to help staff perform a number of different functions more easily and efficiently (See Figure 3).

Advisory/Financial Planning	Credit/Loan Risk Assessment	Operations
<p><b>FINANCIAL STATEMENT ANALYZER</b> Helps capture information embedded in financial statements filed with the SEC. Used by the U.S. Securities &amp; Exchange Commission.</p>	<p>Expert system to evaluate businesses to determine the risk and appropriateness of issuing them surety bonds. Used by CIGNA Corp.</p>	
<p><b>PORTFOLIO MANAGEMENT ADVISOR (ART)</b> Assists investment analysts in portfolio management. Used and sold by the Athena Group.</p>	<p><b>MANAGER'S BROKER (Goldworks)</b> Helps managers monitor brokers' discretionary accounts. Used by Bear, Stearns &amp; Co.</p>	
<p><b>THE TRADER'S ASSISTANT (ART)</b> For stock market decision making. Analyzes current risk assessment criteria and identifies units within the company to be audited during the next cycle. Used by The Equitable.</p>	<p><b>MARGIN CREDIT EVALUATION SYSTEM (Guru)</b> Helps the Credit Administration Dept. in its primary responsibility of setting credit limits on margin accounts with very high debits. Used by Merrill Lynch.</p>	
	<p><b>MARKET/STOCK EXPERT (AIQ Systems)</b> For the analysis of market activity and stock options. Used by Nikko Securities, Japan.</p>	

Figure 3 — Expert Systems Applications in Securities Trading

### Margin Credit Evaluation System

The management Science Group at Merrill Lynch has developed the Margin Credit Evaluation System (MCES) to assist the Credit Administration Department in its primary responsibility of setting credit limits on margin accounts with very high debits.

The Credit Administration sets these limits based upon a careful evaluation of the securities in the account. For accounts with debits below a certain amount, the Credit Administration applies a set of "standard" margin rates and other rules to determine the maximum allowed debt.

The Management Science Group developed MCES to assist the Credit Administration in evaluating credit accounts more quickly and consistently, and to allow more accounts to be evaluated without any additional increases in staff.

The group used different tools and approaches in developing the system. Early prototypes of the system were developed using Level5 and were entirely rule-based. The use of Level5 allowed the

user to see and comment on the system during its early development stage.

The group used Guru to develop the final system because of its ability to integrate databases, spreadsheets, and procedural language features. This allowed a number of enhancements to be made:

- ◆ rules for setting credit limits are traditional IF\_THEN\_ELSE structures;
- ◆ rules for evaluating portfolios are expressed as algorithms, which allows a user to add and delete securities from a portfolio displayed on a spreadsheet;
- ◆ bonds as well as equities can be evaluated, and
- ◆ stock ratings and average daily volumes — for portfolio evaluation — are downloadable with account data.

Development of the system took approximately eight person-months, and the production version was installed in March 1989. MCES runs on a LAN of PCs with account information downloaded daily.

Some of the functions the system performs during portfolio examination are: analysis of equity and fixed income positions representing 10% or more of the long market value of an evaluation; calculation of critical measures such as firm maintenance excess; determination of whether the current debit amount can be supported; and recommendation of credit limits. In addition, it provides an analyst with comments on a specific account.

The system has allowed the Credit Administration to undertake more work without increasing staff. Analysts using the system on a daily basis have enabled the department to evaluate six times as many accounts containing twice the debit. Success of the system has been such that it is being in-

stalled in other departments. Presently, MCES is for internal use only. However, the system may be made commercially available in the future.

### Manager's Broker Monitoring System

Bear, Stearns & Co. is using an expert system developed in cooperation with Coopers & Lybrand to expedite the monitoring of its brokers' discretionary accounts.

Discretionary accounts allow brokers to invest clients' funds without prior investor approval. In the industry, all firms expect their branch managers to be responsible for monitoring broker activity. A typical branch may register 20,000 discretionary transactions per month.

The expert system known as the Manager's Broker Monitoring System maintains a profile of each broker's activity throughout the year and can identify items a compliance manager would be looking for.

The system makes the monitoring process much less time-consuming and more efficient. Managers can access the brokers' transaction information through PCs at each branch.

The system was developed using GoldWorks and operates on a PC/AT with a Gold Hill Computer 386 HummingBoard installed.

### Financial Statement Advisor

The U.S. Securities and Exchange Commission is using a system known as the Financial Statement Advisor (FAS) to capture information embedded in the financial statements — specifically 10Ks and 10Qs — that companies file with the SEC. These files are stored electronically in the SEC's EDGAR system.

Because individual companies use a variety of formats and wording, SEC always reviewed these statements manually. Now, FSA can electronically extract the wealth of information in the EDGAR files and then perform automated numerical analyses of standard financial ratios such as Quick Ratio. Once these ratios are calculated, the system can highlight companies that stand out because of higher or lower averages, unusual balances, or missing information.

FSA was developed by Arthur Andersen and uses object-oriented programming and natural language processing techniques.

### Stock Expert and Market Expert

Nikko Securities, one of Japan's top four securities companies and one of the top ten in the world, has entered into a joint venture with AIQ Systems, Inc. for the development and use of AIQ System's StockExpert and MarketExpert expert systems. Both systems are PC-based applications designed for stock market trading.

Under this agreement, Nikko has exclusive use of the systems in Japan. AIQ Systems and Nikko are jointly developing new knowledge bases applicable to the Tokyo Stock Exchange. At this time, both systems are being used by the Nikko family of companies.

StockExpert is an expert system designed to aid an investor in the analysis of stock options. StockExpert takes daily price and volume signals from technical indicators and computes an expert rating for each stock in the user's database. Through a series of printed expert rating and analysis reports, the system provides the user with advice on whether to buy or sell a particular option. The system automatically protects principal and profits. For more experienced investors, StockExpert offers some advanced features, such as Stock Plots that display a seven-month period of market action for every stock in the database.

MarketExpert (MTS) is a forward-chaining, deductive system that analyzes daily market data to determine when the stock market is about to change direction and move up or down. The system is based on price action of the Dow Jones Industrial Average. Various technical indicators within the system also utilize data from the New York Stock Exchange Index and Standard & Poor's 500 Index. MTS generates expert ratings that signal changes in the direction of the market.

MTS is designed to aid both the investor and trader and can be used for all types of transactions, including stocks and bonds, options, index futures, and mutual fund switching.

AIQ Systems lists some possible benefits of the system: it helps provide the long-term investor with the ability to follow the general direction of

the market and helps a trader catch secondary and minor corrections of the market which could lead to possible swings in the Dow Jones Industrial Average.

Both systems operate on IBM PC/XT, /AT, or PS/2 computers with a minimum of 512 K RAM and two disk drives. StockExpert also requires a graphics package and modem. An 8087 math coprocessor is also recommended.

For more information contact: AIQ Systems, Inc., P.O. Drawer 7530, Incline Village, NV 89450; (800)332-2999/(702)831-2999.

## Summary

Expert systems are now actively being used by banks and various institutions associated with securities trading. Some systems are helping to lend expertise to crucial areas — such as credit and

loan evaluation. Others are being used to enhance existing operations, such as Citibank's pension disbursement system and Chemical Bank's foreign exchange system. In the case of Trustee Savings Bank's Expatriate Advisor, several benefits are being realized: the system provides a visible and impressive customer service that would be difficult and costly to obtain manually, while at the same time it is helping increase the bank's overseas customers.

The role of expert systems in the financial industry will continue to increase as institutions strive to remain competitive. Their ability to be implemented with other traditional data processing operations and to solve problems that are impossible using conventional programming techniques insures that they will flourish.

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## TRENDS AND NEWS BRIEFS

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### IntelliCorp, Kappa, and the Next Generation of Tools

IntelliCorp still isn't saying a lot about its plans, but at least we can give you a little new information. We recently met with Casey Branscomb, IntelliCorp's president and COO. She argues that IntelliCorp's mission is nothing less than to change the way companies build software. Branscomb believes that with IntelliCorp's money, technology, and experience, the company is in the best possible position to define and create the next generation of software development products, products that would go beyond 4GLs and Relational DBMS to provide programmers with the ability to rapidly create new strategic applications.

The ideal next generation environment, according to Branscomb, includes object-oriented representation (she reminded us that KEE was the first commercial OOP environment); high-performance, automated reasoning capabilities (i.e. rules and inferencing); an active graphical interface; and database mapping. At first, it sounds like an argument for KEE, but Branscomb went on to say that the next generation tool must be written in a con-

ventional language (e.g., C) and fit easily into existing corporate computing environments.

IntelliCorp claims it is in the process of introducing the next generation of software development technology, beginning with Kappa (which it recently acquired when it bought Mega-Knowledge). It has rewritten Kappa to improve what we already thought was a superior tool, and will start shipping it on April 30. The development version of Kappa will sell for \$3,500, and the runtime version will sell for \$450.

Kappa offers a powerful hybrid environment, runs in MS-DOS and Windows, is written in C, and runs well on a machine with 640K. It provides hooks to SQL databases and several PC programs. We'll be doing a detailed review of the product as soon as it's available.

The major limitation of Kappa, at the moment, is that it only runs on a PC. IntelliCorp would not discuss specific future plans, but did say it would be making a series of announcements throughout 1990 and 1991. We'll keep you informed.

## AI Corp. Buys 1st-Class

AI Corp. has announced the acquisition of 1st-Class Expert Systems, Inc. The two companies will integrate their operations and principals of 1st-Class will join AI Corp..

Founded in 1985, 1st-Class' product line includes 1st-Class, 1st-Class Fusion, and 1st-Class HT. 1st-Class runs on PCs and DEC VAX hardware. The company has sold some 8,000 copies of 1st-Class since it was founded. (IBM, for example, has some 25 internal applications that were developed in 1st-Class or 1st-Class Fusion. Most are used in the manufacturing environment controlling factory-floor manufacturing operations.)

In essence, 1st-Class is an induction tool that has very good connections to databases. Using the tool, one can create a matrix listing problem attributes across the top and examples down the side. The software will apply a variation of the ID3 induction algorithm to convert the matrix into a set of rules or a decision table. 1st-Class has a very well-thought-out interface and is very easy to use. Several tools, including VP-Expert and Nexpert Object (Nextra) offer induction front-ends that allow users to quickly enter data into their systems.

1st-Class is easily the most popular induction tool on the market, and manufacturing companies have used it to develop a large number of machine problem diagnosis systems. We have consistently recommended it to non-programmers as one of the easiest ways to quickly develop a small system.

According to Will Hapgood, president of 1st-Class, and Larry Harris, AI Corp. founder, the major benefit of the acquisition will be in the area of product development. The combined efforts of the two companies will focus on (and we quote):

- ◆ Supporting 1st-Class products as a CASE-type front-end to KBMS, using its induction capabilities to accept examples and generate rules for KBMS applications. This will allow more direct user involvement in the development of KBMS applications;
- ◆ Applying AI Corp.'s mainframe expertise to develop an IBM mainframe runtime version of the 1st-Class products;
- ◆ Developing a cooperative processing link between KBMS and 1st-Class Fusion, allowing

customers to use 1st-Class for user-written applications on PCs that access KBMS applications on host processors;

- ◆ Providing the ability to merge components of 1st-Class and KBMS applications, so that users can build and maintain modules with 1st-Class and still get the multiple user and DBMS access capabilities of KBMS; and
- ◆ Creating a conversion path between 1st-Class products and KBMS that allows customers to migrate end-user applications to KBMS corporate DP applications.

Both companies have consistently stressed high-quality user interfaces and strong database connections. It will be interesting to see what AI Corp. will do with this acquisition.

## Symbolics Announces Frame-Thrower

Symbolics Inc. has announced two new products that may help cut development time for scores of international companies that are banking on the future of HDTV-based technology. The company unveiled the industry's first commercially available, high-definition videographics processor, called FrameThrower, and announced an all-in-one, high-definition videographics workstation that incorporates the new FrameThrower processor.

In other words, Symbolics is using its knowledge of Lisp and workstations to develop high quality software to help facilitate the development of the high definition television. For more information, contact the Symbolics Graphics Center, Symbolics, 8 New England Executive Park, Burlington, MA 01803; (617)221-1000.

## Exsys Enters into an Agreement with Sumisho Computer Service Corp.

Sumisho Computer Service Corp. (SCS), a subsidiary of Sumitomo Corp., has purchased a 20% ownership in Exsys, Inc. Exsys announced that it would use the cash infusion to expand its operations and improve its product, Exsys. (Exsys is available on MS-DOS, OS/2, Unix, and VAX/VMS.) Exsys licensed its source code to SCS for marketing in Japan. Exsys has been marketing its products in Japan for four years, and

the Japanese market now accounts for about 20% of its sales. Dustin Huntington, president of Exsys, Inc., argued that "Through the resources of SCS, Exsys will be able to focus on the entire Far East market, including China. The arrangement not only gives us capital to enhance our American operations, but gives us a strategic advantage in some very important international markets." For more information, contact: Exsys, Inc., P.O. Box 11247, Albuquerque, NM 87192; (505)256-8356.

### ExperTelligence Signs a Strategic Agreement with Alcatel ISR

ExperTelligence, Inc. announced a strategic agreement with Alcatel ISR, a Paris-based company that is a subsidiary of the giant Compagnie Generale de'Electricite (CGE). The agreement commits Alcatel ISR to make investments in ExperTelligence, Inc. (and gives it a seat on ExperTelligence's Scientific Advisory Board). It commits both companies to joint marketing efforts and a cooperative effort to develop portable versions of ExperTelligence's Action! and ExperAction CASE interface tools (which can be run in a variety of environments using ISR's C-based Spoke object-oriented development system).

Action! is written in ExperTelligence's common Lisp and runs on the Macintosh, usually on a microExplorer. This move, like lots of others, represents an effort for an expert system tool vendor to reposition itself as a CASE vendor. For more information, contact: ExperTelligence, Inc., 5638 Hollister Ave., 3rd Floor, Goleta, CA 93117; (805)967-1797.

### Avignon 90

From our talks with vendors and people in expert systems in Europe, it sounds like Avignon 90 is once again going to be the major expert systems event in Europe this year. The conference has the advantage of a wonderful location, but more important, it has the advantage of excellent organization and consistency — this will be the 10th year that the conference has been held in Avignon at the end of May (May 29 to June 2).

As in past years, the actual conference is divided into several sub-conferences. This year's special conferences include meetings on second generation expert systems (applications that in-

tegrate multiple expert systems techniques with conventional programming techniques to create complex systems), defense, electrical engineering, food processing, bio-technology, chemical and pharmaceutical industries, materials, telecommunications, and transportation. (All sessions are simultaneously translated so they can be heard in either English or French.) As in the past, there will be tutorials on the first two days of the conference and a major exhibition of the expert systems products being sold in Europe and the U.S.

If you can only go to one expert systems conference in Europe in 1990, and want the broadest coverage of the commercial side of expert systems, this is the conference to attend. Contact: M. Jean-Claude Rault, General Chairman, EC2, 269-287, rue de la Garenne, 92024 Nanterre Cedex, France; Phone: 331 4780 7000, Fax: 331 4780 6629.

#### EXPERT SYSTEMS FOR SALE

Harmon Associates is in the process of developing a Catalogue of all of the Expert Systems that we know about that are being offered for sale. If you sell an expert system, or know of a company that does, we would appreciate hearing about it.

Please contact Paul Heidt, Harmon Associates; (415)861-1660.

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# EXPERT SYSTEMS STRATEGIES™

The Monthly Newsletter for Managers and Developers of Expert Systems, from Cutter Information Corp.

Editor: Paul Harmon

## INDUSTRY ANALYSIS

### THE INITIATIVE FOR MANAGING KNOWLEDGE ASSETS (IMKA)

On April 24, Carnegie Group, DEC, Ford, TI and US West announced that they had formally established an new organization, the Initiative for Managing Knowledge Assets (IMKA). IMKA's objective is to develop a next-generation software technology that will allow companies to capture corporate knowledge and manage it as an asset.

Although the formal Initiative is just being announced, the five companies have been cooperating on this project since 1988 and have already invested more than a year of engineering development and some \$10 million in the effort.

They have, for example, already completed the technical requirements document and the functional specifications.

The contract establishing IMKA calls for the five companies to share and contribute technology, manpower and funds toward a joint development effort. The resulting products will be available to all five members to use either internally or to market as they desire.

IMKA's objective is to develop an industrial strength knowledge asset management technology that will be high performance, non-proprietary, easily integrated with conventional systems and applications, and distributed and portable within heterogeneous computing environments. The initiative members intend to work closely with existing standards organizations to ensure the compatibility of the IMKA technology with existing standards.

Carnegie Group will be the lead developer on the project and will undoubtedly draw heavily on its experience with Knowledge Craft. DEC has contributed its advanced version of OPS5 and Texas Instruments is acting as chief technical consultant to the effort.

Although the details are vague, IMKA proposed to develop one or more products that will be written in C and C++, designed to handle hundreds of thousands of objects and rules, and completely embeddable within existing company applications. They will initially run under X Windows and will eventually have hooks into SQL databases. The initial versions of the system will run on workstations but will be ported to various other platforms, interfaces and operating systems

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in time. (From a technical point of view, perhaps the most interesting aspect of the project will be to see how Carnegie implements a powerful semantic network system in C.)

When asked whether the Initiative is open to other companies, Ted Smith (technical director at US West and chairman of the IMKA management committee) replied, "Definitely. I am anxious to return to my office tomorrow and have phone calls coming in from companies in all industries who recognize the need to manage their knowledge assets and who want to participate in some way with the Initiative."

The companies expect to explain the Initiative in more detail at AAAI this summer and start releasing products by the end of 1990.

So what is one to make of this announcement? DEC, Ford, TI and US West are all owners of Carnegie Group. (They each hold about 10% of Carnegie's stock.) At the minimum, it is clear that the group intends to develop a C/C++ version of Knowledge Craft that will be specifically designed for the development and management of very large knowledge bases.

Given the degree to which DEC, Ford, TI, and US West have already invested in expert systems, this effort, if the Initiative is fully supported by the four companies, will bode ill for companies like IntelliCorp, Inference, Neuron Data and others who might have expected to sell lots of their tools to the four companies in the coming years. (Ford also owns an interest in Inference.)

The most exciting interpretation regarding the announcement is that the five companies are combining to challenge IBM's standardization initiatives by providing companies that want to create Unix-based, distributed systems with a non-proprietary standard for knowledge representation.

All current expert system-building tools are proprietary and none of them can share knowledge bases. Thus, as companies like DEC, Ford, TI and US West develop large numbers of expert systems, they find themselves in the same place that companies that use hierarchical databases found themselves in several years ago. They have lots of independent applications and no way to share, systematically update, or manage the data used by the different applications.

DEC's XCON, for example, has over 12,000 rules about how to configure DEC hardware and software products. Several different expert systems rely on the knowledge stored in XCON. At the moment, in effect, all of the expert systems that rely on XCON's knowledge must access that knowledge by using XCON's entire knowledge base. That's why the XCON knowledge base keeps growing. It's as if a company was forced to maintain a single, huge database that all applications had to share. DEC and other leading users of knowledge-based systems realize that a new generation of knowledge base technology is necessary if companies are ever going to build, integrate, and manage the large expert systems that will be built in the next several years.

IBM also realizes that this is a problem, and has proposed to solve it by creating standardized definitions of several knowledge entities (e.g rules, objects) in their AD/Cycle and Repository. Most of the expert systems vendors who are mainframe-oriented (i.e. Aion, AICorp, IBI) have already pledged to keep future versions of their products "AD/Cycle and Repository Compliant." In other words, some vendors hope that IBM will provide a standard knowledge representation format that they can use and that, in turn, will allow customers to store, retrieve and manage the components of their knowledge bases.

What the IMKA companies are proposing is an alternative, non-proprietary standard that will be designed to meet the needs of manufacturing companies that want to build very large knowledge bases and deliver them in Unix, VAX and other distributed environments.

The first step is for the companies to publicly announce the technical and functional specifications they propose. At a minimum, they will define a new expert system-building tool — a C/C++ version of the Knowledge Craft technology. (The consensus among most AI pros has always been that Knowledge Craft was the most powerful and flexible of the Lisp tools — but most have also agreed that it was poorly integrated and hard to use.) Once everyone has a chance to look at what IMKA proposes and learn about exactly how the technology will be non-proprietary, other companies will decide if they want to go along with the

initiative and pressure other tool vendors to become Initiative compliant.

It all sounds a bit like the struggles we've seen over Unix all over again. It makes sense for companies that are primarily in the consulting business (and that includes Carnegie Group, TI and DEC, at least as far as expert systems are concerned) to argue for open standards. Proprietary tool vendors like IntelliCorp and IBI, on the other hand, will probably not be inclined to modify their products in a non-proprietary direction. In any case, it's unlikely that IBM will stop working on its own standardization effort (IBM's TIRS is a part of the AD/Cycle-Repository effort) or that mainframe-oriented companies will no longer comply with any standard IBM promulgates.

When you consider that most of the expert systems developed and running on mainframes are relatively small and unsophisticated, and the really large systems, like XCON, are generally running on powerful workstations (and will increasingly depend on Unix and RISC technology), it's easy to see how the industry might evolve two separate standards — one for more modest, mainframe-related systems that are common in the service industries and another for the larger, distributed systems that are evolving in the manufacturing area.

There is, of course, a third approach that isn't as well-developed as those advocated by either IBM or IMKA — the use of object-oriented databases. There are some OO database people who would love to have their proprietary databases serve as a common storage and management tool for different expert systems. But, in general, the OODB people are oriented toward the C++

programmers and don't offer object definitions that are rich enough to store the objects that are used in expert systems. (More about this in a future issue.) Moreover, they don't include any convenient way to store and manage rules. In addition, the OODB companies are small and new and not in a position to set standards. At the moment, IBM or IMKA seems more likely to lead the way toward object-oriented databases that would simply be a component of an overall knowledge storage system.

To summarize: the significance of the IMKA announcement might simply be that Carnegie Group is going to develop a C/C++ version of Knowledge Craft and its corporate owners have decided to assure themselves unlimited access to the source code this time around. Or it might be the beginning of a very important and much needed move to provide a standard way of representing and storing knowledge. It will all depend on the products that are released and on the announcements that the Initiative members make in the course of the next 6-12 months.

There is certainly a need for knowledge base standardization, and it would be nice if it happened before too many companies build large knowledge bases in a variety of proprietary tools that can't share their knowledge. The problem is how to get from where we are now to where we would like to be. The Unix advocates haven't been doing a very good job of it; is it possible that the knowledge-based systems people can do it better? It's an exciting idea.

For more information, contact: Bruce Russell, Carnegie Group, Inc., 5 PTG Place, Pittsburgh, PA 15222; Phone: (412)642-6900.

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## APPLICATIONS

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### MONITORING, PLANNING AND SCHEDULING APPLICATIONS IN MANUFACTURING

The manufacturing industry has consistently been more active in the development and use of expert systems than any other segment of US industry.

Most of the knowledge-based systems used by manufacturing companies are diagnostic systems. They are the systems that it was easiest to build with the first generation of expert system-building tools. We have reported on manufacturing systems

in the past and most of the systems we described were either diagnostic or configuration systems (the second most popular use of the technology in manufacturing). In this article, we focus on monitoring, planning, and scheduling applications.

As a general rule, the planning and scheduling systems rely on pattern-matching rules, which, in turn, rely on at least some object-oriented or frame-based knowledge representation. (Pattern-matching rules, as we use the term, can do joins on instances of independent objects.) Most companies began with simple rule-based tools and are just now learning how to build hybrid systems that can tackle the more interesting monitoring, planning, and scheduling problems. Since the planning and scheduling applications tend to provide larger paybacks than the diagnostic systems, these systems are of great interest to knowledge engineering groups that want to prove the worth of the new technology.

From our informal survey, we've found that one of the more popular areas for expert system development is in the use of scheduling numerically controlled machines used in the hectic shop floor environment of just-in-time manufacturing.

In this article we'll look at some applications currently in use as well as some commercially available off-the-shelf packages. Sometimes the question as to whether these systems are monitoring or scheduling applications becomes blurry, but these distinctions are usually irrelevant because many of the applications encompass both areas of performance.

### Expert Systems Applications Used for Monitoring

Many manufacturing and most process control facilities operate 24 hours a day. The varying constraints involved in continuous-operation production require constant or real-time monitoring of equipment and inventory. Expert systems are more than ever being used not only to perform continual monitoring, but also to provide plant operators with guidance and assistance in locating and preventing production line problems. These problems can be caused by equipment failure, poor inventory tracking, and insufficient resources, whether parts or raw materials.

Following are some examples of how expert systems are being integrated with sensors, program-

mable logic controllers (PLCs), and other data collection devices to perform monitoring functions.

**CANBUILD** is an application for inventory monitoring designed and in use by Digital Equipment Corp (DEC). The system was developed using VAX OPS5 for tracking, coordinating, and analyzing inventory dispersed at DEC plants worldwide. The system allows management to identify — on a worldwide basis — the amount of inventory left in the pipeline and to determine whether it is more economical to write it off or build it up to make more products.

Prior to Canbuild, existing inventory control systems at DEC looked only at a single plant. The analysis of data across plants was done manually, which was found to be too time consuming, subjective, and inefficient. Also, different plants often released their quarterly reports in different formats, further complicating the inventory control process.

Now, using Canbuild, inventory information can be easily accessed in a consistent format regardless of where the inventory is kept. This allows for the making of timely and more consistent decisions based on up-to-date, corporate-wide inventory information.

Canbuild was developed for internal use only and is not for sale.

**GENERATOR EXPERT MONITORING SYSTEM (GEMS)** is an expert system developed by the Electric Power Research Institute (EPRI) that provides real-time, stand-alone monitoring of power plant generators, 24 hours a day. GEMS alerts plant operators of impending generator failure and instructs them as to the proper procedures necessary to avert it.

Operating at speeds up to 3600 rpm and handling large amounts of electrical current and voltage, turbogenerators are crucial to the operation of any power plant. Major generator failure can lead to repairs that take as long as six months to one year, resulting in power outages that culminate in the loss of millions of dollars.

The monitoring of generators by operations personnel is a constant task requiring that large amounts of data concerning operating speeds, times, equipment vibration, etc. be periodically scrutinized. And, depending on the generator, up

to 300 individual sensors may have to be evaluated at least once every three minutes.

By continually monitoring, correlating and updating sensor data, GEMS provides operations personnel with reliable and consistent advice on avoiding generator failure and power outages.

In developing GEMS, it was crucial that several important criteria be met. The system had to: 1) provide real-time monitoring; 2) be deliverable on different computers using different operating systems; and 3) be easily customized to operate in conjunction with the various generator configurations used in different power plants.

GEMS was developed using Inference's ART on a Symbolics 3670 Lisp machine and is deployed on Sun 3/60 workstations.

The system is presently operating on-line at Ontario Hydro's Nanticoke Power Station.

WOPS is a system developed by Epitec (Sweden) for MoDo-Chemetics and Frofifors Bruk (Sweden). WOPS monitors and controls filter washing operations for pulp mills. Developed using Epitool — a popular shell in Sweden that is sold by DEC in the US — the system monitors and evaluates the pulp washing process, then determines the necessary speed for optimum filter performance. Benefits include improved pulp washing quality and reduced costs.

CAMPBELL SOUP CO. is using an expert system to monitor the sterilization processes involved in their product canning operations.

Each product has its own thermal process heating parameters necessary for sterilization. Before a product can be released, the product safety department determines whether or not strict guidelines for sterilization have been met.

Sometimes, however, problems may occur that can cause processing deviations. When this happens, it is necessary to determine if the deviations have adversely affected the sterilization process — which would then result in the product having to be destroyed.

Prior to the expert system, Campbell was using a Fortran-based system to monitor for processing deviations in sterilization. This system required that data regarding what the conditions were when the food was processed be sent to the processing

safety department, who in turn, would determine whether or not the product would be released or destroyed. This decision, however, could take considerable time — sometimes up to eight weeks.

Now, using the expert system to transfer thermal process deviation controls from the laboratory to the factory, this decision is made in two or three minutes. The system handles multiple processing deviations simultaneously.

This newly acquired ability to make rapid decisions regarding the status of products has led to a reduction of unnecessary inventory. With the expert system products whose status is unknown no longer need to be held in inventory at the plant pending a decision from the processing safety department. Now, the product is either determined as fit for release or destroyed immediately.

The system was developed in-house using Aion's ADS development tool and operates on PCs. Campbell engineers felt that the continual addition of new products to the line required that any new system incorporate separate knowledge bases that could be easily upgraded. An expert system was deemed the most viable solution.

### Expert Systems Applications Used for Scheduling in Manufacturing

Scheduling is an area that lends itself particularly well to the use of expert systems. Due to the complex and demanding production schedules involved in just-in-time manufacturing, expert systems are proving to be useful in assisting shop foremen in task planning and assigning work to different machines. They are also helping to reconfigure line operations when interruptions due to equipment failure or inventory shortages occur.

DISPATCHER is a knowledge-based expert system developed using VAX OPS5 for assembly line and inventory control. Dispatcher selects, transports, and delivers parts for assembly to assigned workstations. By maintaining a database of products, lists of manufacturing steps for products, and manufacturing operations that can be performed on various workstations, Dispatcher controls the assignment of work-in-progress (WIP) on assembly lines consisting of storage carousels, robots, conveyor belts, and workstations.

In assigning WIP to a particular workstation, the system takes into account three factors: the operation a station is currently set up to perform; the completion date of the work, and the capacity/overhead of the storage operations of the line robots.

Benefits include real-time inventory control and increased efficiency of scheduling WIP. Dispatcher was developed internally by Digital Equipment Corporation. The system is presently in use and operates on Unix/VAX workstations.

**FOREMAN'S ASSISTANT for INTEL-LIGENT SCHEDULING (FAIS)** is a 500-rule expert system that does machine scheduling functions at General Dynamics' Division Manufacturing Facilities in Fort Worth, TX. Developed using Teknowledge's M.1, FAIS is designed to assist foremen in the prioritizing of manufacturing jobs to be set up and loaded into various numerically-controlled (NC) machines in a metal parts manufacturing environment — specifically lathes.

Depending upon the foreman's area of work, the need to reschedule operations may arise from several times a day to several times an hour. Efficient, cost-effective scheduling involves considering a number of factors, including the number and status of jobs in backlog, how long each job will take, individual machine constraints as to part dimensions, and the time it will take to set up the machinery for a particular job. FAIS operates by selecting the next job to be manufactured. The system frees the foreman of the task of deciding, once a job is complete, which job should be loaded next on a particular machine.

The system is accessed through a consultation which takes place on three screens. The user fills in a form on the first screen with the date, the number of the Task Center requesting the part to be manufactured, and the identifying number of the machine to be scheduled. Using this data, the system accesses a database of machine tools and a database of manufactured parts to determine which part should be manufactured on which machine, and then lists this information on the second screen. The third screen provides the user with information on any particular part, such as time saved by using a particular machine, whether a job has been "piggy-backed" on another job to save set-up time, and indicating if a job is particularly urgent.

FAIS is connected to an IMS database on an IBM mainframe through API (Application Program Interface) — a format that allows data to be communicated between mainframes and other NC machines. The system's form-filling front-end was created in PANEL — a popular forms sub-routine package for the IBM PC.

In addition to faster and more efficient scheduling, benefits of the system include a reduction in the amount of backlogged jobs and the freeing of shop foremen for more important tasks.

**FORGE SHOP SCHEDULING EXPERT (FSSE)** is an application for scheduling the production of large castings at the Ellwood City Forge in Ellwood City, PA. Developed using Knowledge Craft (Carnegie Group), FSSE has been in operation for nearly a year and is believed to be the first of its kind in the industry.

Ellwood City Forge is a custom order facility that produces large, open-die forgings — forgings that don't require costly closed dies that have to be machined to shape for each job — ranging from 1/4 ton to 25 tons. Individual orders for these forgings typically consist of only two or three castings. Quite often, no two orders are alike. And with over 2,000 orders on hand at any one time, job scheduling is a difficult process that must take into account not only completion deadlines, but also complex and conflicting manufacturing requirements for each part that include different steel grades, special alloys, various molds, strict temperatures and process times, etc.

The production process usually entails 4 steps:

- (1) Parts first begin at the Melt Shop in New Castle, ten miles north, where raw ingots and scrap steel are melted together with various elements, such as molybdenum, to create a steel alloy to meet a particular part's requirement.
- (2) Then, with the steel heated to red or white hot, giant forging presses squeeze it into a somewhat oversized version of the finished part.
- (3) A part is then heat treated, where it is first cooled rather quickly and precisely to preserve a fraction of the critical 1% or so of dissolved carbon that makes iron into steel and controls the degree of hardness. This hardened steel is then tempered by re-heating to a much lower

and precisely regulated temperature — typically 400°-600°F — and kept there for as long as several days. This process replaces brittleness with toughness.

- (4) Finally, the part proceeds to machining, where it is shaped to final dimensions on a huge lathe or milling machine. This entire process may be further complicated if a particular part should require an unusual composition of steel, because it takes approximately the same time and energy to heat a partial melt as it does to heat a full melt.

The objective in planning a production run is to schedule the different job orders so that they coincide with the supply of a particular steel melt on hand (already hot and ready to pour), thereby eliminating the necessity of heating a different batch of steel for each particular casting. Formerly, this responsibility was shared by several human schedulers. However, optimizing overall performance was always an elusive goal.

Now, FSSE enables this scheduling to be done much more consistently and efficiently with benefits that include: improvement in material yield, reduction of energy consumption, and the reduction in order turnaround time from eight weeks to less than three weeks. The system also provides a competitive advantage by allowing the company to more accurately estimate price and delivery times for a particular job, thereby helping to improve customer satisfaction. FSSE was developed in a joint effort between Ellwood City Forge and Carnegie Group of Pittsburgh, PA and runs on series of VAX machines.

**LOGISTICS MANAGEMENT SYSTEM (LMS)** is an expert system developed for internal use by IBM Burlington that aids in the process control of a chip fabrication line.

The fabrication process involved in manufacturing silicon chips is extremely complicated and entails adhering to strict temperature and production guidelines. The entire process involves between two hundred and three hundred steps.

LMS provides continual real-time monitoring of every step in the production process. It maintains a snapshot, available to every manager of every operation in the line, and automatically slows, speeds up, or holds the line as conditions

dictate. LMS was developed using eXpert Environment (XEN).

**MOLD SCHEDULING SYSTEM** is a PC-based expert system for scheduling plastic injection molds and molding machines at the Ford Motor Company's Sandusky, OH, Plastics Plant. The system accommodates cross-loading of molds in machines and multiple copies of the same mold while ensuring that molded parts inventories do not fall below minimum or exceed maximum levels specified by the user. Mold Scheduling System was developed using Production Systems Technologies' OPS83.

### Commercial Expert Systems Development Tools and End-User Products

There are a number of tools being sold for developing monitoring and scheduling applications. We are also seeing more and more end-user applications that can be customized to fit the particular needs of the user.

**FIRED HEATER ADVISOR (FHA)** is a customizable application that provides real-time monitoring and trouble-shooting advice on the operation of fired-heater furnaces and boilers. Fired heaters are a basic component used in most petrochemical plants for heating up and cracking hydrocarbons. The system incorporates the advice of a company's best fired-heater operators and engineers in a knowledge base.

Linked to on-line data from process computers and distributed control systems, FHA reads data on a real-time basis, continuously monitoring the burner, air preheater, fuel supply system, heating coils, fans, and control valves of a fired heater system. It helps identify such problems as line fouling, tube leaks, false drafts, false instrument readings, and control valve malfunctions.

In this manner, the system provides qualitative interpretations of problems facing the operators of fired heater equipment and, most importantly, provides recommendations on how to alleviate them before they become critical. For example, FHA not only helps point out that certain boiler temperatures are too high because the operator has lost control of the primary flow rate, but also alerts the operator as to which pumps have failed or are failing and what measures should be taken in order to restore the proper flow rate.

The major benefit of the system is that it provides operators with real-time monitoring and advice on alleviating problems associated with fired heater operations. It enables a company to apply its best expertise in a situation where some of the problems that arise can be detected at a very early stage, thereby allowing problems to be dealt with in a consistent and well thought out manner. Gavin Fin, consulting Engineer at Stone & Webster, says that "FHA provides fired-heater operators and other plant personnel with the ability to recognize and preempt problems so that they are not suddenly faced with a catastrophe to deal with — rather minor issues before they become major."

The system also saves its conclusions and recommendations in a historical data record, thereby providing additional information for more detailed analysis of plant operations.

The application was developed using Stone & Webster's own development environment — Blackboard — which allows you to run expert systems in real time using real-time data. The system runs on VAX machines and IBM PCs. It can also be linked to the Honeywell TDC3000 and a variety of other distributed control systems.

For more information, contact: Stone & Webster Engineering, Advanced Systems Development Services, 245 Summer St., Boston, MA 02107; (617)589-2737.

**PERSONNEL SCHEDULER** is a system that was originally developed for a large manufacturing company to assign personnel to specific tasks while satisfying a complex set of requirements and constraints. The system matches needs to employee skills and availability, and monitors the experience profile of individual personnel to ensure that professional growth is factored into assignments.

The system is useful for reassigning personnel because of sickness, changed production requirements, or other unforeseen situations. The system operates on a PC.

For more information, contact: Technology Applications, Inc., a division of Bechtel, 6621 Southpoint Dr. No., Suite 310, Jacksonville, FL 32216; (904)737-1685.

**PRODUCTION SCHEDULING ADVISOR (PSA)** is an application to help planners in the bulk chemical industry prepare a long-term production schedule for products that are produced either continuously or intermittently, with the primary focus on intermittent production. It is designed to assist schedulers in planning day-to-day production over a forecast period of up to 12 months.

PSA is implemented partly in a programming language (C) as opposed to being implemented entirely in a shell, and is connected with a linear optimization program as well as an expert system. The system is actually 4 different software programs bundled together to form a stand-alone set of applications consisting of:

- ◆ an input module that is connected to Excel databases;
- ◆ an optimization program using HyperMacLINDO;
- ◆ Stone & Webster's own custom Gantt chart for visual display of the scheduling cycle; and
- ◆ the LEVEL5 expert system for determining the feasibility of a production schedule.

User interaction is provided primarily by the system's interactive Gantt charts, which provide a scheduler with a graphical, color-coded picture of the scheduling process, showing all production constraints and inventories.

The Gantt charts provide scheduling information as to when you can or cannot produce a particular product because of:

- 1) Inventory constraints — too little or too much inventory, or storage capacity has been reached or;
- 2) Conflicts with other units — you don't have the raw materials, the line needs to be reconfigured, etc.

By using a mouse, the user can manipulate a particular production cycle or set of cycles [schedule(s)]. This allows projected changes to be made to the production cycles, which are then immediately reflected on the Gantt chart and the inventory graph.

In this manner, the user can perform "what if" scenarios to determine how different schedules and problems will affect production, such as turn-



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## The Future of the Database

With relational databases (DBs) set for adoption, what will the next step be? This report examines the technological developments taking place and measures them against users' requirements. Distributed DBs will be the cohesive force which will finally enable organizations to reach for that elusive goal ... integration. The most important step will be IBM's introduction of heterogeneous distributed DBs as the first implementation of SAA, linking together all mainstream

products, from PCs to mainframes. By Keith Hales and Christine Guilfoyle. 290pp/1989 Price: \$995, \$1035 outside N. America **Item Code: 04W**

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## CASE Analyst Workbenches

### A Detailed Product Evaluation

There has been a dramatic increase in the number of commercially available CASE analyst workbenches (or CASE tools), providing you with a better choice of functions and features. There is also more you have to consider before choosing a CASE tool. This report helps you select the best tool for the job, saving months of evaluations. A comprehensive guide to analyst workbenches, detailed, comparative product evaluations of more than 50 leading products, and product comparison charts provide you with a quick-view evaluation of currently available products. By Rosemary Rock-Evans. 784pp/1989 Price: \$995, \$1035 outside N. America **Item Code: 09F**

## Object Oriented Systems

### The Commercial Benefits

Object-oriented systems (OOS) offer the best opportunity for improving software productivity in the 1990s. This report explains why — and tells you the implica-

tions for the computer industry and its customers. It covers object-oriented analysis, design, and databases as well as all the vital OOS ideas such as data abstraction and inheritance. You get information on the real ROI you can expect from increased software development productivity. Learn how OOS provides for reusing software components and designing programs for easy maintenance and enhancements. You will find an extensive look at the markets for object-oriented products in the 1990s and strategies you can use to succeed in them. Includes detailed vendor profiles, user case studies, comprehensive vendor directory. By Judith Jeffcoate, Keith Hales and Valerie Downes. 423pp/1989 Price: \$995, \$1035 outside N. America **Item Code: 09H**

## CASE: The Next Steps

This new report gives you a full analysis of the real issues at stake in the CASE market, and shows how it will evolve in the 1990s. Detailed discussion of the benefits of CASE, the implications of technical innovations in "second generation" CASE, like reverse engineering and multi-user repositories. Plus, a comprehensive set of market scenarios and projections for the US, the UK, France, and Germany. A complete update of *CASE: Commercial Strategies* (1987) which is in use by more than 500 organizations worldwide. By Julian Hewett and Tony Durham. 350pp/1989 Price: \$995, \$1035 outside N. America **Item Code: 09G**

## Document Image Processing

### The Commercial Impact

Document image processing (DIP) integrates existing technologies to make it easy to capture and store large volumes of documents — solving the inefficient and expensive task of data input. Major system suppliers, including IBM, are already launching into the market that is expected to double by 1992 and double again by 1994. What are the real benefits and costs? ... How will DIP be integrated with existing applications? ... Which technological breakthroughs will be most critical in broadening DIP ap-

plications? ... How will IBM's entry change the market? Whether you are a hardware supplier, software vendor, systems integrator, or end user, this report gives you a detailed picture of the DIP industry in the 1990s. Includes management summary, technology review, applications, suppliers and markets, supplier profiles, and user profiles. By Keith Hales and Judith Jeffcoate. 300pp/1990 Price: \$995, \$1035 outside N. America. **Item Code: 03Z**

**Analysis Techniques for CASE A Detailed Evaluation**

This new report will help you select the most appropriate analysis technique for your CASE projects. What analysis techniques exist? What do they offer? How do they compare? Which techniques are supported by which commercial tools? Which techniques are most widely used? What do users think about them? You will find the answers to these and more, plus hands-on reviews of 71 analysis techniques and extensive market forecasts. By Rosemary Rock-Evans. 600pp/November 1989 Price: \$995, \$1035 outside N. America **Item Code: 09J**

**Real-Time CASE The Integration Battle**

The real-time CASE market is growing ... to \$1 billion by 1992. Real-time CASE users have different needs from those of other MIS professionals. Real-time customers, including many of the largest systems builders — in aerospace, defense, and engineering — prefer to construct their own Software Development Environment, because they need to support their own development processes and methods. For real-time users, ease of tool integration is therefore critical for success. Whether you are a software product supplier, computer and workstation supplier, systems integrator, software developer, or user with large software projects ... this report provides you with an objective, comprehensive look at the technologies, the market forecasts, the applications, the vendors, and the users. By Caroline Chappell, Valerie Downes, and Collin Tully. 365pp/November 1989 Price: \$995, \$1035 outside N. America **Item Code: 09I**

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*The James Martin Productivity Series* provides you with up-to-date, objective, authoritative information on a wide range of strategically important software technologies. The 17 volumes will help you select and implement new technologies to increase your competitive advantage. Each volume, available individually, include the initial volume in 3-ring binder and 1 year of quarterly updates. Price/Volume: \$307, \$345 outside N. America. *Save 20% on orders of 2 or more volumes.*

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The LEVEL5 expert system module contains a rule base of about 225 generic scheduling rules that apply to all products. One of its functions is to determine if a schedule is feasible given the production capacity at a particular time. It also helps a scheduler in determining the production sequence of various products and can diagnose problems with the initial sequence sent to the optimization program. By diagnosing problem areas in existing schedules, the system can provide advice on how to circumvent production constraints, and suggest trade-offs between various products when a scheduler must reduce overall demand on production.

PSA can be applied to a variety of scheduling situations involving multiple products, units, raw materials, and shared production facilities. The system is presently being used by a large chemical company where the time required to plan a 12-month production schedule was reduced from several days to hours. In operational scheduling, planners are doing 12 month schedules on a day-to-day basis for 60 products produced in 6 individual units (also chemical production).

PSA has been tested for scheduling tasks involving up to 300 products produced in 25 machines for paper manufacturing.

The major benefits of the system are:

- ◆ It helps provide a consistent approach to production scheduling; by "walking" the scheduler through the necessary steps, and by alerting him/her to any production constraints, human error is limited.
- ◆ It provides feasibility checks to determine if a planned schedule is actually possible given the production capacity.
- ◆ It provides a scheduler with guidance in determining the sequence of production operations.
- ◆ It helps determine alternate schedules when production restraints occur.

PSA runs on a Mac II platform with 5 MB of RAM and a 40 MB hard-drive. Additional software required is Microsoft EXCEL, HyperMacLINDO, and LEVEL5. It is currently being ported to an

IBM PC platform running Presentation Manager for large scheduling operations and Microsoft Windows for smaller jobs. In the future, the system will be ported to operate in a VAX environment.

The system can be integrated with existing databases for downloading production information, field inventory, and sales demands, etc. (Mac to Mainframe database transfer.)

John Slater, consulting engineer at Stone & Webster, defined the PSA as a "scheduling system incorporating interactive graphics tools with a lot of built-in constraints and a lot of built-in know-how about production scheduling." He further added: "the successful use of the expert system is not in a stand-alone piece, but as an integrated part of other tools." For more information, contact: Stone & Webster, Advanced Systems Development Services, 245 Summer St., Boston, MA 02107; (617)589-2737.

**THE SCHEDULER**, developed and sold by Intellicorp, is a KEE-based application designed to assist with both tactical (daily) scheduling and long-term planning.

Used as an on-line scheduler integrated with sensors and other data capture systems, the application helps monitor plant operations and enables plant personnel to react to changes on the shop floor as they take place.

Used as a scheduling "workbench", the system allows the user to develop different scheduling methods that support: 1) different search strategies — forward in time, backward from a deadline, or outward from bottlenecks; 2) different "styles" of search expansion — by time or by job; and 3) development of scheduling assumptions that can be modified to suit a particular scheduling scenario, such as batch jobs, use of pre-configured machines, and assembly of component parts.

The system can also be integrated with Intellicorp's ActiveGantt module to provide interactive graphics that allow the development of "what if" schedules. This enables the user to analyze and check the validity of different scheduling options.

Benefits of the system include providing on-line monitoring of plant operations, ease of scheduling and rescheduling production operations, and enhancement of existing data collection systems. In

addition, the system also provides 64 different reports regarding scheduling operations, including: utilization of machine and by which person; work in process by machine and area; throughput time — average and by job; production by machine and area, and scheduling ratings — quantitative descriptions of the validity of a schedule.

Peter Rieman (Applications Group at Intellicorp) says that The Scheduler is one of their most successful applications. The system is now being used in two large European semiconductor plants and for PC board manufacturing. It is also being used for scheduling machining and maintenance operations in an automotive parts plant, and for the simultaneous assignment of molds and machines with different job orders in an injection molding facility.

For more information, contact: Intellicorp, 1975 El Camino Real West, Mountain View, CA 94040; (415)965-5500

### Domain-Specific Tools

**G2** is a powerful Lisp-based expert system-building tool that could be used to develop any number of different types of applications. However, G2 has lots of features that make it especially good at handling real-time planning and scheduling, assembly, optimization, and quality control for large, distributed manufacturing environments. As such, G2 is primarily being sold as a domain-specific tool for manufacturing companies interested in real-time applications. It is being used to develop applications in a large number of manufacturing companies and is also popular in the telecommunications industry.

G2 has advanced facilities for object-oriented knowledge representation, dynamic testing and on-line monitoring and control. Applications developed in G2 can be integrated with other control systems, such as PLCs, databases, dynamic simulation packages and other sources for real-time data. G2 operates on workstations and PCs and a wide variety of mainframes.

For more information, contact: Gensym, 125 Cambridge Park Dr., Cambridge, MA 02140; (617)547-9606.

**EXPERT CONTROLLER** is a CMOS microcomputer-based expert system for factory automation. The system is designed to provide

real-time monitoring, tuning, and diagnosing of line system technology. Expert Controller may be interfaced with alarm systems, programmable logic controllers, and PID controllers. The system can operate independently without an operator.

Expert Controller is a commercial system developed and sold by Umecorp. For more information, contact: Umecorp, 745 San Clemente Dr., D-220, Corte Madera, CA 94925; (415)924-6700.

**ROCKY**, another expert system-building tool that is clearly tailored for the manufacturing domain, has recently been introduced by a new company, Expert Edge. (Not to be confused with a rule-based tool of the same name that was sold by Helix in the UK.) Rocky was introduced at the recent Detroit Society of Engineering IPC conference. Rocky is designed to handle monitoring and diagnosis problems in a manufacturing environment. Thus, Rocky connects to standard controllers, PLCs (Allen-Bradley and Modicon Modbus) and sensors. It also interacts with standard databases and statistical process control programs.

Rocky is available on PC/ATs (and will be available on Macs). The complete PC development version sells for \$4,400, although I/O drivers cost extra (\$900 to \$1800). For more information, contact: Expert Edge, 1000 Elwell Ct. #228, Palo Alto, CA 94303; (415)969-2800.

### Summary

Expert systems are increasingly being used for monitoring and scheduling of manufacturing operations. They are proving to be particularly useful in planning production operations for job-shops — as in the case of the forge scheduling application — and in scheduling the use of numerically controlled machines for just-in-time production (General Dynamics' Foreman's Assistant).

By providing guidance in terms of how to sequence manufacturing operations, they are helping to make such tasks as production scheduling and line reconfiguration much easier and more efficient. And, by providing feasibility checks, expert systems can help determine whether a planned production schedule is in fact possible given the amount of available manufacturing capacity.

Expert systems are also being used to perform tasks where traditional mathematical optimization

approaches do not work well because of the existence of too many non-linearities, for example the recovery of various raw materials left over from a previous production run in chemical manufacturing.

In order to work properly, expert systems should be user-friendly, able to operate on existing plant hardware, and be easily integrated with other

data-collection devices such as sensors, programmable logic controllers, etc.

The use of expert systems in manufacturing will continue to grow. As manufacturers strive to improve production and integrate their operations without adding additional personnel, they will increasingly look to knowledge-based technologies to help them solve their problems.

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## COMPANIES

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### DEVELOPING A SCHEDULING SYSTEM AT FORD

The following is based on an interview conducted with Dr. Hwa Sung Na, a senior computer engineer at Ford Motor Co. Dr. Na has developed and implemented the Foreman's Dynamic Scheduling Assistant, an expert system application to assist foremen in day-to-day production scheduling. The system is a nice example of how expert system-based scheduling applications are being used.

We found her story particularly interesting because of the development approach she outlines and because of the helpful insights she provides into developing a rule-based application — insights that should be of interest to anyone considering building an expert system application.

The Foreman's Dynamic Scheduling Assistant (FDSA) is a rule-based expert system, consisting of approximately 200 rules, that helps a production foreman schedule a 16 hour production cycle in 1 minute or less.

Dynamic scheduling differs from traditional Manufacturing Resource Planning (MRP) in that it addresses a production schedule where a short-term response is required. Dynamic scheduling is intended for use in a more flexible and variable manufacturing environment, being particularly well suited for just-in-time production. MRP traditionally focuses on long-term production goals, not the day-to-day scheduling operations involved in a flexible manufacturing environment.

Realizing that the life of a shop foreman in a just-in-time manufacturing environment is quite hectic, Dr. Na decided to develop an expert system

application to help him/her solve production scheduling problems quickly and consistently.

Dr. Na wanted to build her application very simply, so she developed a set of underlying principles to follow, the most important of which is that the factory foremen are the ones who will be using the system. Therefore, she tailored the development for their use — not a computer scientist's.

The plant for which Dr. Na developed her application operates a flexible manufacturing system comprised of about 100 different varieties of components. These are combined into about 100 different sub-assemblies and then added to more "purchased" components, resulting in about 80 different items that are then shipped to various customers.

#### Foreman's Constraints as Rules

Although many manufacturing constraints are well understood, the constraints imposed on the foreman are much harder to define. In order to keep the application simple and easy to use, Dr. Na interviewed a well-experienced foreman and, rather than try to implement a tremendous amount of rules, she simply asked him to state the major goals he attempts to accomplish when performing his job. He provided her with three separate goals, which in effect, became rules:

- 1) just-in-time production with no stockpiling of inventory;
- 2) if you must stockpile inventory, you must minimize it as much as possible; and
- 3) problems involving scheduling and line operation must be settled quickly.

Dr. Na also imposed another demand on the application — that it perform its task in one minute or less.

However, Dr. Na explained that just-in-time manufacturing sometimes just isn't possible because of the number of machines available, or because of inventory restraints or customer demands. "For instance, if you have 8 available machines and 15 customers, you are going to have to stockpile products whether you (the foreman) like it or not," she says. This necessitates making one component before another — which in turn imposes the additional demand of building up inventory. "The goal," she says, "is to minimize inventory on hand. And to do that, you make that part as close to the original completion date (shipment date) as possible; if it was originally needed at 3:00 you make it at 2:00, etc. However, if all the machines are configured to make a different part at that particular time, you must make it late. But make it as close to the original due date as possible."

These simple goals, provided by the foreman, are the underlying rules that Dr. Na used to develop her expert system application for Dynamic Scheduling.

### Manufacturing Constraints as Rules

Of course, she had to add to the foreman's rules the manufacturing constraints, such as all the parts configurations — which part goes into what product — and demand and volume restraints. She explained that it is necessary to break high volume demands down into small batches. This is because if large orders are not broken down into smaller batches, and one customer has an order for 10,000 parts, and another customer has an order for 200 parts, the smaller order would never be filled. In other words, the time required for producing the larger order in one production cycle would consume most or all of the production/scheduling time.

However, by breaking down large orders into smaller batch jobs, it is possible to juggle the production of parts. For example, you would produce only a partial amount of the order for 10,000 parts — say 300 units — and then switch over and produce the order of 200. Having completed the smaller order, production is again switched over until the larger order is finally com-

pleted. This juggling of orders may take place any number of times until the larger order is finally completed.

Even with all the analysis and empirical reasoning and intuition involved in implementing these constraints as rules, Dr. Na said the overriding principle still must remain the "just-in-time" demand.

### Application Development and Delivery

The application was initially developed in two weeks using OPS5 on a DEC system (she had been gathering the necessary information for over the past year or so). "To develop an expert system is relatively easy," says Dr. Na, "however, implementing it is another matter." (OPS5 runs on a VAX system and the manufacturing plant uses an HP 9000 system.) Dr. Na's intention was to develop the system on a VAX because that is what the division's computer lab operates, and then port the system to the HP operating in the factory and the PC running on her desk. This would allow her to have the application up and running on her office desk at the same time that it was in operation on the plant floor, thereby alleviating the problem of always having to go to the company's computer lab whenever a glitch in the system arose.

Porting the application to the different operating systems — DEC (VMS), HP (UNIX) and PC (DOS) — was a major stumbling block; she'd developed the application in December 1986 and by January 1987 it was up and running. However, she was unable to port it to the HP on the plant floor. This problem with portability is one area that Dr. Na feels developers must consider very carefully: "Sure you can go to the plant and tell them you've got the greatest invention to solve all their problems — all they need to do is purchase some new hardware and software, but you're not going to be received very well by MIS or the would-be operators of the intended system." She adds, "If they are accustomed to operating in the HP world, and suddenly there is a new computer and system that they will have to operate and maintain, all you are doing is creating a new problem to solve an old one..."

### Portability Problem Solved

Her portability problem was finally solved when she purchased the CLIPS expert system shell from NASA for. NASA, being a federally (tax-



payer) funded government agency, must sell the shell at a reasonable (non-profit) cost. Dr. Na feels that CLIPS is one of the best tools on the market concerning portability and user documentation. (However, please keep in mind that Dr. Na is an experienced programmer. Someone with little or no programming knowledge, but who is interested in developing an expert system application, might find CLIPS more difficult to work with.)

Dr. Na purchased the PC version and ported the OPS5 program to CLIPS. CLIPS is a highly portable tool that is able to run in most operating environments. She said that porting the source code to the DEC system only required re-compiling her application — “that it wasn’t necessary to change one bit of the source code.”

This allows the system to be running on a DEC machine in the division’s computer lab, on a PC sitting on her desk in her office, and the Ford factory in Indiana. Porting the system to the HP 9000 system that controls the plant scheduling operations was no problem. Dr. Na says she “simply piped the application to the Indiana plant using a telephone modem.”

In effect, CLIPS allows her to run her application in 3 different operating environments: DOS, VMS, and UNIX. And in order to accomplish this she only had to compile the system one time. “All software developers,” says Dr. Na, “should give you this type of capability.”

### System Use

Dr. Na says that the plant operators immediately welcomed the system. However, at first it wasn’t as robust or error-free as she would have liked it to be. Early problems were usually due to an error on the operators’ part. For example, they incorrectly entered the hours or minutes and the system bombed out. Dr. Na says she didn’t have the time to work out some of these system bugs, so Ford hired a graduate student from the University of Michigan to make the system more user-friendly. In 2 weeks, he was able to make the necessary changes in order to upgrade the system — and he had no former experience with AI or expert systems.

The system is currently being used to perform scheduling operations in a tube-bending area handling about 280 different parts. Because it

would be too impractical time-wise for a foreman to have to look up a required part number, the system is integrated with the plant’s Factory Information System. This makes for easy user interaction. To use the system, an operator first calls up a list of parts on the system screen. Then, the needed part is highlighted and the required volume and completion times are entered. The system then determines the optimum manufacturing schedule and advises the foreman on the needed steps required to set-up the machines, etc.

This allows for fast and efficient rescheduling. If a machine breaks down, a foreman doesn’t have to estimate how long it will be down or try and figure out an alternate manufacturing schedule. All they have to do is enter into the system the number of a machine that has failed and the system will determine an alternate schedule for them. Likewise, when the machine is repaired, this information is entered into the system and it again reconfigures a new schedule. And, thanks to Dr. Na’s earlier development demand, the system is able to perform this task in 1 minute or less.

Dr. Na feels that her system is successful because it is so easy for the operator to use, and the reason for this is because it is integrated with the Factory Information System. She says that 90% of the effort required in implementing the system was spent on integration with the Factory Information System. It has survived three generations of foremen and still remains in use. The system has also proven to be very adaptive. Someone else at Ford has taken her shell and developed an application for scheduling injection molding operations.

Dr. Na provides some pointers for those considering developing expert systems applications:

- ◆ 1) The major point is that “the system must be easy for the operators to use... the user doesn’t care what the technology behind the system is, if a calculator does the job and it’s easy to use, then it is a success.”
- ◆ 2) The application should be able to run on existing hardware.

- ◆ 3) It should be modular so that it is easily upgradeable to fit a constantly changing environment.

Dr. Na also feels that AI and expert systems in particular are not giving us all the benefits we

hoped for 10 years ago because they too often violate the above criteria.

CLIPS costs \$312. For information on CLIPS, contact: Cosmic, The University of Georgia, 382 E. Broad Street, Athens, GA 30602; (404)542-3265.

## ED MAHLER ON EXPERT SYSTEMS

Ed Mahler used to be the head of expert systems at Du Pont. No more; he has just been promoted to Manager of Decision Support. Du Pont has three major IS groups: transactions, data base management and decision support. The expert systems group is now included under decision support — which seems its natural place, according to Mahler.

The way Mahler sees it, the transactions group handles the daily business of a company. They record activities and handle the accounting associated with doing business. They manipulate and create data by adhering to relatively rigid and inflexible procedures. (Which, of course, is just what you want from the people who handle your accounting and manage your inventory.)

Decision support, on the other hand, focuses on diagnosis and planning and provides competitive insight. For these purposes, "close" is often good enough. Mahler goes on to argue that all decision support tools are, in effect, models of the company's business. Thus, decision support requires tools that allow users to develop models of how they do business. You need to use standard tools to get economies of scale, but you want to be able to use those tools to provide custom solutions since every business model is a little different. And that, according to Mahler, is exactly what expert system tools are good at.

We asked how many expert system applications Du Pont has at this point and Ed answered "about 800, but we're likely to double that this year."

Since we have been talking a lot about how the various vendors are all rushing to get versions of their tools up on mainframes, we wanted to know what Ed thought about expert systems on mainframes. Since he has been one of the most vigorous advocates of a small systems approach,

we wondered what role he thinks mainframe-based expert systems will play at Du Pont.

Mahler's first response was to admit that Du Pont had built a number of expert systems on mainframes. But then he quickly added that they had moved a lot more applications from the mainframe to a workstation than vice versa. "Expert systems are memory- and computer-intensive applications," Mahler argued, "and that means they are a lot better running on workstations than on mainframes." He went on to acknowledge that Du Pont had some transaction-based expert systems that should stay on the mainframe, but "not many." Ed said that in his experience, the mainframe expert systems generally run two to three times slower than transaction processing applications. Most of Du Pont's mainframe applications are being used to verify data entry.

Mahler stressed that most of Du Pont's small expert systems had been developed by technicians and casual programmers, but that the mainframe tools were not for casual programmers. Ed has four people in his expert systems group working on mainframe applications. Du Pont uses AICorp's KBMS.

The other two tools commonly used by Du Pont are Level5 and RS/Decision (a forward-chaining VAX-based planning and scheduling tool developed at Du Pont that is being distributed by BBN. RS/Decision is highly integrated with RS/1, a BBN 4GL. We haven't heard much about RS/Decision, but we'll let you know what it's like as soon as we learn more.).

We asked if Du Pont was looking forward to Level5 Object, which they have experimented with in beta. Mahler said that there were some uses that it would be good for, but that Du Pont was still doing lots of small, simple applications, and that for the moment, they would probably stick with the

original Level5 for most of their applications that will run on DOS.

As always, it was fun to talk with Dr. Mahler. And it's nice to hear that Du Pont likes what he has done with expert systems well enough to ask him to take on a lot more responsibility.

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## TRENDS AND NEWS BRIEFS

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### Aion Reduces its Staff

Aion just reduced its staff by 28 people, mostly by consolidating and rearranging its sales offices and laying off salespeople. This leaves Aion with a staff of about 150 employees. At the same time, Aion is in the process of completing a new round of financing. The layoff probably reflects three things: growing competition, the cash-flow problems associated with rapid growth, and being a little late in completing their new financing.

Aion also announced the establishment of a cooperative marketing agreement with IBM Canada, Ltd. which allows IBM to market and take orders for Aion products in Canada.

### Neuron Data Appoints Executive Vice President

Neuron Data just announced the appointment of Randy Dieterle, formerly vice president of systems and support at Oracle Corp., to the newly created position of General Manager and Executive Vice President. Dieterle will be responsible for all operations at Neuron Data. As vice president at Oracle, Dieterle managed over 200 people and his responsibilities included management, marketing and sales, post-sales technical support, customer relations, and advanced systems consulting.

### Expert Systems and AAI

The American Association for Artificial Intelligence will have its annual meeting in Boston from July 29 to August 3. There will hardly be any expert systems presentations during the meetings (AAAI wants to be a research organization and thinks expert systems are too commercial), but there will be exhibits and several companies will be showing new products. Until a new organization or conference emerges as the best place for commercial expert systems people to meet (and several are trying hard for the honors), AAI is

probably still the best place to go to meet people and find out what's happening with the technology.

For more information, contact AAI, 445 Burgess Drive, Menlo Park, CA 94025; (415)328-3123.

### Borland Introduces Turbo C++

Borland just announced the availability of Turbo C++. The new language will feature full compatibility with AT&T's C++ release 2.0 specification.

C++ is already the leading commercial object-oriented language, and up until now there was no version of C++ available on a PC from one of the major language vendors. The new product, which will become Borland's flagship C product, will sell for \$99.95 for at least the first 60 days. Later the price will raise to \$199.95. Borland will also offer object libraries for the new language. Borland already sells an object-oriented version of Turbo Pascal (5.5).

We fully expect most C programmers to convert to C++ in the course of the next two to three years. AT&T has always positioned C++ as the latest enhancement of C language development efforts. Borland will certainly speed the process along by putting its weight behind the movement toward object-oriented programming languages in the way it has.

This will create some interesting opportunities for expert systems developers within corporations. One group of people may be interested in C++ programming and another in expert systems development, but both groups will share a whole new perspective on programming. Expert systems often employ object-oriented techniques, and in any case, both expert systems and OOP entail symbolic programming, modularity and reusability, logical inferencing (in the sense that inheritance is a kind of inferencing), and late or dynamic binding. The two groups could have some interesting

conversations. In the short run, expert systems developers could teach C++ developers some new ways of thinking about design and development. In the long run, knowledge-based systems development will probably be accelerated as other programmers learn about C++ and then feel more comfortable with many of the kinds of concepts that expert systems people have been advocating in the last few years.

### IBM Adopts Smalltalk/V for OS/2 PM Development

At the same time that Borland released C++, IBM has begun encouraging OS/2 Presentation Manager developers to use Smalltalk/V to develop new applications. It is even rumored that IBM might eventually make Smalltalk/V part of its SAA standard. The move, according to IBM sources, has been made to accelerate the development of OS/2 applications.

Smalltalk is the Lisp of the object-oriented world — its a pure OOP language that is powerful and flexible. (Although CLOS, the object-oriented Common Lisp standard, is arguably more powerful and flexible.) Smalltalk, which has been around since the mid-seventies, is very popular among many object-oriented programmers.

In general, however, even though the hybrid object-oriented languages like C++ and Objective C are less powerful, they are more popular because they use an already familiar syntax and they make compromises that make them more efficient at run-time.

IBM has already cut a deal with Stepstone, the company that sells Objective C, and with Next, the company that uses Objective C in its interface which IBM now offers on its new RISC machine. And now IBM adds Smalltalk to its list of object-oriented languages.

A skeptic might say that IBM is going out of its way to avoid endorsing AT&T's C++ (which is closely linked with AT&T's Unix.) An optimist would argue that it has selected a very powerful object-oriented language to advocate. Unfortunately, it may end up like the companies that tried to sell corporations on using Lisp for expert systems development. Sure, Lisp is powerful and flexible, but...

We bet that the success of object-oriented programming, like the success of expert systems, will depend on object-oriented development (or CASE) tools rather on a language.

Smalltalk/V for the OS/2 Presentation Manager is sold by Digitalk Inc. For more information, contact Digitalk Inc., 9841 Airport Boulevard, Los Angeles, CA 90045. Phone (213) 645-1082.

**Correction:** In Issue 3, we misquoted the price of the EntryPaq software product. The software costs \$79.95. Packaged with a copy of the *Developing Expert Systems* book, the package costs \$110.00. In addition, there is a \$5.00 US (\$25 overseas) shipping cost and an additional 7% sales tax if your a resident of California.

### NOTICE REGARDING THE CALENDAR

From recent reader surveys we've determined that the inclusion of our calendar of upcoming AI events in every issue is unnecessary. Therefore, in the future, we will publish the calendar only 3 times a year. It will appear in the November, February, and July issues of *Expert Systems Strategies*. We hope this will help you to plan your schedule accordingly.

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# EXPERT SYSTEMS STRATEGIES™

The Monthly Newsletter for Managers and Developers of Expert Systems, from Cutter Information Corp.

Editor: Paul Harmon

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## APPLICATIONS

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### THE TWENTY-TWO BEST EXPERT SYSTEM APPLICATIONS, ACCORDING TO AAAI

The American Association for Artificial Intelligence held its Second Annual Conference on Innovative Applications of Artificial Intelligence in Washington, D.C. on May 1-3, 1990. AAAI selected 22 papers to demonstrate the successful implementation of expert systems in real-world situations. The chosen systems represent domains ranging from checking truck air brakes to sorting resumes, showing the wide potential for working applications.

The two-and-a-half day conference was an impressive gathering of experienced system developers and managers from companies using and selling expert systems applications. AAAI provided a great forum for these people to meet and share their experiences. At the end of each day, time was set aside to allow participants to question that day's presenters individually about

their applications. The papers give good detailed accounts of the development of each application and are a valuable resource for those looking to learn from the experience of successful developers. The proceedings will be available from AAAI as a book and we recommend you get a copy if you missed the conference.

In Table 1 we present an overview of each of the 22 systems, giving a brief description of what each does, the development environment, and cost and benefits. We've divided the applications into four categories: PC systems, conventional workstation applications, Lisp workstation applications, and mainframe applications.

At both IAAI conferences so far, most of the selected applications have been Lisp-based. This year 16 out of 22 systems were Lisp-based. We don't think this accurately reflects the declining role of Lisp in the overall development of good expert systems applications.

The predominance of Lisp-based systems at the conference probably reflects the lag time between development and recognition by AAAI. Like last year, many of the applications presented this year were begun a couple of years ago when Lisp was the predominant development environment. We have said for some time that we think this predominance is fading and that most new applications are being developed in conventional languages. Future conferences should reflect this trend, but there are a couple of difficulties in getting the very latest applications for a conference like this. One, it takes some time for the system to be used and proven. Two, there's the perennial problem of the reluctance of companies to reveal how they're using AI to gain a competitive edge.

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Table 1a. — 1990 IAAI Applications

System/Company	Description	Tool/Lang/Hardware	Development/Time	Cost/Benefits
Personal Computer Applications				
1. ReValuator Internal Revenue Service	Allows non-experts to perform actuarial reviews of pension fund reports filed to comply with ERISA requirements.	Developed with Nexpert Object. Recoded in C and Assembly for deployment on a laptop.	Prototyping - 3 months. Deployed in Jan. 1989.	Allows enforcement of tax laws that were previously unenforceable generating at least \$100,000,000 in previously uncollectable revenues.
2. Intelligent Comparison Tool ILEX Systems, Inc.	Used in validation of software revisions. Reduces comparisons between two text files to only meaningful and important differences.	TI Personal Consultant Plus on IBM/PC/AT with calls to Lisp and C routines.	About 9 resource months. Used in Spring 1989.	Hardware and software cost: \$4200. Validation reviews reduced from 200 to 4 resource hours with increased quality of review. Lower tedium and higher morale for Review Engineer.
3. Air Brakes Analysis System Eaton Corp.	Combined neural net and kbs for analyzing data on truck brakes to diagnose and solve balancing problems.	Kbs written in Lisp and KEE running on an 80386 machine. Neural network development platform was an HNC ANZA-Plus board in a PC/AT.	10/88 - 2/89	\$105,500 total development cost. \$100,000 expected to be saved annually. Company previously had only one expert to service six field stations. Now field support staff at each of the stations can perform the task.
4. Computer-Aided Logic Expert System (CALES) Lamb-Cargate Industries, LTD	Expert system used in the design of Programmable Logic Controllers which control machines in paper and pulp mills.	Waltz Lisp running in DOS on an IBM PC with 640K RAM.	1985 - present	CALES can now translate PLC instructions 90% as well as "best expert." Software design costs have been reduced by 50%, design errors by 80%.
Workstation Applications (Conventional Language)				
5. Inspector Manufacturers Hanover Trust	Monitors every recorded foreign exchange deal at MHT for compliance with policy and for possible fraud.	Nexpert Object, Oracle, C. Runs on VAX 3100.	2 person years from 11/88 - 9/89.	Enhanced risk management. Has a deterrent effect since traders know all transactions are now monitored daily.
6. Resumix Resumix, Inc.	Resume processing system: scans in text, creates summary, matches candidates to job openings, generates reports, and prints acknowledgement letter to applicant.	Developed on Sun-3/50 Unix workstation with proprietary shell. Runs on Sun3, 386i, 4; DEC 2100/3100; IBM 386 PC.	9 man months.	One company saved \$279,000 by reducing contract recruiter staff by 30 recruiters.
7. Construction Planning for Shield Tunneling Method Okumura Corp., Japan	Designs and provides construction plans for the shield machines used in tunneling under soft ground conditions.	ES/KERNEL - ES Shell EXCEED2 - Relational Database HICAD - CAD system C, Fortran on a Hitachi workstation.	60 person months. Has been used on 11 construction sites since Oct. 1989.	Cost: hrdwr/software - 14mil yen Personnel - 48mil yen Construction planning time reduced from one week to 2-3 days.

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Table 1b. — 1990 IAAI Applications

System/Company	Description	Tool/Lang/Hardware	Development/Time	Cost/Benefits
Workstation Applications (Lisp) con't.				
16. Product Knowledge Manager Boeing Aerospace & Electronics	Intelligent interface for generation and management of the many documents required in development cycle of electronic products.	KEE and Lisp. Apollo workstation.	Fall 1985 - Oct. 1989.	Budgeted for 2 1/4 person levels of effort from 85-89. Traditional documentation methods can take 40 hours. PKM generates in avg. of 3 hours.
17. Knowledge Acquisition Kernel S-Cubed for DoD	Specialized shell for knowledge acquisition to build expert systems in the domain of design practices used to harden U. S. weapon systems against nuclear blasts.	OPS5	Long term project begun in early 1980s.	Productivity increase of 30 times over previous method for generating hardening reports with an increase in the quality of reports.
18. Real-Time Alarm Analysis Advisor Consolidated Edison & Inference	Assists operators of Con Edison's computer Control System by identifying and suppressing repeating or toggling alarms, analyzing the electrical network's status and recommending restoration actions.	ART and Common Lisp. TI Explorer II.	Sept. 1988 - full deployment in Nov. 1989.	Significant reduction of alarms seen by operators. Enhanced operator confidence. Standardization of operator responses according to Con Edison procedures.
19. Electronic Modules Computer Aided Process Planning (ECAPP) Digital Equipment Corp.	Automatically generates process routing plans for the assembly of printed circuit boards.	VAXLisp and CRL-OPS using Knowledge Craft. Runs under VMS on VAX machines.	2 1/2 years	Time to produce process plans reduced from 1-2 days down to 1-2 hours. Much shorter dry runs on production machines.
20. ERASME French Directorate of Roads	Used to help diagnose present conditions of road surface, predict future conditions and recommend best rehabilitation approach.	Developed in SMCEI- a Lisp-based shell.	5/87 - 11/89.	Cost: \$1.5 mil. Now used in 9 French road districts. Estimated cost for a district is \$60,000 with a 4 month ROI time through fewer errors in road maintenance.
Mainframe Applications (Conventional)				
21. Expert System for Claims Authorization and Processing (ESCAPE) Ford Motor Company	Checks for validity of incoming warranty claims.	ART-IM/MVS embedded in COBOL program run on IBM 3090 mainframe.	2nd qtr. 1988 - Oct. 1989	Easier maintenance of warranty validation process code leading to annual savings of \$15,000.
22. Expert System for Security Auditing (AudES) IBM	Automatically audits Resource Access Control Facility reports to identify possible intrusion attempts.	ESE, Pascal		Greatly reduced routine work for auditors with greater consistency. Faster detection and follow-up of security breaches.

*revised charts*

Table 1c. — 1990 IAAI Applications

System/Company	Description	Tool/Lang/Hardware	Development/Time	Cost/Benefits
Workstation Applications (Lisp)				
8. Prism Cognitive System, Inc.	Case-based telex classifier and router for directing bank telexes to the proper department.	Forward-chaining system similar to OPS5 run on a Macintosh II.	Part of a 3 year DARPA contract. In continual daily operation at Chase Manhattan Bank since 10/89.	Processes a telex in 30 seconds with a 76% accuracy rate, both better than previous method. Will allow one bank to cut telex operator staff from 3 to 5.
9. CONSTRUE/TIS Carnegie Group for Reuters Ltd.	Assigns indexing terms to news stories according to their context.	Lucid Common Lisp DEC VAX stations	Began in 1986. 9.5 person years. Delivered April 1988.	Estimated to reduce costs by \$752,000 in 1990. Recall & precision rates of 94% & 84% respectively for assigning index numbers to country reports at speed in minutes compared to days when done by humans.
10. Inventory Asset Analyzer U. S. Army	Planning program for scheduling modernization to new equipment and retiring of old.	Common Lisp & Flavors on a Symbolics machine.	2 years	400:1 improvement in analysis time; minutes as opposed to 3-person-days manual effort. Retention of expertise in environment with high turnover.
11. INCA S.W.I.F.T.	Provides real-time malfunction monitoring of interbank financial telecommunications network.	DANTES - an object-oriented Lisp-based tool. TI Explorer II LX workstations.	6 person years over the course of 1 year. Deployed May 1990.	Takes care of 97% of network problems automatically. Will allow reduction of 50 staff from S.W.I.F.T. network control
12. National Dispatcher Router Digital Equipment Corp.	Schedules ground transportation shipments within Continuous Mileage program to reduce shipping cost.	Knowledge Craft on microVAX II. Lisp, CRL-Prolog.	Approximately 2 years. In production since May 1988.	10% reduction in shipping cost, about \$1mil/yr. Shorter dispatcher training time. Quick schedule redesign. Dispatcher can handle more schedules.
13. Microfossil Identification System British Petroleum Research International	Combines expert system with graphics to help paleontologists identify microfossils from oil drilling samples.	Lisp and KEE on a Sun 3/260 workstation.	14 person months. Not yet fully deployed.	Expertise of company's few paleontologists can be dispersed around the globe at great time and cost savings. Shortened staff training times.
14. PREDICTE Lend Lease Corp., Australia & Digital Equipment Corp.	Makes construction time estimate in early design stage for concrete-framed, multistory building projects.	VAX Lisp on VAX/VMS hardware.	12 person years. 6/85 - 4/88.	All estimates can now be performed at or near expert level. Knowledge of a key expert was captured and preserved before he left the company. Alternative building schemes can be analyzed very quickly.
15. Technical Information Engineering System (TIES) Ford Motor Company & Inference	Product quality and design cycle time management tool that aids team development based on Quality Function Deployment (QFD).	Common Lisp, ART, C. Sun 4 workstation.	Jan. 1987 - Dec. 1989.	Better documentation and distribution of design choices. Better consistency and coordination of vehicle development. Reduced development time. Faster training of new engineers.

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Also, since this is only the second such conference to be held, some of the older systems that have been around awhile but that still deserve recognition were included in the line-up. For example, the Predict system of Lend Lease Corp. in Australia is a standard showcase model and was mentioned in *The Rise of the Expert Company* (Feigenbaum, et. al., 1988). It's still a good system, however, and is still having an impact on the company, so its inclusion is justified.

## Updates on Last Year's Applications

The same is true of the four systems AAI brought back from last year for a special update panel at the end of the first day. It's nice to hear how these systems are faring a year later and that they're making a lasting impact on the companies. These update reports are a good idea that we hope AAI will continue at the next IAAI meeting. The updates were for:

### TARA

Manufacturers Hanover Trust (MHT). This system helps 15 foreign exchange traders make daily foreign currency buy and sell decisions. MHT plans to port it in two stages from the Symbolics platform to a Sun or some other workstation and then to distribute it on DEC terminal workstations.

MHT reported two problems it has had with TARA:

- ◆ To be really useful, data must come in consistently and reliably from vendors (such as Reuters). This is a real-world problem somewhat out of the control of the system developers, but a real limitation of sensitivity of expert systems that must be faced. Perhaps systems such as one Reuters demonstrated this year (see #9, Table 1b) will help.
- ◆ Rule base maintenance has proven to be somewhat tricky. Real-world rules of foreign exchange and financial environments are very dynamic. For example, a rise in a country's interest rates always used to mean an increase in its currency price. This isn't always the case anymore. Such real-world changes require significant changes to TARA's rule base.

Overall, TARA is making money and MHT is very pleased with it.

### FRESH

Navy Battle Management for the Pacific Fleet. This was a huge \$10 million project that Texas Instruments developed for the Navy. It's used for making force and resource deployment decisions in battle plans.

A number of ongoing improvements have been made since last year. The software has been rewritten for robustness and easier documentation and the interface has been enhanced.

One of the main impacts of FRESH has been in proof of concept, fostering trust in AI technology. The system has been in use 24 hours a day, seven days a week by the Pacific fleet giving daily reports and summaries with an estimated six person-year annual savings in effort. It has been approved for general distribution to command centers worldwide. The system can give a force deployment analysis in 96 hours that used to be made only once a year. There are plans to institute the system in real-time operational settings.

### CLINT — Metropolitan Life.

This standalone PC system is used as a checklist to make sure all the legal documents are complete and requirements are met to close commercial real estate loans. It's been in daily use by 50 users in six offices across the U.S. In the future Metropolitan plans to allow clients to use the system and to enlarge it so it will actually generate the closing documents.

### Logistics Management System — IBM.

This is a mainframe application that controls the manufacturing flow at IBM's semiconductor plant in Burlington, Vt. It has a user base of 600-800 and gets regular heavy use. LMS has increased output by 20%. It has also turned out to be a good integrator, adapting well to changes like adding robotics to the processing line.

## Some Interesting New Applications

All of the applications presented in Washington are interesting as examples of expert systems that are actually out there being used. A few of our favorite stories from this year:

### **Air Brakes Analysis System — Eaton Corporation.**

Part of the fun of attending a conference like this is the strange little tidbits you learn about some of the most esoteric business and manufacturing environments. For example, how many people know that fuel economy considerations in the design of big tractor/trailer trucks has led to a dramatic increase in the amount of braking force required to stop them? Decreases in air drag and engine size has meant that brakes have to work harder. "Eighteen wheelers" have eighteen wheels to brake and the braking of the cab has to be coordinated with the braking of the trailer to prevent jack-knifing.

This important safety function is achieved through brake balancing. How brakes are working in concert is determined by the experienced analysis of five tests relating air pressure, time, braking force, and temperature. For large fleets this incurs a huge maintenance cost. Eaton Corporation, which makes and services big rigs, used to rely on one expert who would fly around to six field stations to conduct brake analyses.

Part of the expert's task was to distinguish "good" graphs from "bad" graphs from test outputs that, to the untrained eye, look virtually the same. Field service personnel were unable to learn this task within a reasonable amount of time. Through a combination of neural networks and expert systems, Eaton's Knowledge-Based Systems Lab was able to automate the process and "clone" its expert.

The resulting air brake balance analysis system consists of two knowledge bases and a suite of five neural networks. One knowledge base takes data from visual inspections of the truck and balancer tests to ensure that further balancing tests can proceed. The suite of neural nets have then been "taught" to classify graphs as "good" or "bad." These decisions are fed to the second knowledge base that renders a diagnosis and makes recommendations to correct unbalanced situations.

Developers wrote the expert systems in Lisp and KEE, and they run on a 386 machine. The development platform for the neural networks consisted of an HNC ANZA-PLUS board in a PC/AT. The system was developed over the course of four months from October 1988 to February 1989 at a

total cost of \$105,500. It's expected to save \$100,000 a year. Brake balancing is offered free to Eaton's customers, and six times the former number of fleet appraisals can be conducted using the new system. The ability to conduct a speedy analysis of a fleet has the important payoff of increasing customer good will. The expert in this case, freed from his burden, will probably be promoted.

### **Expert System for Construction Planning for Shield Tunneling Method — Okumura Corporation.**

Okumura Corp. in Japan has incorporated an expert system into a very impressive looking CAD system for making construction designs for shield machines used in soft ground tunneling. In the Shield Tunneling Method, the drill must be shielded from collapsing ground as it digs through soft earth and the tunnel walls are laid down. A machine must be built specifically for each project to match the diameter of the tunnel and specific conditions of the soil.

The system demonstrated at IAAI looks extremely productive. It's a combination of a relational database, an expert system, a CAD system, and a documentation system. After inputting construction conditions such as tunnel diameter, type of segment lining, and location of existing structures, along with ground conditions like soil composition and water level, a drawing for a shield machine design is automatically generated by the CAD system. Design and construction plans for the shield machine can be turned out in about an hour.

The system runs on a 32-bit Hitachi 2050/32 workstation. The expert system was built using a shell called ES/KERNEL written in C. The relational database is called EXCEED2, the CAD system is HICAD, and the documentation system is OFIS/REPORT. C and Fortran were used for complex engineering calculations. The system took 60 person-months to develop and has been used on 11 tunneling sites since October 1989.

### **SOCSS Alarm Advisor — Consolidated Edison Company.**

The real-time alarm system in use at Consolidated Edison Company of New York is a good indication that expert systems can be confidently integrated into sensitive existing computer operations where 100% reliability is a must. If an expert

system disrupted the account balancing or payroll program of a large bank, you'd get a lot of upset customers or employees. If electrical power goes out in New York City, you get a civil emergency. Yet, Con Edison control system operators are confidently relying on a real-time alarm analysis system to help them keep electricity flowing in the 593-square-mile area served by the utility.

Con Edison's System Operation Computer Control System (SOCCS) monitors electrical power transmission and distribution in the New York area. It gathers data from thousands of analog measurements (watts, vats, amps, and volts) and from thousands of discrete component points (breakers, disconnects, links, circuit switches, generators, etc.), compares them to normal expected values, and sends alarms when values are abnormal. During times of normal operation the operators are fed some 1,200 logged entries an hour. When problems occur, the operators can see as many as 200 every two seconds. This is obviously an overwhelming amount of data for a human being to contend with in a crisis.

The SOCCS Alarm Advisor (SAA) is an expert system placed between SOCCS's output stream and the operators to help make life more bearable. Its first task is to filter the stream for "nuisance" alarms. One nuisance is the "toggling alarm" that may be caused by a bad telephone transmission line. This can cause a component to toggle in and out of alarm state thousands of times over a few-minute period. Historical data shows that the percentage of nuisance alarms in the data stream can vary between 13% on a low day to 80% on a high day. This amount of variance is an indication of the expertise needed to know when to ignore certain signals. SAA can filter out 34% of these alarms. While the percentage may not look impressive, that's 10,892 out of 32,016 alarms over a 24-hour period.

SAA's second task is to give an analysis of the current state of the system (e.g., is a malfunctioning component isolated and, if not, what consequences are being propagated to surrounding components?).

Finally, SAA recommends what actions the operator should take to correct or contain a failure. Essentially, SAA incorporates Con Edison's procedural guidelines. SAA employs a truth maintenance system that updates the model of the cur-

rent state after any actions taken by the operator. Thus, SAA maintains a real-time consistent model of the network's state.

SAA was developed and deployed on a Texas Instruments Explorer II workstation. It was written in ART (Inference Corp.) and Common Lisp. It receives the SOCCS data from Gould/SEL 3287 computers. SAA is one of the first deployed real-time expert systems to meet the criteria of a time-critical application. Three criteria were essential in its deployment:

1. All presented data, analyses, and recommendations had to be correct.
2. SAA had to process every alarm presented by SOCCS without losing any data and had to correctly identify all nuisance alarms.
3. SAA had to meet the operator's expectation of receiving an analysis and recommendation within 20 seconds after an initial alarm.

SAA has met these criteria with major benefits for Con Edison:

- ◆ Suppression of nuisance alarms has led to a significant reduction in the alarms operators must contend with.
- ◆ Operators have enhanced confidence in the actions they take in response to alarms from following SAA's recommendations.
- ◆ The actions taken are standardized according to Con Edison procedures.

Some unexpected benefits include:

- ◆ SAA identifies inconsistencies in the SOCCS database.
- ◆ It generates statistical, logging, and outage reports that are useful to operators and management.
- ◆ SAA identifies and prioritizes maintenance tasks.

The system was developed over the period from September 1988 to June 1989 and has been fully deployed since November 1989.

### ***AudES, An Expert System for Security Auditing — IBM.***

Devastating virus attacks and intrusion into computer systems have generated widespread

publicity and concern recently. System security is doubtless getting high levels of attention and resources. Surely, all big sites with large numbers of mainframes and users have some security mechanism like IBM's popular Resource Access Control Facility (RACF). RACF continuously monitors and records every login and resource access attempt providing a record of suspicious events. No shenanigans are going to go undetected, right?

The problem is that an average mainframe system generates thousands of RACF records every day and some human expert auditor has to manually pore over these looking for the rare suspicious event. At one site with a dozen systems, the audit process consumed eight hours a day for a team of two auditors. Sound like an honest day's work? Well, it's so boring the job is frequently given to employees with little training and low motivation on a part-time or temporary basis. Not a very comforting scenario for those charged with the security of sensitive data.

Now envision a tireless sentry of unquestionable loyalty keeping a constant lookout for intruders. IBM comes close to that ideal with its Expert System for Security Auditing (AudES). More accurately, RACF is the tireless sentry, but it now has a very dedicated, intelligent sergeant that receives the reports of suspicious activity and knows what to do about them.

AudES was developed at the IBM Los Angeles Scientific Center. Expert System Environment (ESE) was used to develop the application. Considerations of ease of use and modification, flexibility, and extensive user interface were given precedence over considerations of runtime speed. To compensate, whenever possible, routine, non-rule-based tasks were coded in Pascal.

AudES's knowledge base contains categories of authorized users and rules for detecting violations. It can be run in an interactive mode with an auditor pronouncing judgement when a suspected violation is displayed, or in batch, tagging suspected violations for later inspection by the auditor.

AudES was field tested for eight months with parallel manual auditing. In full daily deployment at an experimental site with 20 to 25 mainframes, a single auditor can do in about 1.5 hours what those

two auditors used to do working eight hours a day. AudES is currently in use at four locations and is being tested in others.

The benefits of using AudES rather than manual auditing of RACF records are:

- ◆ Greatly reduced routine work for auditors;
- ◆ Greater consistency of audit;
- ◆ Timelier violation detection and follow-up;
- ◆ Ability to conduct more frequent audits;
- ◆ Cost savings from reduced paperwork;
- ◆ Clearer verification of auditing rules and procedures;
- ◆ Easy profiling to meet individual site requirements; and
- ◆ Reduced training time and a training tool for auditors.

Overall it appears to enhance a very important and sensitive security function.

## Standards for AI Technology Discussed

At the end of the second day, a panel discussed the possibility of adopting standards for AI technology. On the panel were: Earl Sacerdoti, The Copernican Group; Robert Neches, USC/Information Sciences Institute; Raj Reddy, Carnegie Mellon University; and Joseph F. Scullion, NCR Corporation.

The panel gave general reasons why some loose standards would make development of large projects quicker and less expensive and speed acceptance of the technology. Then, after a few anguished interchanges with the audience over what exactly AI is, a couple of vendor representatives argued that it's too early yet to set standards. Vendors resist standards because they don't want to lose their competitive advantage or their lock on their installed base of customers.

There was a proposal by Robert Neches for two successive levels for standardization: first, coarse grained — knowledge base interchanges and database interfaces, and second, fine grained — standardized rule systems and frame systems. The question is "What market forces will create a demand for standards?"

## IAAI Proceedings

Any one of the applications could be relevant to someone developing in a similar domain or environment. The collection of papers presented in Washington is a valuable resource. The proceed-

ings will be published as "Innovative Applications of Artificial Intelligence, Volume 2" by the MIT Press this fall. For more information, contact AAAI, 445 Burgess Dr., Menlo Park, CA 94025; (415)328-3123.

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## TOOLS

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### DESIGN++: An Expert System for Automating the Engineering Design Process

Ed Feigenbaum has helped to found three expert systems companies: Teknowledge, IntelliCorp, and, just recently, Design Power, Inc. While Dr. Feigenbaum's first two companies were both generic tool companies, his latest company is going to sell an application-specific tool that automates the engineering design process.

A lot of the work done today by engineers is repetitive and time-intensive. Different projects require that new drawings be created, either manually or with CAD systems. This involves repeating many of the same calculations and component selections, looking up the same information in the same tables, and applying it to a particular design project. In other words, the process requires repeating many of the necessary steps for determining, finding, and applying data — in specific ways — that may have been used in solving similar design problems. Design++ (D++) is a new-generation CAD tool for automating the various phases of the engineering design process. It is intended for developing "product-specific" knowledge-based expert systems that allow designers to describe all the necessary calculations, component attributes, and geometric properties of a specific product in a product "library."

Product libraries are actually knowledge bases that contain information related to a particular design domain — for example, the machinery, plant layout, ventilation requirements, etc., needed for the design of an electrical cable manufacturing plant. Knowledge for these libraries is accumulated from experience gained in designing and constructing specific projects (like knowledge accumulated from any expert). These libraries then allow

the rapid generation of solutions for specific design problems.

D++ is based on an object-oriented paradigm that is written in Common Lisp and KEE (Intellipcorp), thus providing an object-oriented environment with direct interfaces to AutoCAD. D++ is not an expert system in the sense that it does not use inference or production rules. Instead, it combines the object-oriented programming capabilities of KEE with a constraint programming engine. (We'll be discussing constraint programming in detail in an upcoming issue of the newsletter.)

D++ allows design and product knowledge to be represented as relations between objects and as structural and functional rules. With D++, the components and assemblies of a product under design are described as objects. Components and properties of various assemblies are described as attributes of the objects. Both domain and product knowledge can be attached to these attributes, thereby allowing this knowledge to be described in various forms, such as design rules, constant values, data lists, references to relational DBs, references to external data sources (e.g., results of proprietary analysis programs), and relations to other objects.

#### Automating Graphic Design and Revisions

*Expert Systems Strategies* was given a product demonstration of D++. The application we witnessed is for the design of a plant boiler system and is quite impressive. For different plant layouts the system automatically configures the necessary components, such as tanks, piping, wiring, etc.



The effects of changes made in one aspect of the design are immediately reflected in the plant schematic. For example, the system correctly makes the necessary changes in pump requirements when the boiler plant's fluid tanks are changed from being situated side-by-side to being stacked one on top of the other. In this instance, pump sizes are increased to make up for the fact that the new arrangement requires more pumping capacity for fluids to be transported to tanks situated at a higher level.

Likewise, the system correctly reconfigures the size of the room that would contain the fluid tanks and pumping equipment. Since the tanks are now stacked on top of each other, the room could be made narrower. Not only are these changes reflected in the screen drawing (plant schematic), they are also recorded in the product library for future use. The AutoCAD interface facilitates the user's interaction with the application and also manages the production of the design documentation.

### Automating Proposals and Textual Documentation

One of the major stumbling blocks in getting a new product from the design board to the production line is the multitude of changes that take place during a product's design stage. D++ helps alleviate this problem by automating the production of a wide range of documents. D++ is integrated with Interleaf, which allows text blocks from design databases to be used for technical documentation of design solutions. This permits quick and efficient generation and editing of diagrams and proposals. Drawings, bills of materials, manufacturing instructions, technical specifications, and reports may be updated quickly and easily should an engineer or client suddenly decide to implement changes during any stage of the design/proposal process. This helps insure that proposals remain neat, up-to-date, and ready when needed. In addition, this information is also retained in product libraries for future use.

### The Development of D++

Since April 1987, Tampella Ltd., of Finland, has been using the development version of D++ (known as Scema in Finland) to automate the design process of large recovery boilers. Tampella

calls its system Integrated Boiler Plant Design (IBPD).

According to Tampella, one of the better features of the system is its ability to be integrated with the company's existing workstation-based "Computervision" CAD system, its VAX-based engineering analysis system, and its Oracle relational databases.

Design Power reports that Tampella has given estimates that its use of the system has resulted in a 30% time savings in the overall boiler design process. Additional benefits include a reduction in delivery time of recovery boilers from 24 months to 21 months, and an increase in the reliability of its boilers.

D++ differs primarily from traditional CAD systems in that it helps engineers make fundamental decisions regarding a product's structural and functional properties. The system can automate many of the repetitive tasks involved in design work, such as searching for information from electronic catalogs and conducting calculations for dimensioning, etc. It also supports concurrent engineering, thereby allowing different design and manufacturing groups to participate in product development at the same time, and helps maintain consistency in design formats and changes.

D++ is well suited for:

- ◆ Complex engineering design projects such as boilers, paper machines, marine structures, constructed facilities, and elevators;
- ◆ System configuration problems such as motor control center layout, computer network configuration, and programmable logic circuit (PLC) installations; and
- ◆ Chemical process design situations such as petrochemical plants, pulp and paper mills, and power-generation facilities.

Representatives of Design Power believe that the system could also prove beneficial in other process industries, such as ship building and heavy machine and equipment design. And, with the addition of the appropriate libraries, the system could be used for designing complex electronic products ranging from printed circuit design to electronic packaging.

D++ operates on SUN 3 & 4 workstations, including SUN SPARCstations, and on a Mac II equipped with a TI microExplorer board. The system has an SQL interface developed using Design Rule language to facilitate interaction with data in external databases. This allows direct access to Oracle and Sybase. Other SQL-based database interfaces are also possible. In addition, ASCII files can be used as external data sources (allowing all types of reports or data to be produced in common ASCII file format). Integration with Interleaf and AutoCAD is via bidirectional links. And, because the system was developed with KEE, it can be integrated into any KEE-based application, such as Intellicorp' Scheduler for plant operations.

The development version of D++ sells for \$35,000 (including KEE runtime license, AutoCAD and Interleaf interfaces, and a Library Shell for creating "expert" libraries). A year of sup-

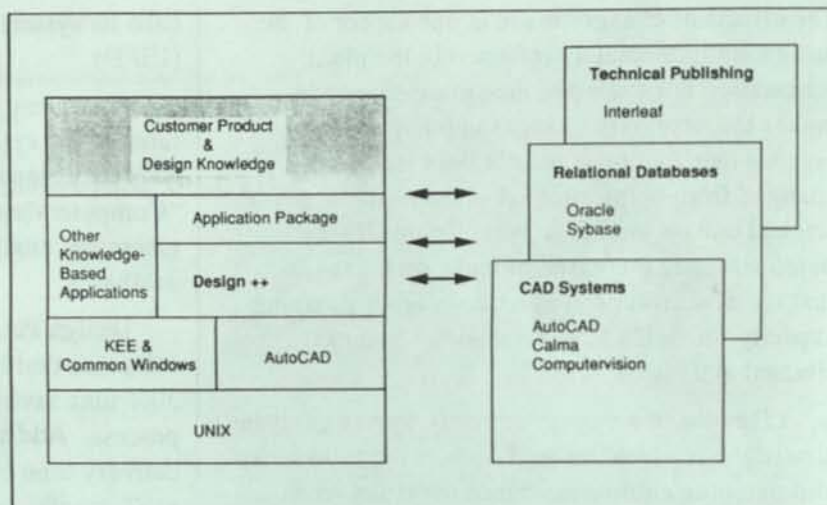


Figure 2 — D++ System Software Structure

port and initial training are available for \$6,000 and \$3,500 respectively.

To date, 10 systems have been successfully fielded in Finland. The official U.S. release date for D++ was June 12 at the Architectural & Engineering Systems '90 conference in Atlanta, Georgia.

For more information, contact: Design Power Inc., 444 Castro St., Suite 400, Mountain View, CA 94041; (415)966-8222, Fax: (415)969-3722.

## TRENDS AND NEWS BRIEFS

### AICorp Prepares to Go Public

AICorp has just announced that it will be making an initial public offering (IPO) in the near future. The offering will be handled by Alex, Brown & Sons and Donaldson Lufkin & Jenrette. The proposed NASDAQ symbol of the new company is AICP.

2,250,000 shares are being offered (1,500,000 are being offered by the company and 750,000 are being offered by existing investors). The proposed stock price is between \$7 and \$9 per share. If the stock sells at that price, AICorp will raise some \$12 million.

This is the first public offering by an expert systems company in four years. Since the IPO process requires the company to issue a prospectus

that describes the financial condition of the company, it provides an interesting chance to see how AICorp has been doing and how it perceives the market.

### Revenues and Profits

AICorp reported the following revenues and income.

	Revenues	Profit(Loss)
1986	\$6,309,000	385,000
1987	\$4,980,000	(3,100,000)
1988	\$9,505,000	1,025,000
1989	\$11,512,000	54,000
1990	\$15,109,000	1,012,000



AICorp's fiscal year ends on March 31.

In its prospectus, AICorp avoids calling itself an AI or expert systems company. It uses the term "Knowledge Base/CASE" company to describe its business. It also puts most of its emphasis on selling KBMS and not on future sales of Intellect. (In 1988-89, KBMS sales increased by 379% while Intellect sales declined by 32.6%. In 1989-90, KBMS sales grew by 106.7% while Intellect sales declined by 60.7%.)

AICorp has sold some 290 copies of Intellect and over 2,000 copies of 1stClass.

When the company describe its competition, it lists the following companies:

Mainframe market — Aion, IBM, Inference;

DEC market — Inference and Neuron Data;

PC market — Neuron Data, IBI, and TI.

The analysis probably represents AICorp's historical experience pretty well, but may not reflect the near future so well. Not considering IBI (Level5) competition in the DEC and mainframe markets, especially when Level5 Object is just being released, is probably a mistake. AICorp might also have listed Kappa in the PC market to give a better idea of the competition it will face in the coming year.

AICorp lists its major customers as: Bethlehem Steel, British Telecom, Burlington Northern, Chrysler, ConRail, CSX, DuPont, Frito-Lay, Liberty Mutual, Mattel, MCI, Mercedes Benz, Mutal Life, Sara Lee, Stop & Shop, Safeway (Canada), The Gap, Travelers, Union Pacific, and UNUM. No single customer accounts for more than 5% of AICorp's revenue.

All things considered, AICorp may be going public a little soon by conventional market standards, but perhaps the time is right. A successful offering will certainly strengthen AICorp's position in the expert systems market and will make things just a little harder on its rivals, (e.g., Aion and Inference) which also probably plan to go public sometime in the future.

To obtain the AICorp prospectus, contact: Phyllis Swersky, AICorp., 100 5th Ave., Waltham, MA 02254; (617)890-8400.

## Aion's Financial Data

Aion is not going public, but the AICorp move put lots of pressure on Aion to explain its own financial position to companies that are trying to choose between Aion and AICorp products. Thus, in an unusual and perhaps unnecessary move, Aion has volunteered some audited information on how it has been doing.

Using the data that Aion has volunteered, we can make the following comparisons between the two competing companies:

### Total Revenue (\$000)

	AICorp	Aion
85/86	6,309	478
86/87	4,980	838
87/88	9,505	2,753
88/89	11,512	8,976
89/90	15,109	14,500

AICorp has a fiscal year ending on March 31. Aion has a fiscal year ending on December 31. Aion's revenue is derived only from the sale of ADS products, while AICorp's revenues come from the sale of Intellect, KBMS, and 1stClass.

During the 88/89 period, revenue from KBMS increased by 379.5%. During the 89/90 period, revenue from KBMS increased by 106.7%. During the 88/89 period, revenue from ADS increased by 226%. During the 89/90 period, revenue from ADS increased by 62%.

Keep in mind that although AICorp (founded in 1975) is older than Aion (founded in 1984), Aion has been selling ADS for five years while AICorp has only been selling KBMS since 1988. It's always easier to get very large increases when the product is just being introduced, and it gets harder as the product is sold over the longer haul.

Aion did not volunteer information on its profits (or losses), so that aspect cannot be compared.

Other data that only compares KBMS vs ADS:

	AICorp	Aion
Customers:	75+	475+
Mainframe products licensed:	107+	340+

PC products licensed:	234+	5400+
Total employees:	110	158
R&D personnel:	26	41

Aion completed its last round of capitalization in December. It received \$5.4 million from various investors. Aion has not been growing as fast as it had projected, and recently reduced its staff by 28 people in order to insure that it would stay profitable during this fiscal year.

### Dun & Bradstreet Credit Analysis Expert System

Dun & Bradstreet, in conjunction with Inference Corp., has developed an expert system to provide credit analysis and recommendations for D & B customers in the apparel industry.

The system allows D & B's Credit Clearing House (CCH), a product group within D & B Business Credit Services, to provide on-line credit ratings and dollar-specific recommendations to approximately 60,000 apparel manufacturers, wholesalers, jobbers, and marketers. In so doing, CCH tracks and maintains information on approximately 200,000 retailers.

To make a recommendation, a user first enters a CCH customer request into the system, which then accesses financial, historical, and background information on a particular company or companies. This information resides in three different segments of the CCH recommendations database, which is part of D & B's corporate reports database containing more than 10 million files.

The system then applies a selection of rules from over 800 rules in its knowledge base, makes a decision, and then transfers that decision with supporting information back to the user. D & B customers may rely on the system's decision or use the findings to help determine their own conclusions regarding a customer's credit rating.

These recommendations, previously made manually, used to take up to three days to complete. Now, using the expert system, they take only three to seven seconds.

In addition to providing faster and more consistent credit recommendations to customers, use of the expert system has allowed CCH to expand its

coverage of the apparel industry. This aids CCH customers in establishing credit lines for retail stores that they do business with.

The system was developed on a PC using ART-IM/MS-DOS (Inference Corp.) and then ported to two DEC VAXstations which act as co-processors to IBM 3090 mainframes running CICS with database access through IDMS.

Inference's Professional Service Division assisted D & B in the various stages of the application development and in training the company's technical personnel in maintaining and building future systems.

D & B says it chose ART-IM because it is written in C, which allows for ease in porting between VAXstations, PCs, and IBM Mainframes.

At this time, the system is being used to analyze and make recommendations on approximately 85% of the companies reviewed by CCH, with the remainder being tagged for review by human analysts. In the future, CCH hopes to use the system to process an even higher percentage of credit requests.

For more information, contact: Inference Corp., 550 N. Continental Blvd., El Segundo, CA 90245; (213)322-0200.

### Enterprise/Dx: A KB-Based Diagnostic Software Tool for High-Tech Service and Support

Enterprise/Dx (E/Dx) is a knowledge-based development tool that allows developers to create and embed diagnostic systems in manufactured products as well as in information processing environments. The system is aimed at the high-technology customer service and support market. Manufacturers and end-users of computer, office automation, communication, electronic and medical instrumentation products all stand to benefit from the diagnostic capabilities of E/Dx.

The system provides the basic knowledge and problem-solving methods for developing diagnostic applications in a customizable shell. This enables nonspecialized personnel, lacking in traditional programming experience, to develop KB-based diagnostic applications.

E/Dx uses "failures" to represent the primary diagnostic information about an application. Failures describe any abnormal situation or operating state that can be isolated during diagnosis. They can provide general information such as "equipment is not working" or specific fault diagnosis, for example "pin 7 of part A576 is stuck." The system takes into account that one failure may be caused by another. Further, failures are linked to form a failure network. These failure networks are modeled on the mental processes used by a troubleshooter in diagnosing a problem.

Some of the benefits provided to service organizations by E/Dx are:

- ◆ reduction of on-site service calls by increasing the percentage of problems resolved over the phone;
- ◆ reduction in the number of repeat on-site service calls through the dispatching of proper service technicians and the correct replacement parts;
- ◆ faster and easier identification of replacement parts; and
- ◆ lower training costs of service personnel through the distribution of servicing knowledge.

Barry Plotkin, CEO at Coherent Thought, says that "E/Dx differs from other development environments in that it allows diagnostic systems to be developed and imbedded alongside or within existing applications. In this manner, the diagnostic system serves as a sub-routine to existing programs without compromising existing application performance."

E/Dx was formerly known as the Diagnostic Reasoning Template (beta test version). Initially, Coherent Thought positioned its tool for the

general diagnostic market, but it is now stressing the value of the tool for more specific application areas, including: hot-line help, field engineering, technical assistance centers, product support organizations, and repair depot and product design engineering.

The only tool that is really similar to E/Dx is TestBench, but, in fact, there is no comparison since TestBench is a standalone, generic diagnostic tool that is written in Lisp. TestBench requires a Lisp machine for development and allows applications to be fielded on the PC. E/Dx, on the other hand, is written in C, is embeddable, and runs on a wide variety of platforms.

Release 1 of E/Dx is now shipping. The earlier beta version of the tool has already been used to solve a number of different diagnostic problems. Amdahl Corp. used the tool to develop an application to provide both autonomous and embedded diagnostic support in a help-desk situation as well as for its field engineering service. Data General used it to develop an application to support some

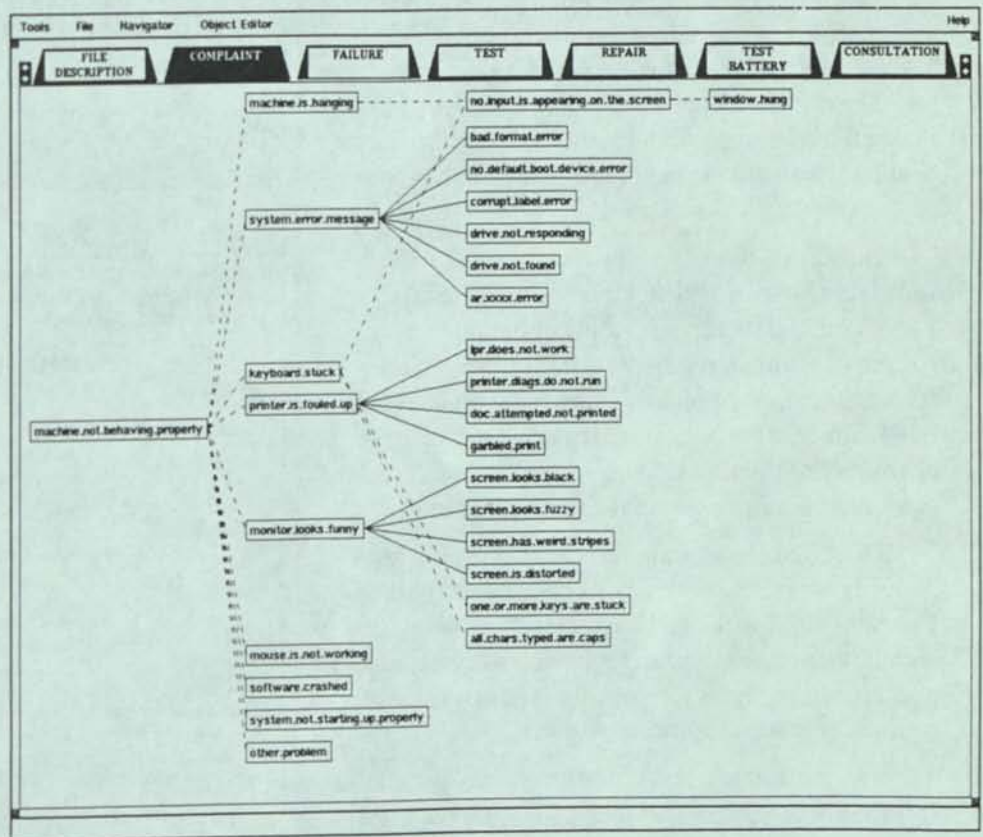


Figure 3 — E/Dx Screen of Diagnosis Support System Failure Network.

of the company's product lines at its Central Technical Assistance Center. General Electric Information is also using an application it developed to handle product support.

E/Dx runs on PCs, minis, workstations, and mainframes, and operates under a wide range of environments, including Amdahl UTS, SunOS, UNIX system V, Data General DG/UX, and IBM MVS. Other environments to be supported include DEC VAX/VMS, DEC Ultrix, HP-UX, Apollo UNIX, IBM AIX, MS-DOS, OS/2, and IBM MVS/CICS. Fees for development and production licenses for E/Dx range from \$42,500 for an individual workstation-based system to approximately \$300,000 for large mainframe-based systems.

For more information, contact: Coherent Thought, 3350 West Bayshore Rd., Palo Alto, CA 94303; (415)493-1555.

### Expert System for Chemical Toxicity Classification is Runner-Up in *Computerworld's* Smithsonian Awards

An expert systems application for determining and classifying the toxicity of different chemicals has been chosen as a finalist in *Computerworld's* annual Smithsonian Awards. The award is presented to groups or individuals deemed to have benefited society through innovative applications of information technology.

The application, presently being used by Lubrizol Corp., was developed on a PC using Aion's ADS development tool. It captures the expertise of company toxicologists for determining the chemical properties of Lubrizol's products. In this manner, the application frees the company's chemists from the time-consuming task of calculating and generating material safety data sheets.

These data sheets are important for people working with new chemicals or products (both Lubrizol employees and customers) because, should an accident occur, its effects are known and necessary treatment for specific types of chemical injuries is made readily available.

Giorgio Sorani, head of information systems at Lubrizol Corp., says that the system allows information on chemicals to be automatically updated and stored... "this means that customers will al-

ways have the most current information about products."

The system took approximately 1½ years to develop and deploy. It now provides product/chemical hazard information to Lubrizol customers and employees worldwide.

Presently the system is operating in three environments: on an IBM 3090 mainframe under MVS for headquarters' operations; on a PC-based system for handling Canadian operations, and on an IBM AS/400 with IBM database connections at a European subsidiary.

Expert Systems Strategies always likes to hear about good things being done with expert systems. We congratulate Lubrizol on being selected as a finalist and wish the company luck in the competition.

#### Special \$100 Discount

Enclosed with this issue is a brochure describing the upcoming conference entitled CASE for the 1990s presented by Carma McClure and James Martin. Mention that you subscribe to *Expert Systems Strategies* and save \$100 off your registration fee. Registrations may be placed by mail, or by phone.

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# INTELLIGENT SOFTWARE STRATEGIES

FROM CUTTER INFORMATION CORP.

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THE MONTHLY NEWSLETTER ON EXPERT SYSTEMS, OOP, CASE, NEURAL NETWORKS & NATURAL LANGUAGE

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## A NEW NAME

Observant readers will notice that we have changed the name of the newsletter. As you all know, the expert systems market has been evolving rapidly. As expert systems move into the mainstream, the name "expert systems" is being left behind. Many people are focusing on using the techniques involved in expert systems development, in combination with other software techniques, to develop applications that cannot be called expert systems.

From the beginning, we have attempted to keep the newsletter narrowly focused on the commercial uses of expert systems. Other newsletters have tried to keep track of a much wider variety of academic and commercial AI activities. As the Nineties begin, that narrow focus is no longer possible or appropriate. In the last issue of the newsletter we reported on an expert system developed by Eaton Corp. (Air Brakes Analysis System) that combines inference-based techniques with a neural network. In the same issue, we discussed Design ++, a domain-specific tool to help companies create power plant proposals. The system is built in KEE, but it doesn't use inference. Instead, it relies on KEE's OOP capabilities, combined with a constraint propagation engine.

The good news is that expert systems techniques have become widely acceptable in corporate computing environments. The downside, however, is that expert systems techniques are being combined with a variety of other techniques to create products and applications that aren't easy to classify.

In addition, many companies now prefer to use the terms "knowledge-based systems" or "inference-based programming" to avoid the restrictive connotations that are often associated with "expert systems."

We are not going to abandon expert systems — just the opposite — we are going to continue to pursue them as they expand and mutate and get mixed in with other technologies.

Hence we have a new name, one that will suggest a slightly wider focus. (We know the name is a little ambiguous, and that's one of the things we like about it. We think it's an intelligent strategy to use software that incorporates inference techniques.)

We believe that our name change reflects the experience and hopes of our readers. Most of our readers began subscribing to *Expert Systems Strategies* when they found themselves considering or actually working on an expert systems development effort. Today, that same reader may still be working on an expert system (although his or her

company may now call them knowledge or inference systems). But in addition, that same reader may be exploring neural networks, object-oriented programming, or one of the CASE tools that incorporate an inference engine or an object-oriented database. In other words, our readers are trying to determine how to use the techniques originally associated with expert systems in a wide variety of different ways. We want to report on that activity and we believe our new name reflects our present concerns. We hope you agree.

## TOOLS

### U.S. EXPERT SYSTEMS BUILDING TOOLS

Once again, we have tried to pull together information about all of the major expert systems tool vendors who are active in the U.S. We have undoubtedly missed some of the smaller vendors and perhaps one or two of the newer vendors. The increasingly specialized marketing strategies pursued by new vendors, combined with the reluctance of some vendors to use the term "expert systems," make it very hard to get a firm handle on all of the vendors who are selling expert systems tools.

We have reorganized our classification system to reflect the current market. We have placed tools into one of three categories: tools that run on multiplatforms; PC, Mac, and other specialized tools (in-

cluding those that just run on VAX hardware); and tools that are tailored for specific types of problem solving or for specific industries. Within the tables, each tool entry is listed by name. An alphabetical list of the companies selling the tools follows.

The tool market is changing rapidly. Many new companies have entered the market at the same time that a few companies have emerged as the dominant players. We will provide an overview of these thriving companies when we summarize the overall expert systems market in the next issue, which will come out just after AAAI and will include all the new product announcements the vendors make during the show.

#### LIST OF VENDORS AND PRODUCTS MENTIONED IN TABLES

Aion Corp.  
ADS  
101 University Ave.  
Palo Alto, CA 94301  
(415)328-9595.

AI Corp Inc.  
Ist-CLASS  
KBMS  
138 Technology Drive  
Waltham, MA 02154  
(617)891-6500/(800)288-5267.

Albathion Software  
ENTRYPAQ  
P.O. Box 7926  
San Francisco, CA 94120-7926  
(800)338-0364.

Artificial Intelligence Technologies, Inc.  
MERCURY KBE  
40 Saw Mill River Rd.  
Hawthorne, NY 10532  
(914)347-6860.

Automated Technology Systems Corp.  
I-CAT  
25 Davids Drive  
Hauppauge, NY 11788  
(516)231-7777.

Bell Atlantic Knowledge Systems, Inc.  
LASER  
P.O. Box 3528  
Princeton, NJ 08543-3528  
(609)936-2843  
Contact: James E. Lyons.

CAM Software, Inc.  
LOGIC TREE  
Westpark Bldg.  
Suite 208  
750 North 200 West  
Provo, UT 84601  
(801)373-4080.

Carnegie Group, Inc.  
KNOWLEDGE CRAFT  
TESTBENCH  
SERVICE/MAINTENANCE  
PLANNER  
OPERATIONS PLANNER  
Five PPG Place  
Pittsburgh, PA 15222  
(412)642-6900.

CIMTelligence Corp.  
INTELLIGEN  
One Forbes Rd.  
Lexington, MA 02173  
(617)861-1996.

Cogensys Corp.  
COGENSYS JUDGMENT  
SOFTWARE  
9665 Chesapeake Drive  
Suite 401  
San Diego, CA 92123  
(619)467-1500.

Cognition Technology  
MACSMARTS/MACSMARTS  
PROFESSIONAL  
44 Wheeler Street

Cambridge, MA 02138  
(617)492-0246.

**Coherent Thought**  
ENTERPRISE D/x  
3350 West Bayside Road  
Suite 205  
Palo Alto, CA 94303  
(415)493-8805.

**COSMIC/University of Georgia**  
CLIPS  
382 E. Broad St.  
Athens, GA 30602  
(404)542-3265.

**Computer Associates**  
CA-DB:EXPERT  
201 University Ave.  
Westwood, MA 02062  
(617)329-7700.

**DEC**  
EPITOOL  
VAX DECISION EXPERT  
VAX OPS5  
AI Information Center  
290 Donald Lynch Boulevard  
Marlborough, MA 01752  
(508)490-8256.

**Design Power Inc.**  
DESIGN ++  
444 Castro St., Suite 400  
Mountain View, CA 94041  
(415)966-8222.

**Emerald Intelligence**  
MAGELLAN  
MAHOGANY  
INTRODUCTORY/PROFESSIONAL  
3915 Al Research Park Drive  
Ann Arbor, MI 48108  
(313)663-8757.

**Expertech Inc.**  
XI PLUS  
206 Sacramento St.  
Suite 211  
Nevada City, CA 95959  
(916)265-6635.

**Expert Edge**  
ROCKY  
1000 Elwell Ct., No. 228  
Palo Alto, CA 94303  
(415)969-2800.

**ExperTelligence, Inc.**  
EXPERCOMMONOPSS  
EXPERFACTS  
EXPEROPSS+  
5638 Hollister Ave, Suite 302  
Goleta, CA 93117  
(805)967-1797.

**Expert Knowledge**  
NEMO (2.0)  
1801 Avenue of the Stars, Suite 507  
Los Angeles, CA 90067

**Exsys Inc.**  
EXSYS  
EXSYS PROFESSIONAL  
P.O. Box 11247  
Albuquerque, NM 87192-0247  
(505)256-8356.

**Gensym Corp.**  
G2  
125 Cambridge Park Dr.

Cambridge, MA 02140  
(617)547-9606.

**Georgia Tech. Research Inst.**  
GEST  
AI Branch  
Georgia Institute of Technology  
Atlanta, GA 30332  
(404)894-3559.

**Gold Hill Computers**  
GOLDWORKS II  
26 Lansdowne St.  
Cambridge, MA 02139  
(617)621-3300.

**Helix Expert Systems Ltd.**  
EXPERT EDGE  
190 Strand  
London, WC2R 1DT, UK  
(01) 836 7788.

**Human Intellect Systems**  
INSTANT EXPERT  
INSTANT EXPERT+  
NEXUS  
1670 S. Amphlett Blvd.  
Suite 326  
San Mateo, CA 94402  
(415)571-5939.

**Hyperpress Publishing Corp.**  
INTELLIGENT DEVELOPER  
P.O. Box 8243  
Foster City, CA 94404  
(415)345-4620.

**IBM Inc.**  
ESE  
KNOWLEDGE TOOL  
TIRS  
P.O. Box 10  
Princeton, NJ 08543  
(201)329-7000.

**ICAD Inc.**  
ICAD  
201 Broadway  
Cambridge, MA 02139  
(617)868-2800.

**Inference Corp.**  
ART  
ART-IM  
550 North Continental Blvd.  
El Segundo, CA 90245  
(213)322-0200.

**Inference Engine Technologies**  
SIERRA OPSS  
1430 Mass. Ave.  
Suite 306-I  
Cambridge, MA 02138  
(800)255-0625.

**Information Builders Inc.**  
LEVEL5  
LEVEL5 OBJECT  
1250 Broadway  
New York, NY 10001  
(212)736-4433.

**Intellicorp**  
KAPPA  
KFE  
1975 El Camino Real West  
Mountain View, CA 94040  
(415)965-5700.

**Intelligent Environments**  
CRYSTAL

2 Highwood Dr.  
Tewksbury, MA 01876  
(508)640-1080.

**KDS Corp.**  
KDS 2 & 3  
934 Hunter Rd.  
Wilmette, IL 60091  
(708)251-2621.

**Knowledge Garden Inc.**  
KNOWLEDGEPRO/  
KNOWLEDGEPRO WINDOWS  
473A Malden Bridge Rd.  
Nassau, NY 12123  
(518)766-3000.

**McGraw-Hill Book Co.**  
MICRO EXPERT  
11 West 19th St.  
4th Floor  
New York, NY 10011  
(212)337-5962.

**MDBS Inc.**  
GURU  
P.O. Box 248  
Lafayette, IN 47902  
(800)344-5832.

**Millennium Software**  
HYPER X  
3275 Laguna Canyon Rd., Room 02  
Laguna Beach, CA 92651  
(714)497-0050.

**Mind Path Technologies**  
EST  
INTELLIFORM  
12700 Park Central Drive, Suite 1801  
Dallas, TX 75251  
(214)233-9296.

**Mitech Corp.**  
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74 Junction Square  
Concord, MA 01742  
(508)371-2002.

**Neuron Data**  
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444 High Street  
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(415)321-4488.

**OXKO Corp.**  
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P.O. Box 6674  
Annapolis, MD 21401  
(301)266-1671.

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Berkeley, CA 94710  
(415)644-2116.

**Park Row Software Inc.**  
EASY EXPERT  
4640 Jewell Suite., 232  
San Diego, CA 92109  
(619)581-6778.

**Production Systems Technologies Inc.**  
OPS/83  
5001 Baum Boulevard  
Pittsburgh, PA 15213  
(412)683-4000.

**Quintus Computer Systems, Inc.**  
FLEX  
1310 Villa St.  
Mountain View, CA 94041  
(415)965-0551.

**Radian Corp.**  
RULEMASTER  
P.O. Box 201088  
Austin, TX 78720  
(512)454-4797.

**Rosh Intelligent Systems, Inc.**  
CAIS  
One Needham Place  
50 Cabot St.  
Needham, MA 02194  
(617)449-0049.

**Sofbro Midwest, Inc.**  
GENESIS V  
10349 West 70th St.  
Eden Prairie, MN 55345  
(612)944-2252.

**Softsync Inc.**  
SUPEREXPERT  
162 Madison Ave.  
New York, NY 10016  
(303)445-0903.

**Software A & E**  
KES II  
KES/VE  
1600 Wilson Blvd., Suite 500  
Arlington, VA 22209  
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**Software Artistry, Inc.**  
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APPLICATION SOFTWARE  
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Indianapolis, IN 46268  
(317)876-3042.

**Software Plus**  
CxPERT  
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Crofton, MD 21114  
(301)261-0264.

**Symbolics Inc.**  
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11 Cambridge Ctr.  
Cambridge, MA 02142  
(617)221-1000.

**Symbologie Corp.**  
SYMBOLIC ADEPT  
15379 N.E. 90th St.  
Redmond, WA 98052  
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**Texas Instruments**  
PERSONAL CONSULTANT EASY  
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Austin, TX 78769  
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**Umecorp**  
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45 San Clemente, D-200  
Corte Madera, CA 94925  
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Table 1.1 Multi-Platform Expert Systems Building Tools

TOOL (Knowledge Representation) (Vendor)	Price Range	Hardware (Operating System/Language)	Generates SQL	Databases that system can access without writing hook	Memory Requirements RAM/Hard Disk
<b>1st-CLASS</b> (Inductive) (AI Corp., Inc.)	\$995-2,495	IBM PCs and compatibles, VAX under VMS (Pascal)	No	Lotus 1-2-3, dBASE III, HyperText, ASCII files	Dev.: 512 K HT: 640 K
<b>Aion Development System (ADS)(5.1)</b> (Hybrid) (Aion Corp.)	\$7,000-97.5 K	IBM PCs and Mainframes S/370 (MVS/TSO, CICS, IMS, DB/DC, VM/CMS, MS-DOS, OS/2) (Pascal, COBOL, C)	Yes	dBase, DL/I, DB2, SQL/DS, QSAM, VSAM	PC: 640 K OS/2: 1.5 mb/RAM Hard Drive recom.
<b>Application Software Expert (ASE)</b> (Software Artistry)	\$5,000-36 K	IBM AS/400, IBM RS/6000, IBM PCs, PS/2, IBM 4680 & 4684 (Pascal)	No	Any Database on the AS/400	-
<b>ART (Hybrid)</b> (Inference Corp.)	\$22.5-30 K	Symbolics (Genera), TI Explorer, DEC workstations (VMS), Sun, Apollo & HP workstations (Unix), (Lisp)	No	Flat files, Call Facilities	12 mb min., 16 mb recom.
<b>ART-IM (Hybrid)</b> (Inference Corp.)	\$8,000 - 160 K	IBM PC/AT, PS/2 and compatibles (MS-DOS) IBM Mainframes (MVS), Sun 3 & 4 (Unix), DEC (VMS), Apollo (Unix), TI Explorer I & II, Symbolics 3600 series, HP, IBM RISC/6000, Data General (Unix) (C)	No	IMS, DB2, VSAM, Flat files	PC: 640 K 1-2 mb ext. memory; 8 mb Hard Drive M/F: 3 mb address space for develop.
<b>CA-DB: Expert</b> (Formerly Enterprise Expert) (Rule/Goal) (Computer Associates)	\$2,000 - 71 K	IBM Mainframes (OSV2, MV2, MVS/XA, MVS/SP, DOS-VSE, VM/CMS CICS, IDMS/DC, UCF), Dec VAX (VMS), (Cobol)	ANSI std. SQL	IDMS, VSAM, Rdb, RMS, CA-DB/VAX	1mb 25mb Hard Drive
<b>Epitool (Hybrid)</b> (Epitec AB/Digital Equipment Corp.)	\$11.3-50 K	IBM PC/AT, all Dec VAX machines, (VAX/VMS) (VAX Lisp)	-	-	PC: 6 mb
<b>Expert System Environment (ESE)</b> (Structured Rule) (IBM)	\$23,410-\$60,440	IBM PCs - delivery, Mainframes (MVS/XA, MVS/TSO, VM/CMS, MVS/CICS, MVS/IMS) (Pascal)	Yes	DB2, SQL/DS, VSAM	-
<b>Exsys Professional</b> (Rule/Frames) (Exsys, Inc.)	\$795 - 12 K	IBM PC/AT and compatibles (MS-DOS, OS/2, UNIX, VMS), VAX (VMS or Altrex), Unix, Sun 3 & 4, (C)	No	dBASE III, Lotus 1-2-3	640 K Hard Drive recom.
<b>GEST (Generic Expert System Tool)</b> (Georgia Tech. Research Institute)	\$15-45 K	VAX workstations, Sun Micro Symbolics, Explorer, (Lisp)	No	-	-

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Table 1.2 Multi-Platform Expert Systems Building Tools

TOOL (Knowledge Representation) (Vendor)	Price Range	Hardware (Operating System/Language)	Generates SQL	Databases that system can access without writing hook	Memory Requirements RAM/Hard Disk
<b>GoldWorks II</b> (Hybrid) (Gold Hill Computers)	\$7,500	286 PC, Mac, Sun (Golden Common Lisp)	No	dBASE	6 mb
<b>GURU</b> (Structured Rule) (MDBS Inc.)	\$6,500	IBM PCs and compatibles (MS or PC-DOS), Dec VAX (VMS), OS/2, LANs, (C)	Yes	dBASE III	PC: 640 K Hard Drive required
<b>KAPPA</b> (Intellicorp)	\$3,500 per license	IBM 286/386 PCs, PS and compatibles (MS-DOS), Unix workstations, Mac	-	Lotus 1-2-3, Symphony, dBASE III	PC: 640 K
<b>KBMS</b> (Hybrid) (AI Corp., Inc.)	\$5,000 -  \$90-250 K	IBM PCs 286 & 386 or compatibles (MS-DOS & OS/2)  IBM Mainframes (MVS/XA, MVS, VM, CICS, TSO, IMS/DC, CMS), (C)	Yes	DB2, SQL/DS, IDMS, VSAM, ADABAS, IMS	4 mb
<b>KEE</b> (Hybrid) (Intellicorp)	\$9,000 - \$98 K or \$4,900 mo.	VAX, Apollo, Sun, Symbolics, Explorer, MicroExplorer, 386 PC (Lisp), Mainframe (MVS)—access via PC	Yes	DB2, IMS/DB	10 mb 100 mb Hard Drive recom.
<b>KES II/KES/VE</b> (Structured Rule) (Software A&E, Prime Comp., Unisys, Control Data)	\$4,000-60 K	IBM PCs and compatibles (MS-DOS), Workstations, Minis, Mainframes (NOS/VE, MVS/TSO, CICS, IMS and VM/CMS)	Yes	dBASE, Oracle	PC: 640 K Hard Drive recom.
<b>KnowledgeCraft</b> (Hybrid) (Carnegie Group)	\$10,000 -70 K	386 PC (Unix), Sun MicroVAX (VAX), Symbolics, Explorer, Mainframe (VAX)	Yes	Oracle, dBASE	8-16 mb recom.
<b>Knowledge Tool</b> (OPS) (IBM)	\$950/mo.	IBM Mainframes (MVS/XA/TSO, MVS/ESA/TSO, IMS/VS, CICS/OS/VS, VM/SP/CMS, VM/SP/HPO), (PL/I)	Yes	DB2, D/I, VSAM, SQLDS, PL/I Supp. Struct.	-
<b>Laser (2.0)</b> (Bell Atlantic Knowledge Systems)	\$900-25 K	IBM RT PCs, PS/2 (OS/2), Mac II, Sun 3 & 4, VAX (Unix), (C) IBM 9370 & 3090 Mainframes (MVS, VM)	No	-	2 mb

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Table 1.3 Multi-Platform Expert Systems Building Tools

TOOL (Knowledge Representation) (Vendor)	Price Range	Hardware (Operating System/Language)	Generates SQL	Databases that system can access without writing hook	Memory Requirements RAM/Hard Disk
Level5 (Rule-based) (Information Builders Inc.)	\$685 -	IBM PCs and compatibles, PS/2 (MS-DOS), Mac+, SE and II	No	PC: dBASE II & III Mac: HyperCard, Excel Mainframe: Focus, DB2, SQL/DS VAX: Focus, Rdb, RS1, RMS - CDD	PC: 512 K Mac: 512 K  Hard Drive recom.
	\$48,000 - 57.6 K -	IBM Mainframes (VM/CMS, MVS)			
	\$1,200-58.4 K	Digital VAX (VMS)			
Level5 Object (Hybrid/Object-oriented) (Information Builders Inc.)	\$995	IBM PCs and compatibles, (MS-DOS/Microsoft Windows)	No	dBASE, Lotus 1-2-3, Focus Hold SQL server	640 K (2 mb recom.) Hard Drive recom.
Nexpert Object (Hybrid) (Neuron Data)	\$5,000-8 K	Wide range of hardware, including: IBM PC/AT, PS/2, 386 and compatibles (MS-DOS), (OS), Mac +, SE and II, Dec stations (VMS and Ultrix), IBM RT, Sun Apollo, HP, VAX (Unix), Mainframe (delivery) - (VM),(MVS), NEXT, (C)	Yes	Oracle, Sybase, Ingres, Informix, Lotus 1-2-3, dBASE III, SQL, RDB	IBM: 1mb and 1 mb ext. memory. Mac: 2 mb
OPS/83 (Rule-based) (Production Systems Technologies Inc.)	\$1,900-25 K	IBM PCs and compatibles (MS-DOS), Apollo, AT&T 3B & 386, Unix 386 (Unix), HP 9000, VAX, MicroVAX, Sun 3&4, OS/2 or compatible, DG Avion, (C)	No	dBASE III	PC: 640 K; Hard Drive recom.
RuleMaster (Inductive) (Radian Corp.)	\$7,500-28 K	IBM PCs and compatibles (MS-DOS, Xenix), VAX and Unix workstations (Unix, VMS)	Yes		
TIRS (IBM)	\$11,000 - 60 K	IBM RT/PC, PS/2, IBM Mainframes, (MVS/CICS, MVS/TSO, VM/CMS) (C)			

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Table 2.1 PC, Mac & Miscellaneous Specialized Tools

TOOL (Knowledge Representation) (Vendor)	Price Range	Hardware (Operating System/Language)	Generates SQL	Databases that system can access without writing hook	Memory Requirements RAM/Hard Disk
CLIPS (OPS) (COSMIC/University of Georgia)	\$312	IBM PCs and compatibles (DOS & Xenix), Mac, VAX, Sun, Apollo, HP9000, CDC Cyber, CRAY (C)	No	-	-
Crystal (Rule-Based) (Intelligent Environments)	\$995-1,995	IBM PCs and compatibles (MS-DOS); OS/2, (C)	No	dBASE, Lotus 1-2-3, Lotus Symphony, Graphics	PC: 350 K OS/2: 2 mb RAM Hard Drive recom.
CxPERT (Software Plus)	\$795 - 4,000	IBM PCs and compatibles (MS-DOS)	-	-	C Compiler
Easy Expert (Rule-based) (Park Row Software Inc.)	\$49.95	MS-DOS	No	-	256K
EntryPaq (Inferencing/OOP) (Albathion Software)	\$79.95	Mac (Hypercard)	-	EP Rules, Excel	1 mb (2 mb recom.)
EST (Rule-based) (Mind Path Technologies)	\$495	IBM PCs and compatibles (Pascal)	No	Lotus 1-2-3	256 K
ExperCommonOPS5 (OPS) (Expertelligence)	\$625	Mac (Requires ExperCommonLisp) (Lisp)	No	-	1 mb
Experfacts (Rule-based) (Expertelligence)	\$495	Mac (Requires ExperLisp) (Lisp)	No	-	512 K
ExperOPS5+ (Rule-based) (Expertelligence)	\$495	Mac (Requires ExperLisp) (Lisp)	No	-	512 K
Expert Edge (Rule-based) (Helix Expert Systems Ltd.)	\$795	IBM PCs and compatibles (C)	-	Lotus 1-2-3, Multiplan, dBASE	256 K 512 K recom.
Exsys (Rule-based) (Exsys Inc.)	\$395-7,500	IBM PC/AT and compatibles (MS-DOS), VAX (VMS or Altrex), Unix, Sun 3 & 4, (C)	No	dBASE III, Lotus 1-2-3	640 K Hard Drive recom.

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Table 2.2 PC, Mac & Miscellaneous Specialized Tools

TOOL (Knowledge Representation) (Vendor)	Price Range	Hardware (Operating System/Language)	Generates SQL	Databases that system can access without writing hook	Memory Requirements RAM/Hard Disk
flex (Hybrid) (Quintus Computer Systems)	\$750	IBM PCs (MS-DOS), Mac (Multi-Finder) Prolog required	No	-	PC: 640 K Mac: 1 mb Hard Drive recom.
GURU FirstStep (Structured Rule) (MDBS Inc.)	\$895	IBM PCs and compatibles (MS or PC-DOS), Dec VAX (VMS), OS/2, LANs, (C)	Yes	dBASE III	PC: 512 K Hard Drive required
Hyper X (Hypercard) (Millennium Software)	\$199	Mac (Hypercard)	-	-	-
Instant Expert/ Instant Expert + (Rule-based) (Human Intellect Systems)	\$69.95 \$498	IBM PCs and compatibles (MS-DOS), Mac, (Modula II)	No	-	PC: 640 K Mac: 512 K
Intelligent Developer (Rule-based) (Hyperpress Publishing Corp.)	\$695	Mac +, SE or II (C)	No	HyperCard, HyperText, SuperCard, Plus, dBASE, Foxbase	1 mb
Joshua (Hybrid) (Symbolics)	\$10,000	Symbolics (Lisp)	-	-	-
KDS 2 & 3 (Inductive) (KDS Corp.)	\$970-1,495	IBM PCs and compatibles (MS-DOS), (Assembler)	No	Lotus 1-2-3, dBASE	640 K Hard Drive recom.
KnowledgePro/ Knowledge Pro Windows (Rule-based/hypertext) (Knowledge Garden Inc.)	\$495-695	IBM PC/AT and compatibles (MS-DOS) (Turbo Pascal)	No	dBASE III, Lotus 1-2-3	640 K Hard Drive recom.
Logic Tree (Rule-based) (CAM Software, Inc.)	\$495	IBM PCs and compatibles (MS-DOS) (Assembly, Fortran, Basic)	-	-	640 K Hard Drive
MacSmarts/MacSmarts Professional (Rule-based) (Cognition Technology)	\$195-495	Mac (Prolog, C)	No	HyperCard, HyperText, SuperCard	512 K 1mb & Hard Drive recom.
Magellan (Rule-based) (Emerald Intelligence)	\$99	Commodore Amiga (Amiga DOS)	No	Super Base, Lotus 1-2-3, ASCII, ARexx	1 mb
Mahogany Introductory/ Professional (Hybrid) (Emerald Intelligence)	\$149-495	Mac, IBM PC (MS-DOS)	No	-	Mac: 1 mb PC: 640 K

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Real-time CASE users include many of the largest systems builders — in aerospace, defense, and engineering — and they prefer to construct their own software development environment, because they need to support their own

development processes and methods. For real-time users, ease of tool integration is therefore critical for success. This report provides you with an objective, comprehensive look at technologies, market forecasts, applications, vendors, and users. By Caroline Chappell. 365pp/November 1989 Price: \$995, \$1035 outside N. America **Item Code: 09I**

### Analysis Techniques for CASE A Detailed Evaluation

What analysis techniques exist? What do they offer? How do they compare? Which techniques are supported by which commercial tools? Which techniques are most widely used? What do users think about them? This report provides the answers, reviews of 71 analysis techniques and extensive market forecasts. Plus practical advice to help you gain the most from the technique you choose. By Rosemary Rock-Evans. 600pp/November 1989 Price: \$995, \$1035 outside N. America **Item Code: 09J**

### Ada Strategies™ The Monthly Source of Ada Competitive Strategies and Contract Evaluation Guidelines

The newsletter for government contractors, procurement offices and agencies, insurance and financial institutions, vendors and manufacturers worldwide. It shows you how to: structure a corporate Ada im-

plementation plan, set up and run Ada training programs, team up in the interim so you can win contracts now, critique software and hardware products — plus report news and trends from around the world. Editor: Ralph Crafts. 12 issues/year Annual Price: \$337, \$407 outside N. America **Item Code: 07A**

### Knowledge-Based Systems Markets, Suppliers, and Products

This report provides the answers to the tough questions facing vendors and users. How big is the KBS market? ... How quickly is it growing? ... How will it mesh with MIS? ... Who is making money with KBS? ... Which countries and sectors offer the greatest opportunities? ... Which services and products are most widely used? Includes extensive supplier and product profiles. By Tim Johnson. 300pp/1990. Price: \$995, \$1035 outside N. America. **Item Code: 04X**

### The Future Of The Database

With relational DBs now set for adoption, what will the next step be? This report examines the technological developments taking place and measures them against users' requirements. Distributed DBs will be the cohesive force which will finally enable you to reach for that elusive goal ... integration. Includes market forecasts for DB systems. By Keith Hales. 290pp/1989 Price: \$995, \$1035 outside N. America **Item Code: 04W**

### Understanding Neural Networks

A comprehensive, concise introduction to this emerging field — to provide you with a working knowledge of this strategic technology. What is a neural network? Why are they important? How will such networks benefit my operations? What is "fuzzy" processing? Adaptive processing? What is the current status of the neural networks field? What are the commercial opportunities? What does the future hold? Find the answers in *Understanding Neural Networks*. 60pp/1988 Price: \$107, \$117 outside N. America **Item Code: 04P**

### The James Martin Productivity Series

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Table 2.3 PC, Mac & Miscellaneous Specialized Tools

TOOL (Knowledge Representation) (Vendor)	Price Range	Hardware (Operating System/Language)	Generates SQL	Databases that system can access without writing hook	Memory Requirements RAM/Hard Disk
<b>Mercury KBE (Hybrid)</b> AI Technologies	\$21,000	VAX workstations	Yes	Rdb, Sybase, Oracle, DB2, RMS	-
<b>Micro Expert</b> (Rule-based) (McGraw-Hill Book Co.)	\$54.95-64.95	IBM PC/AT and compatibles (MS-DOS), Apple Computers, (Pascal)	No	-	256 K
<b>Nemo (2.0)</b> (Rule-based) (S2O Development/Expert Knowledge)	\$12-17 K	386 and Sun 3 & 4 Workstations (Unix) (C)	-	-	-
<b>Nexus (Hybrid)</b> (Human Intellect Systems)	\$698	IBM PC/AT and compatibles (MS-DOS), Mac, (Modula II)	Yes	dBASE	640 K Hard Drive recom.
<b>Personal Consultant Easy</b> (Rule-based) (Texas Instruments)	\$495	IBM /XT/AT or compatibles, PS/2, Explorer or MicroExplorer (PC or MS-DOS), (Scheme, C)	No	dBASE, Lotus 1-2-3	640 K; extended mem.
<b>Personal Consultant Plus</b> (Structured Rule) (Texas Instruments)	\$2,950	IBM /XT/AT or compatibles, PS/2, Explorer or MicroExplorer (PC or MS-DOS), (Scheme, C)	No	dBASE, Lotus 1-2-3, ext. Lang. Interf.	2 mb ext. mem.; KB occupies 640 K
<b>PC Expert Professional</b> (Structured Rule) (Software Artistry)	\$495	IBM PC, PS/2 or compatibles (MS-DOS) (C, Pascal)	No	dBASE, Lotus 1-2-3	-
<b>Sierra OPS5 (OPS)</b> (Inference Engine Technologies)	\$795	IBM PC/XT/AT or compatibles (DOS 2.0 or later) PS/2 (OS/2)	No	-	384 K
<b>SuperExpert</b> (Inductive) (Softsync Inc.)	\$199.95	IBM PCs and compatibles (MS-DOS), Mac, PS/2, (Pascal)	No	-	256 K
<b>Symbologic Adept</b> (Procedural) (Symbologic Corp.)	\$1,995	IBM PCs, PS/2 and compatibles (MS-DOS) (C). Also requires MS Windows.	-	-	-
<b>VAX Decision Expert</b> (Digital Equipment Corp.)	\$6,000-28 K	Any Dec VAX workstation (VMS), (VAX C)	No	-	16 mb and RD54
<b>VAXOPS5 (3.0)</b> (Digital Equipment Corp.)	\$6,000-28 K	All VAXstations, MicroVAX, (VMS), (Bliss)	No	-	User: 8 mb Dev: 16 mb
<b>VP-Expert</b> (Rule-based/Inductive) (paperback Software)	\$249	IBM PCs and compatibles (MS-DOS) (C)	SQL version	dBASE 1-4, Lotus 1-2-3, VP-Info	512 K
<b>XI Plus</b> (Rule-based) (Expertech)	\$1,995-17 K	IBM XT/AT and compatibles (MS-DOS), all MicroVAX workstations (MProlog/Assembler)	No	dBASE, Oracle	640 K Hard Drive recom.

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Table 3.1 Domain Specific Tools

TOOL (Vendor)	Price Range	Hardware (Operating System/Language)	Domain	Memory Requirements RAM/Hard Disk
CAIS (Rosh Intelligent Systems Inc.)	\$100-200 K	Unix-based or MS-DOS (Prolog)	Troubleshooting for service technicians	PC/AT or higher 640K
Cogensys Judgment Software (Cogensys Corp.)	\$60,000 - 290 K	PC/AT, PS/2 or compatibles (DOS or OS/2) (Pascal, C) Operates standalone, on LANs—LAN servers to mainframes	For developing financial applications: consumer lending, credit card, commercial lending, etc.	520 K 20 mb Hard Drive recom.
Design ++ (Design Power, Inc.)	\$35,000	Sun 3 & 4, SPARCstations, MicroExplorer (KEE), (Lisp)	Engineering design automation	-
Enterprise D/x (Coherent Thought)	\$19,000 -100 K	Mainframe (MVS/XA/TSO, CICS) IBM PCs, various workstations, (C)	Equipment Diagnosis	-
Expert Controller (Umecorp)	\$10,000	Development: IBM PCs and compatibles (DOS), Runtime on Expert Controller	Automation of process controller programming	PC: 640 K, 10 mb Hard Drive recom.
G2 Real Time Expert System (Gensym Corp.)	\$18,000	Mac II, Compaq 386, DEC workstations, Symbolics 3260, TI Explorer, Sun, Dec VAX, (Lisp)	Real-time processing	8-16 mb
Genesis V (Sofbro Midwest, Inc.)	\$14,950	System/38	Develops expert frontends for relational databases	-
GURU Sloveur (MDBS, Inc.)	\$4,995	IBM PCs and compatibles, OS/2, LANs, Dec VAX (VMS)	Application generator for diagnostic expert systems.	640 K Hard Drive required
ICAD (ICAD Inc.)	\$20,000 - 95 K	Sun 4/110, 4/260, SPARCstation, Apple MicroExplorer, Symbolics 36xx, HP 9000 series 300 (Lisp)	Engineering automation	32 mb 600 mb Hard Drive
I-CAT (Automated Technology Systems Corp.)	\$18,000	IBM PC/AT (DOS), MAC II, Apollo, Unix, Sun, Dec VAX, Unix-based 386 systems (Lisp),	Diagnostic testing of mechanical and electrical equipment	-
Induce (OXKO Corp.)	\$95	IBM PCs and compatibles (PC-DOS), (Production Rule)	Classification	640 K 1 mb
Intelliform (Mind Path Technologies)	\$495	IBM PCs and compatibles (C)	Intelligent Forms Entry	512 K

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Table 3.2 Domain Specific Tools

TOOL (Vendor)	Price Range	Hardware (Operating System/Language)	Domain	Memory Requirements RAM/Hard Disk
Intelligen (CIMTelligence Corp.)	\$ 5,000 - 10 K	Dec VAX (VMS), HP 9000 (Fortran 77, C)	Generates process plans	4 mb
Maingen (OXKO Corp.)	\$195	IBM PCs and compatibles (Level5), (PC-DOS), (Production Rule)	Maintenance Application Systems	640 K 1 mb
Operations Planner (Carnegie Group)	\$39,000	IBM PCs and compatibles, (MS-DOS), (Fortran)	Create and compare alternative scenarios of plant operations	640 K Hard Drive recom.
Procedural Consultant (Decision Tree) (Texas Instruments)	\$495	IBM /XT/AT or compatibles, PS/2, Explorer or MicroExplorer (PC or MS-DOS), (Scheme, C)	Decision Tree analysis	640 K; ext. mem.
ROCKY (Expert Edge)	\$5,000 - 6 K	IBM PCs and compatibles (MS-DOS), Mac, (C)	For on-line, real-time mon- itoring of manufacturing and process control equipment	PC; 640 K Mac; 2 - 4 mb Hard Drive recom.
RTAC (Mitech Corp.)	\$15,000 - 22 K	VAX machines (VMS), PCs supporting X-windows (C)	Real-time advisory system for process control	-
Service/Maintenance Planner (Carnegie Group)	\$295 K	Sun 4, TI Explorer, Symbolics (Lisp)	Develops service and maintenance plans and schedules	-
TestBench (Texas Instruments/ Carnegie Group)	\$35,000 - 40 K	TI Explorer, Sun, MicroVAX (Lisp) Delivery via PC (C)	Equipment Diagnosis	8 mb, 2 Hard Drives of 140 mb recom.

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## APPLICATIONS

### EXPERT SYSTEMS FOR SALE: A SAMPLER

In past issues of the newsletter, we have run lists of expert systems applications in use. The number of expert systems in use today has grown beyond what we can list in a single issue. (We estimate that there are now several thousand applications.)

To provide our readers with a new index to the overall growth and variety of expert systems applications, we decided about six months ago to create a catalogue of all of the expert systems being sold. We currently have a list of about 75 expert systems that you can buy "off the shelf." We intend to wrap up the first release of the catalogue in October and then send it to subscribers as a bonus when they resubscribe. (Once it is published we will also have copies for sale.) We don't really expect that people will use the catalogue to order ex-

pert systems, but we hope it will provide a good overview of the ways in which expert systems are being used.

In this issue of the newsletter we have included 12 of the systems that will be in the catalogue just to give you an idea of this important new part of the expert systems market.

We have divided the systems in our sampler into five areas:

1. Underwriting Applications
2. Credit and Loan Approval
3. Decision Support Applications
4. Help Desk and Operations
5. Instructional Aids

## UNDERWRITING APPLICATIONS

Underwriting applications account for a large number of systems being offered for sale. This is probably due to the fact that the rules and decisions used in the underwriting process lend themselves particularly well to expert systems implementation, and that there is a real need to automate the underwriting process because of a high turnover of personnel.

*LIFEWRIter* is an automated life insurance underwriting system that is used to analyze new life insurance applications for potential risks and conduct an evaluation based on adherence to company underwriting policies. The system is intended for use by life insurance companies and other insurance underwriters.

Lifewriter accesses a database containing applications and information on company policies, etc. Upon reaching a conclusion, the system will either approve an application for issue without human intervention, or refer the application for manual resolution should any problems be found.

By automating the underwriting process, Lifewriter helps provide a more consistent method of applying company policy. Future versions of the system will include image processing capabilities and work-in-process.

Lifewriter was developed using Aion's ADS expert systems development shell. It operates on IBM PC/XT/ATs with a minimum of 640 K RAM.

The system sells for \$100,000.

For more information, contact: Applied Intelligence Systems, Inc., 1220 Broadway, Suite 500, New York, NY 10001; (212)629-8310, (800)443-0778.

*COVERAGE PRO UMBRELLA ANALYZER* (CPUA) is a policy analysis tool that allows insurance brokers and risk managers to analyze and compare umbrella and excess liability insurance policies. It is intended for use by commercial insurance agents and brokers. The system is designed to identify coverage gaps between selected umbrel-

la forms or an underlying commercial general liability policy. Users receive supplemental data disks adding information to the knowledge base periodically throughout the year.

CPUA allows insurance professionals to quickly determine if an insurance policy meets their clients' needs. The system also helps identify coverage gaps created by different policy provisions and provides insights into enhancing policy coverage. CPUA also serves as a marketing tool by pointing out discrepancies in a potential customer's existing policy, and printing out policy summaries and analyses for clients.

International Risk Management Institute claims there are more than 200 subscribers to the service.

CPUA was developed using Knowledge Garden Inc.'s KnowledgePro expert systems development tool. It operates on IBM PC/XT/ATs with a hard disk and a minimum of 512 K RAM.

The initial price of the system is \$698. The annual renewal fee is \$199 — this includes periodic updates.

For more information, contact: International Risk Management Institute, Inc., 12222 Merit Drive, Suite 1660, Dallas, TX 75251; (214)960-7693, (800)827-4242.

## CREDIT AND LOAN APPROVAL

Credit and loan approval is another financial application area where one sees a lot of end-user systems being offered for sale.

*LOAN ORIGINATION INFORMATION SYSTEM* (LOIS) is an expert system with over 1,800 rules that pre-underwrites borrowers applying for residential mortgage loans. The application assesses the borrower's conformance to the guidelines established by the Federal National Mortgage Association and the Federal Home Loan Mortgage Corp.

LOIS is intended for use by mortgage bankers, mortgage brokers, credit unions, savings and loans,

and other financial institutions providing residential mortgage loans.

Use of the system provides such benefits to lenders as: increased approval rate, increased customer satisfaction, increased file quality, and decreased resubmission rate. The system also provides alternatives and suggestions for solving lending problems applicable to different borrowers' situations and needs. In addition, LOIS also can serve as a low-cost training tool for new loan officers and/or processors.

LOIS was developed with Information Builders Inc.'s Level5 expert systems building tool. It operates on an IBM PC/XT, AT, PS/2, or 386 with a minimum of 512 K RAM and DOS 2.1 or higher. The system varies in price from \$900-3,600, depending on quantity. Leasing is also available.

For more information, contact: MasterLoan, Inc., 22845 N.E. 8th Street, Suite 456, Redmond WA 98053; (206)868-4282.

### DECISION SUPPORT TOOLS

Decision Support Tools are increasingly providing advice on such matters as starting a new company to advising managers on the pros and cons of acquiring expert systems technologies. Sometimes it is hard to discern whether an application is for decision support or operations. However, since these systems usually encompass both areas, this distinction is often irrelevant.

*BUSINESS PLAN EXPERT* (BPE) is designed to provide a user with a business profile based on his or her input. The system is intended for use by both new and existing companies. A company may use the system at any stage in its development.

Through the use of a question-and-answer consultation, BPE enables a user to create the preliminary element of a business plan. This includes an outline for product, marketing, and operations strategies. Having completed a consultation and arrived at a plan of action, the user can print out a business strategy profile that can form the basis of a business plan.

A number of different businesses and organizations are using BPE in a variety of ways. These include: planning for *The Travelling Family* magazine; the Table Toys Inc. toy company, the Botswana Management Assistance Program — a USAID organization; and in an MBA program at Columbia University in New York.

BPE was developed using Decision Master, a proprietary expert system shell developed by AIS. It operates on IBM PCs with a minimum of 256 K RAM and sells for \$195.

For more information, contact: Expert Technologies Corp., 3618 Burlington, Houston, TX 77006; (713)526-8069.

*THE LOGISTICS EXPERT SYSTEMS ADVISOR* (LESA) is an application designed to help managers determine the applicability of expert systems for their business. LESA can be applied to such domains as inventory, transportation, warehousing, purchasing, customer service, and maintenance.

The system analyzes factors such as potential for success, estimated cost and development time, fielding, and maintenance. The system also recommends hardware and development tools and helps calculate a potential system's return on investment.

LESA provides users with insights and an independent analysis of how expert systems technologies might benefit their businesses. By calculating ROI and recommending development tools and hardware, the system helps target a company's approach to acquiring and implementing expert systems.

LESA was developed using the CIMflex/Technology M.1 development tool and operates on IBM PC/ATs. The system sells for \$195.

For more information, contact: Intellogistics, 3620 N. High St., Columbus OH 43214; (614)261-8011.

*SPILL & RELEASE ADVISOR* is a PC-based application designed to help manage spill and release

incidents. It is designed for producers, users, and transporters of chemical products.

The system consists of a database containing information on reportable quantities, CAS and U.S. Department of Transportation numbers, and heuristics for determining if a spill or release should be reported. Through a question-and-answer session, the Advisor determines if a report to the National Response Center (NRC) is necessary. Should the system determine that a report is necessary, it generates the required forms and helps users develop an incidence report. Because the system has been developed in a modular format, it can be expanded to meet various local and state reporting regulations.

Spill and Release Advisor helps take the guesswork out of reporting releases and spills by providing a consistent approach to their analysis. In addition, it further automates the reporting process by generating the required forms for filing a report to the NRC.

Spill and Release Advisor operates on IBM PC/XT/ATs; a hard disk and 640 K RAM is recommended. The system is implemented in Information Builders' Level5 expert system building tool.

Spill and Release Advisor sells for \$12,000. This price includes five days of consulting to customize the application to meet a client's particular needs.

For more information, contact: Oxko Corp., P.O. Box 6674, Annapolis, MD 21401; (301)266-1671.

*KNOWLEDGE SEEKER* (version 2.0) is a decision support application designed for the intelligent retrieval of information from databases. It employs heuristic programming techniques to simulate the actions that a skilled statistician might use in analyzing and extracting information from databases. KnowledgeSEEKER is intended to provide business, research, and engineering professionals with the kind of information they need to make better marketing, finance, and engineering

decisions. It was developed under contract to Canada's National Research Council.

The system works as a statistical engine that allows managers or analysts to compare different parameters. It also determines significant relationships and displays them in order of significance. The major benefit of the system is that it enables the user to analyze a greater amount of information much more quickly than is possible using conventional analysis methods. The system also allows information extracted from databases to be written out in the form of predictive rules — both "generic" expert system and Prolog rules.

Some current users include: Canadian Astronautics, which is using the system to detect and analyze anomalies in data transmissions from satellites; and The Geological Survey of Canada, which is using the system to predict the location of ore deposits.

KnowledgeSEEKER was developed using FirstMark Technologies' own development environment, which is written in MicroSoft C. It operates on IBM PC/XT/ATs with a minimum of 640 K RAM. The system provides direct support for dBase, Lotus 1-2-3, and Excel file formats.

KnowledgeSEEKER sells for US\$ 495 or CAN\$ 595.

For more information, contact: FirstMark Technologies Ltd., 16 Concourse Gate, Suite 600, Ottawa, Ontario K2E 7S8 Canada; (613)723-8020, (800)387-7335.

## HELP DESK AND OPERATIONS APPLICATIONS

Help Desk and Operations Applications probably account for the largest segment of expert systems applications being sold today.

*HELP DESK ASSISTANT* is a tool designed to assist personnel working on a data center help desk. It is intended for use by all help-desk applications. It currently handles data center problems and can

be extended for use in customer service, sales, or other functional areas.

The system aids first-level personnel in the tracking, diagnosing, repairing, and dispatching of help-desk problems. Help Desk Assistant contains problem management support facilities, integration with mainframe problem management system, and diagnostic and repair knowledge bases. Two knowledge bases are available:

1. a knowledge base for handling network-oriented problems associated with mainframe terminals, peripheral devices, CICS, and Teleview; and
2. a knowledge base for solving PC-related hardware and software problems.

The system saves time and helps insure rapid and accurate tracking, diagnosis, and repair of help-desk related problems. Help Desk Assistant is presently being used by Warner Lambert.

Help Desk Assistant was implemented using Aion's ADS/OS2 and operates standalone on an IBM PC or LAN. The system sells for \$25,000 per server copy; each additional node costs \$1,000.

For more information, contact: Advantage KBS, Inc., 4 Ethel Road, Suite 405 B, Edison, NJ 08817; (201)287-2236.

**EXPERT INVENTORY MANAGEMENT SOFTWARE (INV-1)** is designed to manage inventory in maintenance and MRO storerooms. The system includes such features as reorder reports, purchase requisitions, purchase orders, daily transaction reports, inventory valuations, budget modules, cycle counting, and multiple vendors. A bar-coding module and a module for printing bin/shelf labels will also be available shortly.

The system can manage spare parts and supplies inventories for small- to medium-sized factories as well as hospitals, commercial buildings, and institutions. Benefits of the system include better tracking and handling of inventory and ease in replenishing stocks.

INV-1 was implemented in GURU (MDBS) and runs on IBM PCs equipped with a hard disk. The system operates under MS-DOS, OS/2, and Local Area Networks for multi-user applications. It can also be implemented with microcomputers or DEC/IBM mainframes. Customization is also available.

Prices start at \$2,950. This includes purchasing and vendor modules. A free demo disk is available from Eagle Technology.

For more information, contact: Eagle Technology, Inc., 5150 N. Port Washington Rd., Suite 230, Milwaukee, WI 53217; (414)332-7800, (800)523-9131.

**EXPERT REALISTOR** provides an interactive multimedia interface to real estate multiple listing services. By integrating audio/visual, relational database, communications, and expert systems technologies, the system allows a real estate agent to evaluate a client's needs and qualifications by means of a computer "consultation." Clients are then "walked" room-by-room through high quality image and audio tours of homes maintained in a database.

Expert ReaListor uses IBM's Audio Visual Connection (AVC) facilities for the capture and display/replay of images and audio related to a real estate agency's listings. Based on a client's preferences and financial status, pictures of available listings are displayed on the screen of a desktop system. Interior and exterior pictures can be displayed individually or together, as well as scenes of the surrounding neighborhood and community. These pictures are accompanied by corresponding audio descriptions.

Expert ReaListor is intended for use by real estate agencies and other property management companies. The system saves time and improves customer service by providing on-line listings of available real estate. It allows an agent to search a database of homes based on specific criteria such as price, city, neighborhood, MLS number, etc. By providing a room-by-room tour of any home that in-

cludes commentary in FM stereo-quality sound, Expert ReaListor helps eliminate unnecessary automobile trips to unacceptable listings.

The system was developed using Aion's ADS and operates on micro and mini computers — IBM PS/2 Model 70 or higher and Local Area Networks (LAN). It can also be integrated with mainframe applications.

Additional requirements are the IBM Audio-Visual Connection, IBM OS/2, and the Aion Execution System.

The Expert ReaListor in a standalone environment sells for \$1,995. A LAN-based version is also available which includes no limitations on the number of workstations attached to the LAN.

For more information, contact: Competitive Solutions, Inc., 7927 Jones Branch Dr., Suite 400, McLean, VA 22102; (703)556-0091.

## EDUCATION AND INSTRUCTIONAL APPLICATIONS

We're sure that there are a lot more of these applications being offered for sale, but because our survey has focused on business and industrial applications, we just aren't aware of them yet.

*ILLIAD* is a Macintosh-based application designed to teach the problem-solving skills required of a good physician. It is currently used as an educational tool for medical students in universities and hospitals.

The system operates primarily in two modes. In the consultation mode, Illiad allows students to directly enter (in text form) observations made during a patient examination. It can also offer a student consultation regarding the differential diagnosis at any stage of the examination and can educate the student on the most appropriate observation to make next. In addition, the system is able to recognize any disease with which a medical student is expected to become familiar. In the simulation

mode, Illiad can emulate a virtually unlimited number of simulated patient cases — all of which are statistically valid and unbiased.

Through the use of simulated cases, Illiad helps teach and test a student's medical decision-making skills. The system also helps evaluate a student's diagnostic capabilities by comparing the observations of different students.

Illiad operates on a Macintosh and requires 1 mb of RAM.

The system is priced according to user: the student version is \$450; for a practicing physician the cost is \$1,150, and a multi-user license is \$2,500. These prices are for yearly licenses, which are updated on a quarterly basis for a fee which is one-half the initial purchase cost. All prices (except multi-user) are for single machine use.

For more information, contact: Applied Informatics, Inc., 295 Chipeta Way, Salt Lake City, UT 84108; (801)584-3060.

*ROOT DIRECTORY* is an application that helps landscapers and gardeners (in N. America) to decide which flower and tree varieties would best fit a particular situation. In addition to professional landscapers and gardeners, anyone interested in gardening or selling garden products might find RootDirectory useful.

There is a RootDirectory for advice on flowers and a RootDirectory for trees. The system helps take the guesswork out of landscaping by providing advice on planting and maintaining gardens and trees.

Root Directory runs on an IBM PC/XT/AT with a minimum of 512 K RAM. It was developed with Knowledge Garden's KnowledgePro expert systems building tool. Both RootDirectory Flowers and RootDirectory Trees sell for \$39.95 each.

For more information, contact: Randy Farrar, Garden Tech, 1730 Goodman Avenue, Redondo Beach, CA 90278; (213)372-5810.



# INTELLIGENT SOFTWARE STRATEGIES

FROM CUTTER INFORMATION CORP.

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THE MONTHLY NEWSLETTER ON EXPERT SYSTEMS, OOP, CASE, NEURAL NETWORKS & NATURAL LANGUAGE

Editor: Paul Harmon

## WHAT'S HAPPENING IN THE EXPERT SYSTEMS MARKET?

Since 1983, AAAI has been the major event of the year for commercial expert systems, just as OOPSLA is the major event for people interested in object-oriented programming. This year was no exception, although the crowds were smaller (about 4,000) and the exhibits were smaller. Even vendors who sell more products at other shows still feel it's necessary to make a token appearance at AAAI.

The technical program had many theoretical papers and little of commercial interest. However, AAAI converted what had been a vendor's track into a new track called "AI On-Line." Most of the talks and panels of the AI On-Line track played to standing-room-only audiences, proving that there were many at AAAI who were interested in the commercialization of AI.

On the other hand, AAAI in Boston was nothing compared with the Avignon conference held in France at the end of May. More U.S. vendors, TI and Apple for example, exhibited at Avignon and the crowds were larger and more enthusiastic. One might argue that Europe is simply behind the U.S., but we're inclined to think there's more to it than that. The Avignon conference is clearly organized to stress commercial activity. Moreover, the general Avignon conference meets in conjunction with a number of specialized conferences focused on different commercial areas (transportation, finance, communications, defense).

Next year, AAAI has scheduled the technical conference and the innovative applications conference (IAAI) to meet together in Anaheim from

July 14 to 19. Thus, it seems that AAAI may be trying to encourage business people to return.

## AN EXECUTIVE OVERVIEW

From the AAAI exhibits, vendor announcements, and many conversations, one can usually get a good overview of the state of the expert systems market in the U.S.

The key things that impressed us, include:

- ◆ The major tool vendors are all introducing improved versions of their tools.
- ◆ IntelliCorp introduced a new high-end tool named ProKappa, written in C, and positioned it as an application development tool, not an expert system-building tool.
- ◆ Several vendors introduced problem- or domain-specific tools, including two new domain-specific tools by Aion.
- ◆ Consultants were exhibiting.
- ◆ There were many presentations about serious applications.
- ◆ There was a lot of talk about standardization.
- ◆ Lisp may not be dead, but it has become a very specialized concern.

To provide a more detailed understanding of the entire expert systems market as of August 1990, we'll review each part of the market — ranging from hardware and languages through tools and consultants.

### EXPERT SYSTEM-BUILDING HARDWARE

Symbolics was present and demonstrating its Ivory-chip co-processor boards on SUN and Apple workstations, but its main emphasis was on its Lisp software (e.g. the General Lisp environment). There were no other Lisp hardware vendors in attendance. Texas Instruments did not exhibit, nor did Apple. (Although Apple held a reception at its Cambridge research center.)

The other hardware vendors at AAAI this year were HP, DEC, IBM, and SUN. Each vendor offered a version of Lisp running on its platform, but none was emphasizing Lisp. Instead, they were using their machines to showcase various software packages and expert systems/applications.

Hewlett & Packard, for instance, not only demonstrated some of its own software products, but was showing a whole slew of third-party tools and applications to suit a number of domain-specific areas: for manufacturing environments, there were demos of I-CAT (Automated Technology Systems Corp.), the G-2 Real-Time Expert System (Gensym Corp.), and KEE (Intellicorp); In the engineering area, HP demonstrated the latest releases of Nexpert Object 2.0 (Neuron Data) and Concept Modeler (Wisdom Systems Technology); and for software development solutions, it was showing an auto leasing system, developed using Inference's new UNIX-system version of ART-IM, and the Knowledge Engineering System (KES), (Software Architecture & Engineering).

In addition, HP also showed some of the different languages, such as ObjectWorks for Smalltalk-80 (ParcPlace Systems), as well as some of its own software tools: the HP Visual User Environment — a graphical user environment for the Domain/OS and HP-UX workstations, and its Domain/CommonLISP and HP CommonLISP, ver. 4.0.

DEC's exhibit was organized around the idea of a company, with each portion of the booth demonstrating a different expert system application that the hypothetical company might use. The applications were written in VAX OPS5 and various third-

party tools and demonstrated systems that would help manufacturing, R & D/Engineering, MIS, Prime Contracting, and Sales/Marketing/Finance. DEC also offered various one-hour presentations, such as "AI and Manufacturing," "Knowledge Acquisition," and "Knowledge-based System Scheduling."

IBM was primarily at AAAI to show off its software. IBM demonstrated its expert system building tools — TIRS, ESE, and KnowledgeTool, and these other IBM software products: Prolog for 370, the AS/400 Neural Network Utility, Knowledge Director, and the Audio Video Connection.

SUN demonstrated Sun Common Lisp and the Symbolic Programming Environment — two of its more popular AI software products.

The most interesting specialized software vendor was International Chip Corp. ICC showed its latest hardware and software offerings — REX and CAKE. REX is a co-processor board designed to fit expansion slots of most computers, including PCs and workstations, and is capable of processing 5 million rules per second for rules consisting of one condition and one action per rule. CAKE is a software tool for developing expert systems applications. For more information, contact: ICC, AT&T Building, 1201 Main St., Suite 2000, Columbia, SC 29201.

### SYMBOLIC LANGUAGES

#### LISP

More Lisp vendors attended this year than last year, although it's hard to imagine why. Gold Hill still has the PC market for commercial Lisp, and Lucid has pretty well tied up everything else. The one company that seems likely to cut into the market is Kabuki Lisp, which is popular in schools and is being used by Gensym to get a lot of speed out of G2. (Kabuki Lisp is written on top of C and compiles to C.) Otherwise, the Lisp vendors are all fighting for a share of a small, stable market.

Lucid, Inc. demonstrated Lucid Common Lisp. Other hardware vendors also demonstrated applications developed using LC LISP, including DEC, who was showing it at its R&D/Engineering exhibit.

Clearly Lucid is the established standard in commercial Lisp in the U.S. Most of the other Lisp vendors are trying to gain market share in the commercial market but living off their sales to colleges and more specialized research institutions.

Franz Inc. was showing Allegro Common Lisp, Allegro Common Windows, and Allegro Composer. Allegro Common Windows is a high-level Lisp-based window toolkit that provides an interface from Lisp to X.11 Windows. Allegro Composer is an interactive window-based development environment that contains a debugger, inspector, and profiler, as well as a status display of process.

Harlequin Ltd. introduced its latest Lisp development environment, LispWorks 2.0. In addition, the company showed two other recent products, DataWorks and KnowledgeWorks. DataWorks is a package for developing graphical and OO interfaces for relational databases. KnowledgeWorks extends LispWorks by providing additional knowledge representation and organizational functions.

IBUKI was showing its IBUKI Common Lisp, which is written in C and generates C code as part of the compilation process. IBCL is billed as the smallest, least expensive, fastest, and most widely used version of Common Lisp on workstations, a reference to its popularity in colleges and universities. The most interesting user of IBUKI Lisp is Gensym in its newer versions of G2.

Top Level demonstrated its Top Level Common Lisp and MetaDebug, an external Lisp Debugger. Top Level also showed Lisp Insight, a window-based source level debugger.

Chestnut Software demonstrated several of its software products, including Lisp-to-C Translator, Memory Designer — an add-tool for Lisp-to-C Translator that allows applications to run using minimal system memory, a dBLISP and FoxLISP — Common Lisp interfaces that allow applications to create and read dBASE and FoxBASE compatible memory files.

Line System Company Ltd. showed its Lisp-to-C translator, Moebius. Moebius is designed for AI developers to develop applications in Lisp and deliver in C.

#### PROLOG

There were more Prolog vendors at the show this year than last year. We would have written off Prolog two years ago, but in fact, Prolog is alive and staging something of a resurgence. Last year Alain Colmerauer, the Frenchman who developed Prolog, introduced Prolog III. Prolog III replaces the unification process that was the core of Prolog I and II with a constraint propagation engine. Colmerauer argues that rule-based programming should be considered as a subset of the broader category — constraint programming. This is not about to turn Prolog into a popular commercial language, but it is an important development that expert systems developers will want to watch. We'll consider constraint programming in detail in a future issue of the newsletter. Meantime, Prolog vendors are at least as lively as the Lisp vendors — quite a change from 1989.

Quintus Computer Systems provided demonstrations of the new Quintus Prolog 3.0, which it touts for its ability to create applications that can be easily embedded within applications written in other languages. Quintus representatives explained that release 3.0 allows users working in other languages, such as C, to make calls to Prolog. 3.0 is presently being Beta tested and should be on sale in a few months. Quintus also demonstrated ProFLEX, a frame-based expert system written in Prolog. And Quintus announced that it will migrate Quintus Prolog to the IBM RISC System/6000.

Like Lucid in the Lisp world, Quintus is the dominant Prolog vendor to commercial companies and has developed most of the versions of Prolog sold by the major hardware vendors.

Arity Corporation was demonstrating its Prolog development software, including version 5.1 of the Arity/Prolog compiler and interpreter. Also shown

were versions of Delphia Prolog for workstations and minicomputers.

IBM exhibited Prolog and was targeting it primarily for research environments and universities.

Paralogic, Inc. showed its Paralogic Parallel Prolog, designed to operate on a network of Inmos transputers. The current release is an interpreter-based product that supports networks ranging from one to eight transputers.

### OBJECT-ORIENTED LANGUAGES

There were no object-oriented language vendors, as such, at AAAI. The companies selling C++, Smalltalk, and others, will be at OOPSLA in October. We will review those vendors and products in detail in the next issue of ISS.

The dominant expert systems development language at the moment is C. There is talk about using C++, but, at the moment, the language does not support the more sophisticated object-oriented programming requirements of expert systems.

### EXPERT SYSTEMS-BUILDING TOOLS

A number of new, small tool vendors showed products at AAAI, but the overwhelming impression is that the market has contracted, that main vendors are now established, and that they will focus on improving their products during the next few years.

Increasingly, the tools of the major vendors look more alike. On the surface this simply reflects the fact that most of the tools now run in windows environments (See Table 1). At a deeper level, it reflects the fact that each vendor is modifying its tool to incorporate a core set of functions, including objects, message passing, pattern matching rules that can do joins across objects, automatic SQL generation, and graphical knowledge base browsers. Vendors may lead in some areas and lag behind in others, but they are all moving toward the same general goal. Moreover, they are all working to ensure that their tools will run on all of the major platforms: mainframes, PCs, Unix workstations, VAX hardware, and RISC workstations.

Major Tools	Windows 3.0	Presentation Manager	X Windows Motif
ADS (6.0) Aion Corp.		✓	
ART/IM (3.0) Inference Corp.		✓	
ESE ( ) IBM		✓	
Kappa PC (1.0) IntelliCorp	✓		
KBMS (404) AICorp, Inc.		✓	
Level5 Object Information Builders	✓		
Nexpert Object (2.0) Neuron Data	✓	✓	✓
ProKappa (1.0) IntelliCorp			✓
TIRS (1.0) IBM		✓	

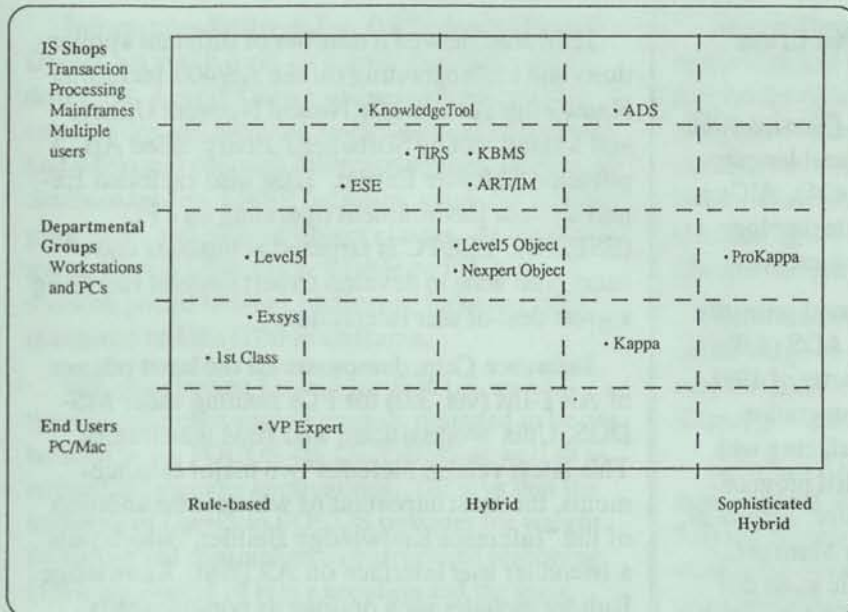
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Table 1 — The major tools do windows.

IntelliCorp's introduction of ProKappa, a C/Unix tool that will soon appear on the mainframe and on the VAX, indicates that IntelliCorp wants to break out of the Lisp niche market. Although it will undoubtedly continue to sell and support KEE, IntelliCorp is clearly betting its future on C. In effect, the Lisp tools market is being left to specialized vendors like Gensym and Mercury, Gold Hill and EpiTool.

Figure 1 provides our subjective first impression of the spread of new versions of the major tool vendors' products. In Figure 1 we tried to contrast the corporate group we thought would be most likely to use the tool with the overall power of the knowledge representation capabilities of each tool. Tools near the top of the chart stress high performance and multi-user capabilities. Tools to the right of the chart have more sophisticated rule and object programming capabilities.

Readers may choose to take Fig. 1 with a grain of salt since several other things — user and



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Figure 1 — A subjective impression of the power and appropriate use of the major tools.

of the vendors, and talking to people at Beta sites who have been playing with early versions of the tools. We will be doing detailed reviews of most of these tools in the course of the coming year and may end up changing our evaluation; we'll keep you informed.

We'll consider each of these tools, and others, in more detail in the discussion that follows.

### MULTI-PLATFORM TOOLS

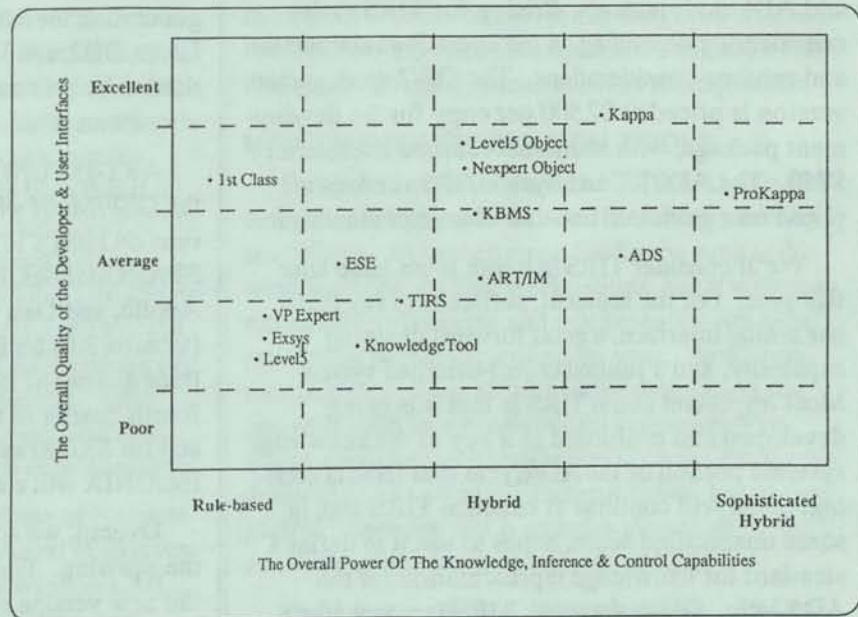
We've played around with different ways of classifying expert systems tools and finally arrived at the category "multi-platform tools" to describe the emerging hybrid tools that run on PCs, Unix workstations, IBM mainframes, and VAX

developer interfaces, database connections, and so forth, must be considered when evaluating these tools.

hardware. The major vendors who expect to be

We took another cut at placing the tools in Figure 2 where we keep representational power on the horizontal axis, but substitute our subjective evaluation of the overall quality of the user and developer interface on the vertical axis. We include in "interface," the knowledge entry facilities, browsers and other test facilities, the ease of database connections, and tools available for user interface displays. (Focusing on interface features tends to favor the workstation and PC tools that have been developed in a more graphical environment.)

As we said, these are subjective opinions, based on looking at the demos, asking questions



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Figure 2 — A subjective impression of the power and interface of the major tools.

around in a few years all offer tools that fit this category.

AICorp was demonstrating KBMS (Version 404), 1st-CLASS (Version 2.5), and its natural language database front end, Intellect (Version 404). AICorp announced that it would be licensing technology from IMKA, which we'll consider in a moment.

Aion's contribution to AAAI focused primarily on demonstrating the new version of ADS (6.0), which will be released in the first quarter of 1991. Version 6.0 has enhanced database integration (SQL generation) to allow faster interfacing with external databases, new object-oriented programming capabilities, and improved editors. Moreover, the OS/2 version runs in Presentation Manager. Aion also announced problem-specific tools that run on top of ADS, which we'll consider shortly.

IBM officially announced the availability of TIRS — The Integrated Reasoning Shell — and its booth focused primarily on promoting TIRS with demonstrations of applications, including one by Coopers & Lybrand that linked TIRS with the IBM Audio Visual Connection, operating in the OS/2 and AIX environments. Pricing for TIRS varies considerably depending on the operating environment and runtime considerations. The OS/2 workstation version is priced at \$7,500 per copy for the development package, with additional runtime licenses for \$750. The AIX/RT and System/370 versions are priced on a graduated one-time charge or monthly fee.

We'll consider TIRS in depth in an issue later this year. For the moment, suffice it to say that it has a nice interface, a good forward chaining capability, and a limited object-oriented system. Most important about TIRS is that it is being developed and positioned as a key to the knowledge systems portion of the AD/Cycle that IBM is creating. IBM will continue to enhance TIRS and, in some unspecified sense, hopes to use it to define a standard for knowledge representation for the AD/Cycle. Given that goal, TIRS is a tool worth careful study, even if the present version doesn't yet compare with ADS, ART, or KBMS.

IBM also showed a number of different applications and tools operating on the AS/400, including KnowledgeTool, IBM's Neural Network Utility, and a small tool by Software Artistry called Application Software Expert. IBM also exhibited Expert System Environment operating on a PC (ESE/PC). ESE/PC is targeted at business end-users who want to develop expert systems requiring a great deal of user interaction.

Inference Corp. demonstrated the latest release of ART-IM (ver. 3.0) for PCs running under MS-DOS, Unix Workstations, and IBM mainframes. This latest version includes two major enhancements, the most important of which is the addition of the "Inference Knowledge Builder," which puts a friendlier user interface on ART/IM. Knowledge Builder includes such options as pop-up menus, windows, and a cut-and-paste feature to allow easier mouse-assisted user interaction. The second enhancement, the "Inference System Builder," provides an object-oriented architecture to allow for easier integration of knowledge-based applications into existing software environments. Inference claims that this enhancement allows automatic code generation for integration with Oracle, D-base, Lotus, DB2, and VSAM databases and allows applications to be built on PCs and ported to mainframe environments without change.

ART-IM/UNIX is now available and supports the OSF/Motif windows standard. ART-IM/UNIX runs on IBM's RISC System 6000, Sun-3 and SPARCstations, HP series 9000, 300, and 800, Apollo, and Data General workstations. ART-IM (version 3.0) for PCs will become available in the third quarter of 1990 and for mainframes in the fourth quarter of the same year. The versions will sell for \$8,000 and \$160,000 respectively. ART-IM/UNIX will cost \$12,500.

Overall, we are impressed that Inference is on the upswing. We'll be providing a detailed look at the new version of ART/IM for the PC and the mainframe sometime this fall.

Information Builders Inc. (IBI) showed Level5 Object, its new hybrid tool operating under Windows 3.0. Level5 Object features object-oriented capabilities and includes such functions as forward and backward chaining inference engines, relational database models, CASE facilities, graphical debugging tools, and built-in object classes. At the moment, Level5 Object is available on PCs but will soon be ported to other platforms, including DEC machines and the IBM mainframe.

IBI also showed Level5 for FOCUS, an optimized inference engine module designed to be embedded in the FOCUS 4th GL/DBMS as well as in compiled language applications. IBI says that the addition of Level5 to FOCUS provides for weight factoring and comprehensive structured reasoning, allowing control of rule execution and the logic paths that are pursued, thereby freeing developers from the hassle of having to explicitly code every possible line of reasoning. Level5 FOCUS is available for all versions of FOCUS for IBM VM and MVS operating systems, and DEC VAX running VMS. Prices are \$19,200 for the mainframe version and \$2,800 for DEC VAX.

Level5 will still be offered and is available on a wide variety of platforms. Of all of the expert system tool vendors, IBI is uniquely positioned. It has a very large installed base of FOCUS users and is using expert systems technology to enhance the value of its 4GL product at the same time that it is selling its expert systems products. Moreover, it has just invested substantial money and R&D resources into the creation of a new tool, Level5 Object, which it priced very aggressively at \$995. IBI plans to introduce mainframe and DEC versions of Level5 Object within the next 6-9 months. That powerful combination gives IBI a good chance to wrap up the market for departmental expert systems.

Neuron Data showed its new release of Nexpert Object (Version 2.0) and showed several demonstrations of the system operating under Windows 3.0, ToolBook, Hypercard 2.0, Nexpert Forms, and database access.

Neuron Data claims that Version 2.0 supports multivalued and list data types, provides enhanced support for objects, and allows pattern matching rules that can do joins between objects in separate classes or databases. If this proves to be the case, Neuron Data will have gone a long way toward eliminating the limitations we have complained about in the past.

Unfortunately for Neuron Data, just as it seems on the verge of getting its act together, it now faces very formidable competition from Level5 Object and Kappa, good tools both priced well below Nexpert.

Software Architecture & Engineering demonstrated the newest release of KES (Version 3.0) and its new comprehensive development environment, SNAP. SNAP is billed as an object-oriented toolkit for building workstation-based applications. Operating in conjunction with KES, SNAP is intended to speed development of complex software applications through the use of reusable software components. SA&E says that applications developed using SNAP will cost between \$200,000 to \$400,000, depending on size and complexity. SNAP has been used for applications such as the management of locomotives and freight cars in railroad scheduling, real-time operations control of airlines, and communications network management.

### NON-LISP, WORKSTATION TOOLS

The most interesting new tool at AAAI was ProKappa, a sophisticated C-based tool introduced by IntelliCorp. At the moment, ProKappa runs in X windows/Unix on Sun workstations, but it will soon run on other platforms and will probably run on a mainframe before the end of the year. ProKappa represents a serious effort to offer developers the power of KEE in a conventional language. ProKappa applications compile into C code. ProKappa doesn't include all of KEE's capabilities, but at first glance, it appears that it includes almost all of the commercially important features of KEE.

We'll reserve a final opinion until we've had a chance to explore ProKappa in more depth, but we'll be surprised if it doesn't turn out to be the

most powerful and flexible expert system-building tool available in C. Of course, knowledge representational power is only a part of the game these days. To be really competitive, ProKappa will have to run fast (it seems to run very fast), offer multi-user capabilities (the current version is essentially a single user version), offer efficient database access (ProKappa automatically generates SQL via a KEEConnection-like package.), and so forth.

IntelliCorp is positioning ProKappa as an "Application Development Environment," suggesting that it intends to move away from an expert systems focus and toward an intelligent CASE focus. One could, of course, describe ProKappa as a very powerful C application development tool, although most C developers would be challenged even to begin to understand all of the various programming facilities ProKappa offers. Examples are inferencing, object-oriented programming, programming with demons (which IntelliCorp has decided to rename "monitors"), etc.

A development version of ProKappa, on the SUN 3 or 4, costs \$9,995. If you want to do data access, add \$1,995 and then add another \$2,595 for the interactive C environment, and you come to \$14,585. An equivalent runtime version of ProKappa will cost you \$2,990.

ProKappa is not compatible with either KEE or Kappa PC. All three products are object-oriented and the object portions of a knowledge base can be moved among the three tools without too much trouble, but porting the rules, control elements, and the interface portions of a knowledge base require significant effort. In describing the effort involved in moving an application from KEE to ProKappa, IntelliCorp suggests that, "Typical applications take 10 to 15% of the total development time to migrate from KEE to ProKappa. The effort required is dependent on the application. IntelliCorp recommends an assessment before migration is attempted." (IntelliCorp offers to help clients with the migration for prices ranging from \$3,000 to \$55,000!)

In effect, IntelliCorp is now marketing three independent products, each intended for a different market niche. Further, the company is variously positioning the products as a knowledge-based development tool (KEE), a C application development tool (ProKappa), and an object-oriented programming tool (Kappa PC). Moreover, when IntelliCorp moves ProKappa to the mainframe, it will come under pressure to offer a development version of ProKappa on the PC and it will then, presumably, have two PC products. It will be interesting to see how well IntelliCorp manages these divergent goals in multiple markets.

Bell Atlantic Knowledge Systems demonstrated a new release of Laser, its C-based hybrid workstation tool. DEC also provided a demo of Laser operating on a DECstation at their R&D Engineering booth. In addition, Bell Atlantic and Deloitte & Touche announced a joint agreement to develop and implement knowledge-based systems.

Software Artistry Inc. demonstrated its expert system building tool, Application Software Expert (ASE), along with its latest product, the Knowledge Engine. Knowledge Engine is a hypermedia development environment that enables the user to create applications combining text, graphics, animation, images, and sound, then integrate them with databases and programs to form graphical user interfaces. Knowledge Engine operates on IBM PCs and AS400s. The PC version sells for \$495 and the AS400 versions range from \$2500 to \$5000.

Exsys Inc. showed EXSYS Professional version 2.1, which includes a new rule editor and easier portability between DOS, VMS, UNIX, and OS/2. In addition, EXSYS also introduced an entry-level expert system shell for PCs called EXSYS EL, priced at \$175. Also being demonstrated was a Japanese version of EXSYS, produced by the company's affiliate, Sumisho Computer Service Corp. of Japan.

Production Systems Technologies promoted OPS/83, a rule-based expert systems development environment available for a wide variety of hardware.



## PC & MAC TOOLS

For flash and ease of use, the most exciting tool at the show was IntelliCorp's new tool, Kappa PC. Kappa PC is an improved version of the tool that MegaKnowledge demonstrated at AAAI last year (IntelliCorp bought MegaKnowledge). Kappa has a powerful object-oriented capability coupled with a very good forward and backward chaining rule system. Moreover, it runs very fast in Windows 3.0 and has all of the pop-up windows and pull-down menus and graphic displays that a developer could wish for. A single copy sells for \$3,500.

Given its power, interface, and price, Kappa PC is clearly the standard against which all other hybrid PC tools will now be judged.

If IntelliCorp chooses to port Kappa PC to workstations it might become the dominant mid-sized tool. If, on the other hand, it tries to position ProKappa rather than Kappa PC as its workstation offering, it will limit the sale of both tools. ProKappa won't be an easy tool to use; it has a good bit of KEE's power but it also has quite a bit of KEE's complexity. ProKappa is clearly more sophisticated than Kappa PC, but Kappa PC is as powerful or more powerful than any of the other tools in its class and much easier to use. The only thing that would lead us to choose any other mid-sized tool right now would be the fact that Kappa runs only on the PC and that IntelliCorp might not make versions of the tool available for Unix or VAX machines. (We predict that IntelliCorp will live to regret its decision to confuse the market by naming its new high-end C tool "ProKappa;" the only thing Kappa PC and ProKappa have in common is a name. Its easy to imagine that IntelliCorp might have a version of Kappa PC running on a Unix machine and a version of ProKappa on the PC within a year or so.)

We understand that IntelliCorp has already sold several hundred copies of Kappa PC and it has just announced a deal worth \$1 million to supply HP with Kappa PC for the development of internal applications at HP.

A recent flyer advertising Kappa PC positioned the tool as an object-oriented development tool. It could certainly qualify as an OOP tool; it provides more object-oriented capabilities than languages like C++ or Smalltalk, and certainly is easier to use. On the other hand, most object-oriented programmers don't know anything about inferencing or demons (IntelliCorp still calls them "demons" in Kappa PC, even though it decided to call them "monitors" in ProKappa). Selling Kappa PC to object-oriented programmers will be at least as challenging as selling ProKappa to C developers. IntelliCorp is evidently feeling very ambitious.

CAM Software, Inc. demonstrated LogicTree, its expert system tool which began shipping this April. LogicTree is a PC-based system employing decision trees to develop applications for areas such as diagnosis, decision making, automatic coding, documentation, and procedural training. LogicTree retails for \$495.

Emerald Intelligence showed Mahogany Introductory, its rule-based expert system shell, and Mahogany Professional, a hybrid rule and OO-shell. Emerald's latest product — Mahogany HelpDesk — was also demonstrated. HelpDesk is a customized application development tool that allows users to develop help systems using Mahogany Professional. All these systems operate on both the PC and Macintosh. Emerald announced that it will soon release VAX/VMS versions of these tools.

Paperback Software International demonstrated the latest version of VP Expert version 2.0. Recent additions to the program include an enhanced user interface providing dynamic graphics, mouse support, hyperwords to create intelligent documents, and the ability to run other programs from within a VP Expert shell. VP Expert is still a very popular PC tool, with runtime, SQL, and educational versions available.

Symbolic Corp. demonstrated Symbolic Adept (version 1.03), its procedure-based expert system. Adept employs a graphical building environment operating under Windows 3.0. Sym-

bologic reduced the price of the tool from \$1,995 to \$695. The runtime operating environment has also been reduced to \$145 per copy, with additional reductions for volume purchases.

Albathion showed EntryPac in the John Wiley & Sons booth. EntryPac is a slow, but very powerful small tool that runs on the Mac and can be used in conjunction with the book, *Developing Expert Systems*, which was written by two of Albathion's principals, Ed Payne and Bob McArthur.

### LISP-BASED TOOLS

The dominant Lisp-based tool is clearly IntelliCorp's KEE. IntelliCorp introduced a new version of KEE (4.0) which included a number of improvements. It's also clear that IntelliCorp is moving out of the Lisp market and into the conventional tool market. It's not that the company won't continue to sell KEE and support KEE customers, but it will probably put most of its energy into ProKappa and Kappa PC.

The second largest Lisp tool vendor is probably Inference. Like IntelliCorp, Inference continues to sell its original tool, ART, but its main emphasis is on ART/IM, the C-based product line.

Were it not for the fact that there are some smaller Lisp vendors who are making money selling Lisp-based tools, we might conclude that IntelliCorp's introduction of ProKappa was the final nail in the coffin of Lisp.

Gensym Corp. is one example of those smaller Lisp vendors. Gensym sells G2, a Lisp tool that is especially effective for developing real-time applications. G2 seems to be very popular with companies that have difficult, complex process control problems. (Early versions of G2 ran in Lucid Lisp, but the recent versions are running in Kabuki Lisp — which means that you can develop in a Lisp environment and then compile most of the application into C code.)

At AAAI, Gensym demonstrated several versions of G2, including versions supporting Japanese

(Kanji) and each of the major Western European languages.

The company also announced the first G2 application package for message management. Priced at \$4,000, the Message Application Package is intended to allow G2 users to create network-wide systems for managing and distributing data among other G2 application users.

The DEC booth demonstrated a G2 CIM application that enables engineers to develop, test, and deploy monitoring and control systems. Gensym representatives say that there are now over 400 G2 applications deployed worldwide.

Gensym used AAAI as an opportunity to announce that G2 can now run on Data General Avion workstations.

Artificial Intelligence Technologies (AIT) is another Lisp vendor that seems to be getting a lot of attention these days. AIT's Mercury Knowledge Base Environment (KBE) is popular with companies that want to use Lisp systems to access large databases. Mercury KBE incorporates CASE tools and features a CLOS compliant object system and the ability to be closely integrated with SQL DBs.

AIT also showed the Mercury Intelligent Statistical Process Analysis system (ISPA) — a tool for developing mathematical process models — and Mercury Intelligent Simulator (ISIM) — a tool designed to help chemical and control engineers develop models of chemical, food, and steel plants. Both Mercury ISPA and Mercury ISIM operate on VAX/VMS workstations and, depending on hardware size, are priced from \$30,000 - \$70,000. AIT announced a PC-version of Mercury which will become available this October and sell for \$14,900.

AIT and ExperTelligence also announced a joint agreement whereby AIT will integrate ExperTelligence's Action!, an object-oriented graphical interface development tool, with the CLOS compliant object system integral to AIT's Mercury KBE product.

ExperTelligence provided examples of its Procyon Common Lisp ver. 2.0 for the Macintosh,

and its OOP environment SPOKE. Procyon Common Lisp is full common Lisp and includes CLOS, the object system that provides multiple inheritance, generic function dispatch, incremental compilation, and dynamic classes. SPOKE is an OO language that, in conjunction with its two libraries, SPOKE Windows+, and SPOKE Engine, is intended for developing applications such as expert systems, database interfaces, graphic user interfaces, and diagnostic and scheduling systems. SPOKE supports multiple inheritance and incremental compilation and generates C and C++ code.

In addition, we witnessed a demo of an airline parts scheduling application being developed using ExperTelligence's Action! for Iberia airlines — the Spanish air carrier. Action! is an interactive OO interface development environment for the Macintosh and MicroExplorer. The application we saw was operating on a MicroExplorer. The complete SPOKE development environment sells for \$10,000 with multiple copy discounts. The entire Action! development environment is priced at approximately \$3,000 for the Macintosh version and \$1,850 for the MicroExplorer.

Envos/Venue showed various products and development environments, including: Medley, a Lisp development environment; LOOPS, an OOP environment which includes multiple inheritance, active values, and a library of user-interface widgets.

Blackboard Technology Group demonstrated the recently released GBB 2.0. GBB, or the Generic Blackboard Development Framework, is a Common Lisp programming environment for developing blackboard-based AI applications. GBB 2.0 provides a blackboard development database facility, knowledge-source languages, control shells, and a blackboard examinations graphics tool. GBB is an extension of Common Lisp and CLOS, and it inherits the programming environment and development tools provided by the host implementation. GBB 2.0 operates on DEC stations, Encore, Sequent, SUN (including SPARCstations), Symbolics, TI Explorer and

MicroExplorer, and Macintosh computers running Apple Macintosh Allegro Common Lisp.

For more information, contact: Blackboard Technology Group, 401 Main St., Amherst, MA 01002; (413) 256-8990.

Gold Hill Computers did not have a booth this year, but they held a reception and introduced the latest version of Golden Common Lisp running in Windows 3.0. They expect to port the PC version of GoldWorks II to Windows 3.0 in the near future.

Gold Hill has gone through a painful reorganization this year. The result is a new Gold Hill that is owned by a group of its former employees who have foresworn the more ambitious goals of the former management and are now concentrating on selling high quality Lisp language and tool products to schools and companies that still want to use Lisp to develop PC products. Given Gold Hill's predominant place in the college Lisp market, there is every reason to expect that a prudently run company might stay in business for a long time.

The market for Lisp tools isn't very large. Lisp-based tools still provide the best possible environments for developing big, new, complex systems that would be difficult to develop in any other way. (Bachman's impressive CASE tool that IBM currently supports as part of its AD/Cycle was written in Golden Common Lisp.) But only so many applications are complex enough to warrant Lisp, and only a handful of developers are capable of taking advantage of the power offered by such tools. Moreover, successful Lisp tools probably need to be specialized for a particular niche, as Gensym has specialized G2 by making it fast enough for tough process control problems.

The market for Lisp tools isn't large enough to support a company the size of IntelliCorp or Inference. It may, however, contain niches large enough to support companies such as Gensym, AIT, ExperTelligence, and Gold Hill — if they tailor their products for specific tasks and if they create the specialized development environments

that make it easy to solve the hard problems that cannot be easily solved in any other manner.

### PROBLEM- AND DOMAIN-SPECIFIC TOOLS

There were more problem- and domain-specific tools shown at AAAI than in past years. Most of the tools that fall into this category, however, are probably being shown only at specialized shows. Moreover, they are not being called expert systems tools, but described in terms of the problem domain in which they are designed to function. The domain-specific tools being shown at AAAI were mostly tools developed by tool vendors that have generic tools and were showing their more specialized products on the side.

Aion's two new problem-specific tools provide an appropriate example. Checklist Builder and Path Builder are both application-specific tools implemented using ADS. Checklist Builder is designed to develop business procedure applications that will complete a goal or generate a checklist of steps needed to solve a problem. Path Builder is a problem-specific tool for the development of service aid and help-desk applications that perform a series of steps to identify and correct a problem or make a decision based on answers to a series of questions. Aion has tailored both tools so that they are considerably easier to use than ADS. They are designed to allow non-programming domain specialists to develop checklist and service-aid applications. Both products will be released in the 3rd quarter of this year.

Aion and Stone & Webster also announced a cooperative agreement to market STONERule, S&W's systems interface that allows ADS to operate in conjunction with mainframe CAD/CAM systems, such as CATIA (Dassault Systemes) and CADAM (CADAM, Inc.).

Micro Database Systems, Inc. (MDBS) provided demonstrations of GURU version 2.0 operating on a wide variety of hardware and operating environments, including DOS, a new OS/2 and a DEC/VAX VMS versions, and SunOS Unix (SPARC). MDBS was also showing GURU First-

Step, an introductory version of GURU, and GURU Solveur, an application generator for diagnostic expert systems that is intended for use by non-computer professionals. Other announcements from MDBS include an SQL interface for its KnowledgeMan/2 and GURU software.

Automated Technology Systems Corp. demonstrated various applications using I-CAT, its model-based expert system for electrical and electro/mechanical applications. I-CAT operates on UNIX-based 386 or Macintosh platforms. The system can accept input through scanner, optical reader, or laser scanning, as well as traditional input methods. I-CAT was introduced in 1984 and is now in use at a number of sites throughout the world: General Motors in the U.S., British Telecom in Europe, and C. Itoh Corp in Japan.

Wisdom Systems showed a number of applications developed using Concept Modeler, its OO knowledge-based engineering design tool. Concept Modeler is intended to support simultaneous engineering through a constraint-based design and programming approach. One particularly impressive application was a system for automating the design of mass flow meters. Company representatives say there are approximately 165 copies of Wisdom deployed worldwide.

### IMKA

Carnegie Group, DEC, Ford, Texas Instruments, and U.S. West are continuing to work on their Initiative for Managing Knowledge Assets (IMKA), an effort to establish an open standard for the representation of knowledge and for handling the inference and control associated with such knowledge. If successful, the companies involved, and others that support the IMKA initiative, would insist that vendors' products adhere to the IMKA standard. The good news for the companies involved is that knowledge would be represented in a common way and they could then develop different systems drawing on the common base of knowledge. The catch, however, is that this would require tool vendors to modify their underlying technology to

ensure compliance with the standard. At the moment, the IMKA partners are working on a Unix standard, but they intend to generalize it to all standard hardware platforms. The IMKA technology would not involve either developer or interface components. Thus, the IMKA technology is not a tool definition; it is a definition for the underlying inference, control, and knowledge representation elements that comprise the core of a tool.

The formation of IMKA was announced last spring. At AAAI, the IMKA partners presented their Phase I **Software Functional Specifications for Knowledge Representation**. This document is available from IMKA. IMKA has created a number of different membership categories and seeks to talk with companies interested in an open standard either as a consumer or a vendor of knowledge systems. Membership is open to any company in the world.

AiCorp became the first company to announce that it would license the technology for use in KBMS. (It also said it is seriously considering joining IMKA as a full partner.) The move by AiCorp can be viewed in at least two different ways. It can be taken to mean that AiCorp supports the idea of open standards and wants to get on the bandwagon early. IMKA could certainly benefit from AiCorp's technology for creating database objects and accessing databases on mainframes. On the other hand, it could be taken as evidence that the existing AiCorp inferencing and knowledge representation technology is limited and that AiCorp thinks joining IMKA would provide it access to a better core technology than the one presently available in KBMS.

IMKA is currently talking to a number of major vendors, including Aion, IntelliCorp, and IBM. Each of those vendors, however, is likely to conclude that its existing technology is just as good or better than the technology that IMKA proposes. Moreover, each will be very reluctant to recode its current tools and thus frustrate its existing customer base to join an effort that has only a limited chance of succeeding.

IBM, of course, has already proposed its own standard, the Knowledge Processing Environment

(KPE) which is somehow related to the AD/Cycle and the Knowledge Systems component in the AD/Cycle Repository. Most of the major vendors have pledged to remain AD/Cycle compliant. Unless IBM decides to join IMKA, which seems unlikely, most vendors will have to decide which standard to support.

We have just received a copy of the IMKA Software Functional Specification and will review it in detail in a coming issue, comparing it with the functional capabilities of Aion's ADS 6.0, Inference Corp's Art/IM, IBM's TIRS, and IntelliCorp's ProKappa to provide readers with some perspective.

We think standardization is an important issue. As larger companies develop more expert systems, they will find that they are accumulating knowledge bases and will wish to share knowledge between them in some more or less transparent manner. At some point, large companies will want a standardized way to represent knowledge and, hence, a specification to handle the inference and control associated with the modules of knowledge.

On the other hand, we don't think standards are created by committees; especially a committee that includes a tool vendor (Carnegie Group). Consider that UNIX was a well respected standard that split apart because many companies thought that AT&T was giving SUN an inside track and you get some idea of what might worry companies like Aion, IBM, and IntelliCorp when they hear that Carnegie Group is the primary developer of the IMKA technology. The IMKA group is certainly aware of these potential problems and claims it is making every effort to work them out.

It would certainly be nice if corporations could agree on a standard before many more knowledge bases get built, but we suspect that it's too early to try to standardize. This much is certain, unless IBM joins IMKA soon, and in effect lets IMKA set the standard for the knowledge systems portion of the AD/Cycle Repository, the project will necessarily remain rather limited in its scope. We'll keep you informed of IMKA's progress.

For more information about IMKA, contact Ted Smith, Chairman of the IMKA board of directors, US West Advanced Technologies, 6200 S. Quebec, Englewood, CO, 80111; (303) 899-6405.

### CONSULTANTS

There may have been one or two consulting organizations advertising their services at previous shows, but we don't remember them. (We're excluding companies like Inference, IntelliCorp, and IBM who attend as tool vendors and sell their consulting services in the context of their tool sales.) This year, by contrast, we saw many consulting groups who had rented space and were displaying applications they had developed.

The largest and most impressive consulting firm demonstrating at this year's AAAI was Andersen Consulting. In its booth and in an AI On-Line session, Andersen showed a number of applications it had developed for its clients. The common theme of these presentations was that expert systems are being embedded within larger strategic applications that are changing the way companies conduct their business and saving them large amounts of money.

Two of the applications demonstrated by Andersen Consulting illustrate this: (1) A real-time system developed using VAXOPSS to aid in the control of pulp processes in the manufacture of fine paper products. This system helps diagnose color quality problems and recommends solutions to plant and machine operators. (2) The other system was designed to assist help-desk personnel in trouble-shooting problems occurring at retail point-of-sale (POS) terminals. Developed using Andersen Consulting's own MODEL/1 methodology, AC:ESS makes the knowledge maintained in various support manuals easily accessible to help desk workers by "walking" them through a series of diagnostic question-and-answer sessions.

We talked with Joe Carter, the head of Andersen Consulting's knowledge-based systems group. Carter told us most of his clients with projects that incorporate knowledge-based systems came to the consultancy for other help. Once Andersen looked

at the problem, they included a knowledge system component within the larger architecture to handle a specific part of the problem. Interestingly however, the specific part often amounted to a large amount of the value of the system, since it handled quality control or decision access components that made a big difference in the overall cost of the system. Mr. Carter noted that while some companies are still interested in small expert systems, Andersen's clients are primarily concerned with solving complex business problems and that Andersen Consulting is using knowledge-based systems as one tool among many that it employs when it designs sophisticated applications for its clients.

Another consulting company at the show was Bolesian, the Dutch firm that has been training people in the use of a structured approach to expert systems design. Bolesian and Aion announced that Bolesian would provide training and support for Aion clients in Europe.

A third consulting company was Technology Applications, Inc., a Bechtel division demonstrating its on-line plant advisory system, OASYS. OASYS is used to monitor and interpret sensor data from electrical power plant generating equipment. The system provides plant operators with real-time assessments and recommendations to help prevent and alleviate equipment failures. OASYS was developed in Lisp and operates on IBM ATs and VAX computers. It is being installed on-line at the Indian Point 2 and San Onofre nuclear power plants. We've provided a list of the names and addresses of all of the consulting companies who were showing their wares at this year's AAAI conference.

### APPLICATIONS

There were simply too many applications being demonstrated to begin to list them all.

DEC demonstrated applications developed using its own systems as well as the systems of other vendors: ABACUS, a Swedish air base expert, is an application developed using Epitex's (of Sweden) Epitool, an expert system tool now being marketed by DEC in the U.S. ABACUS is an air-defense

threat monitoring system that analyzes potential threats, alerts air-defense commands, and recommends the appropriate responses; Expert Expense Advisor is an application that shows how Nexpert Object can be used in conjunction with any standard spreadsheet application to develop an expense "expert." The system can be implemented across all major platforms and includes secure access to multiple databases. Also demonstrated was the Logistics Planning System (LPS), being developed for the U.S. Army by Carnegie Group. LPS helps facilitate the capture of expert knowledge which represents battlefield relationships and operational practices. The underlying knowledge-based methodology of LPS demonstrates how knowledge — whether military or corporate — can be captured and maintained for future dissemination.

Another interesting example was provided by Molecular Knowledge Systems, Inc., demonstrating SYNAPSE, an expert system to help design better

chemical products. Using a sophisticated interval search paradigm and graphical problem representation, SYNAPSE generates and tests vast numbers of candidate compounds computationally, thus reducing the time and expense needed to discover better chemical products. Company president Dr. Kevin Joback, said that, "unlike traditional molecular design software, SYNAPSE focuses on macroscopic properties, either interactively or automatically designing the molecular compounds which satisfy those constraints." Presently, Molecular Knowledge Systems is using SYNAPSE to design environmentally safe refrigerants which will not deplete the ozone layer, and to develop applications for lubricant, polymer, and solvent design. SYNAPSE was written in Common Lisp and operates on a Mac II equipped with Symbolic's MacIvory chip. The system will become commercially available in June 1991.

For more information, contact: Molecular Knowledge Systems, Inc., 26-452 Kessler Farm Drive, Nashua, NH 03063; (603) 881-9821.

**COMPANIES AT AAAI THAT WERE  
PRIMARILY OFFERING THEIR SERVICES AS  
TRAINERS OR DEVELOPERS OF EXPERT  
SYSTEMS**

Andersen Consulting 100 South Wacker Drive, Chicago, IL 60606; (312) 507-6485.

Bolesian Inc. One Kendall Square, Suite 2200, Cambridge, MA 02139; (617) 621-7181.

Carnegie Group Five PPG Place, Pittsburgh, PA 15222; (412) 642-6900.

CMD (Consultants for Management Decisions) One Main Street, Cambridge, MA 02142; (617) 225-2200.

Cognitive Systems, Inc. 234 Church Street, New Haven, CT 06510; (203) 773-0726.

Foundation Technologies, Inc. One Kendall Square, Suite 2200, Cambridge, MA 02139; (617) 720-2760.

HNC, Inc. 5501 Oberlin Drive, San Diego, CA 92121; (619) 546-8877.

Stone & Webster Engineering 245 Summer Street, Boston, MA 02107; (617) 589-5483.

Technology Applications, Inc./AI Institute-A Bechtel Co. P.O. Box 3965, San Francisco, CA 94119; (415) 768-1500.

**NEURAL NETWORK TOOLS, NATURAL  
LANGUAGE, ETC.**

In addition to the expert systems vendors, there were a few Neural Network vendors and a couple of vendors showing Natural Language products. We've listed them below and will treat them in more detail in future issues of the newsletter which will focus on these topics.

HNC exhibited its IDEPT (Image Document Entry Processing Terminal) workstation — a neural network character recognition system that reads handprinted characters. Demonstrations included applications for reading and recognizing data on checks and on IRS 1040 EZ forms.

HNC also demonstrated KnowledgeNet — a neural network package that explains how answers are derived and generates expert system rules automatically, and ExplorerNet 3000 — a PC-based neural network software package operating under Windows 3.0.

In addition, HNC and Bechtel announced an agreement which gives Bechtel U.S. and Canadian distribution rights for HNC's ExplorerNet 300, neural network software for PCs and compatibles.

For more information, contact: HNC, 5501 Oberlin Drive, San Diego, CA 92121; (619) 546-8877.

Neural Ware, Inc. demonstrated several of its neural network products, including NeuralWorks Professional II and NeuralWorks Designer Pack. NeuralWorks Professional is a development environment for creating specific neural network applications. It operates on a wide variety of hardware, including IBM PC/AT, PS/2, Macintosh, and SUN workstations. NeuralWorks Designer Pack embeds created networks within specific applications by converting the user's created network into C source code.

For more information, contact: NeuralWare Inc., Penn Center West, Building IV, Suite 227, Pittsburgh, PA 15276; (412) 787-8222.

AICorp. provided demonstrations of Intellect, its natural language database front-end. The latest version of Intellect, released earlier this year, has been used to develop such applications as Executive Information Systems, Information Intensive Applications, and General Ad Hoc Query. AICorp states that Intellect has been installed in more than 600 sites worldwide.

Synchronetics, Inc. released and demonstrated its latest version of NL Builder 5.0, a natural language processing shell for SUN, DEC VAX, Apollo, Macintosh, IBM PCs, and NeXT machines. The system, written in C, develops NL applications for human/computer interfaces, text processing and translation, message understanding, and higher education laboratory work. Applications were shown demonstrating English text processing capabilities.

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For more information, contact: Synchronetics, Inc., 301 N. Front Street, Baltimore, MD 21202; (301) 752-1065.

## WRAP UP

In terms of new and different product introductions, this year's AAAI wasn't a very exciting show. Instead, the major vendors offered refinements of their current products and consultants offered to help companies integrate knowledge systems into their overall computing strategy. Knowledge based systems have become a mainstream concern; the flash and hype has been replaced by such important but mundane things as how fast and efficiently a particular tool can generate SQL. Application development is the primary focus of the expert systems market today and vendors and consultants are working hard to convince the IS departments of major corporations that they can help provide the solutions everyone is now interested in.

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# INTELLIGENT SOFTWARE STRATEGIES

FROM CUTTER INFORMATION CORP.

TM

THE MONTHLY NEWSLETTER ON EXPERT SYSTEMS, OOP, CASE, NEURAL NETWORKS & NATURAL LANGUAGE

Editor: Paul Harmon

## OBJECT-ORIENTED SYSTEMS

Object-oriented programming, object-oriented databases, object-oriented analysis and design — almost anything with the words “object-oriented” (OO) in its name is hot right now. In this issue of ISS, we provide a brief explanation of OO technologies and discuss the overall market for OO products. In the next issue, we will feature part two of this article, which will include detailed charts describing the various commercially available OO products and vendors.

### WHAT IS “OBJECT-ORIENTED”?

Object-oriented programming (OOP) is a new way of thinking about programming. It is a fundamental shift that has already led to new languages, to window-based graphical user interfaces, to object-oriented databases and to sophisticated ways of representing knowledge in expert systems. It has also resulted in a whole new way of analyzing problems and designing software programs. We

believe that computer instruction in the 90s will be reorganized to emphasize the key conceptual role of the object in any software development effort.

Whenever you think about the world, you think in terms of objects: of people you know, of tools you use, of cars and houses and animals. You also think of abstract, conceptual objects like “justice” and “addition” and “squares.” Moreover, when you think of an animal like a rabbit, you think of it as a whole. A rabbit has data associated with it. For example, rabbits are mammals, rabbits have fur, rabbits weigh between 5 ounces and 25 pounds, etc. In addition, we associate behavior with rabbits. Rabbits eat clover. Rabbits give birth to their young, dig burrows and run from foxes. Normally, when we think of a rabbit, it never occurs to us to subdivide our idea of a rabbit and think of its attributes as separate from the behaviors or procedures we associate with it.

In conventional programming, however, that’s exactly what we do. We describe the attributes of the rabbit in data structures and then describe the behaviors of the rabbit as procedures that operate on the data structures. Conventional programming is often called “procedural programming” because it tends to put the emphasis on the procedures and treat the data structures as if they were of secondary importance. OOP shifts the emphasis and focuses first on the data structures and only secondarily on procedures. More important, OOP allows us to analyze and design programs in a more natural manner. We can think in terms of rabbits and clover

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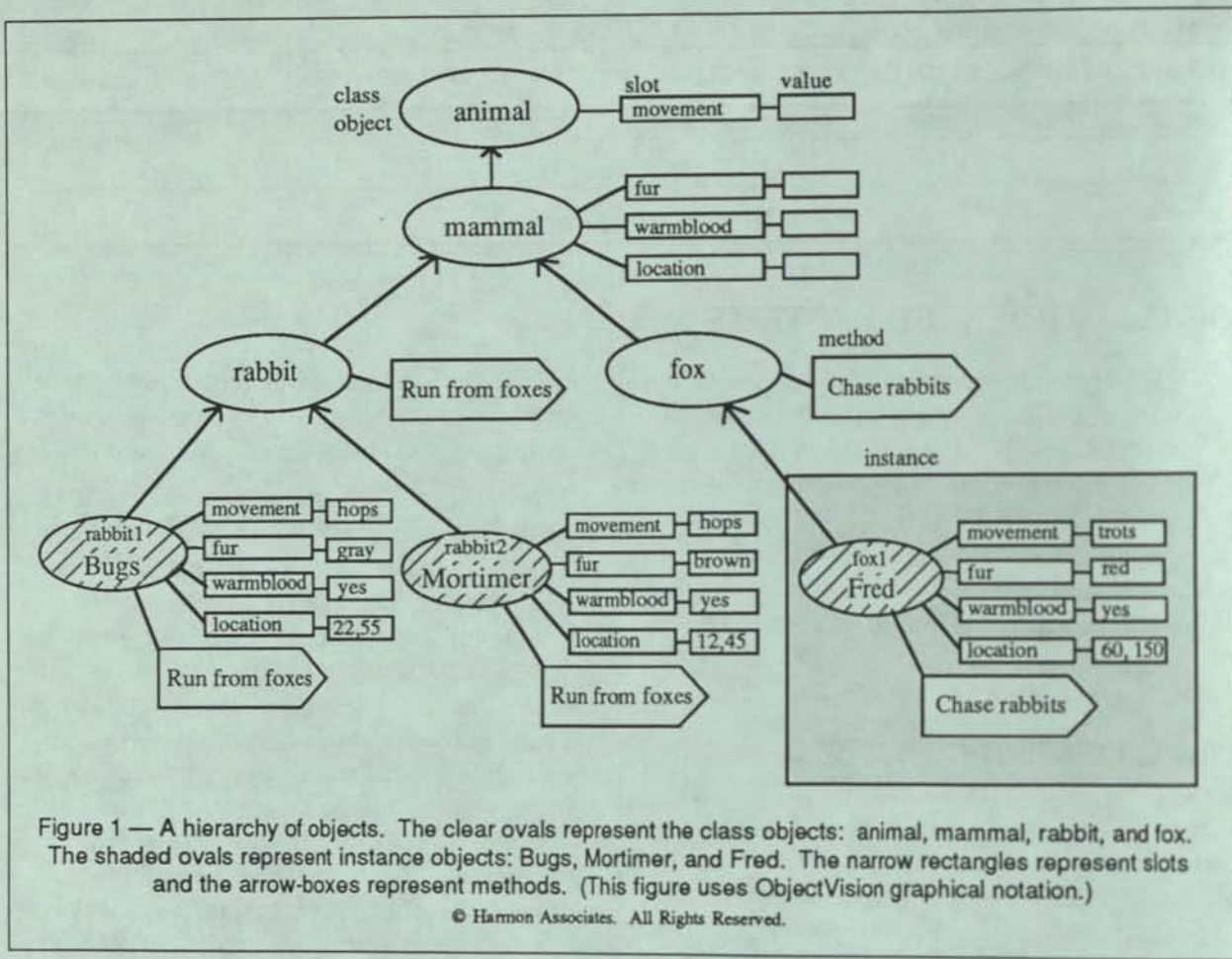


Figure 1 — A hierarchy of objects. The clear ovals represent the class objects: animal, mammal, rabbit, and fox. The shaded ovals represent instance objects: Bugs, Mortimer, and Fred. The narrow rectangles represent slots and the arrow-boxes represent methods. (This figure uses ObjectVision graphical notation.)

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and foxes rather than focusing on either the behaviors or the data structures of rabbits.

### THE BASIC CONCEPTS

Object-oriented programs are organized around objects. An *object* has a name and includes both data and procedures. In a sense, an object is a virtual program. Given some input, the object applies procedures to its data and produces some outputs. An object hides its data and the specifics of its procedures from other objects. It's as if each object were a capsule whose contents are hidden from every other capsule — a concept that is usually termed data abstraction or *encapsulation*.

Consider our rabbit example. A rabbit object might contain attributes like age, sex, color, and location. It might also contain procedures like Eat-

clover, Run-from-foxes, etc. If we present our rabbit object with an input like "A fox is approaching," we expect that our rabbit object will run away. In effect, our rabbit object will look inside itself, locate its procedure for how to deal with approaching foxes, execute that procedure and, in the process, change its location (a data structure).

Objects can be related to other objects in *inheritance* hierarchies. Thus, one object may represent a refinement or "child" of another object. Objects that stand in a child relationship to another object inherit that data and procedures contained in the parent object.

As a rule, higher-level objects are more abstract and lower-level objects are more specific. Our rabbit object might have a mammal object for its

parent. The mammal object, in turn, might have an animal object for its parent.

Each object in the hierarchy could have attributes (or *slots*) associated with it. In addition, each child object would inherit all of the characteristics associated with all of the objects that were above it in the hierarchy. Thus, if one of the attributes of the animal object was type-of-movement, then the mammal and the rabbit objects would both inherit that attribute (see Figure 1). By the same token, if the mammal object had two attributes: fur and warm blood, the rabbit object would inherit those attributes as well. Moreover, if there were a general procedure for mammals to give birth to their young, the rabbit would inherit that procedure.

Notice in Figure 1 that we have added a fox object to our hierarchy. A fox is also a mammal. Since we have already specified certain characteristics of all mammals, when we added the fox as a child of mammal, the fox object immediately inherited all of the characteristics of mammals and animals. By using inheritance, we avoid having to enter the same information twice. We simply assert the proper relationship and let inheritance do the rest.

So far, we have created four objects: animal, mammal, rabbit, and fox. Each of these objects is, in effect, a template. They describe the general characteristics of any mammal, any rabbit, etc. If we want to add specific objects that refer to particular animals, we create instances of our general objects.

Different OOP systems use different terms. In general, the template objects are called *classes* and the specific objects are called *instances* or *objects*. Whenever there is any chance for confusion, we will call the template objects "class objects" and the specific examples "instance objects."

In most OOP languages, class objects have slots for data, but do not have specific data (values) associated with the class. Instances, on the other hand, have values associated with their slots.

By developing hierarchies of objects we can describe everyday situations in a much more natural

manner than we can in most conventional procedural programming languages.

Another nice feature of inheritance is *specialization*. You can create a general behavior (a procedure or *method*) which you attach to the highest object in your hierarchy. Then you can create a child of that object. The child will inherit the data structures and the methods of the parent object. If you wish, however, you can modify one or more of the methods associated with the child object.

Imagine, for example, that you are developing an application that will involve graphics. You anticipate that your users will use your application to draw several different types of images on the screen. Imagine, further, that you start a hierarchy with an object called "polygon" and describe the data that you will need to keep about a polygon (e.g. the number of sides, how to locate it on the screen) and the procedures that you will need to use the image in your program (e.g. how to connect points to draw the polygon, etc.). Having described a polygon, you next decide to describe a rectangle. In a conventional language, you would need to start all over again and write code to create rectangles on the screen. In an OOP system, however, you can take advantage of inheritance and specialization to avoid having to rewrite lots of code. In this case, you would create a rectangle object that was a child of the polygon object. The rectangle object would inherit all of the data structures and the procedures you had already created for your polygon object.

You could then proceed to modify any of the structures to make the new object an effective rectangle. Likewise, if you decide you need a square, you can create another new object, a square, and have that object inherit all of the characteristics of the rectangle. Then you can modify the characteristics inherited from the rectangle to make them appropriate for squares. Thus, for example, you might modify a slot associated with "rectangle" to specify that all rectangles have 4 sides. Knowing that the two ends and the two sides are equal, you can refine the more generic method of calculating

the area of a polygon to a more specific method that will calculate the area of a rectangle.

Inheritance and specialization create possibilities for reusing code in a manner and on a scale that had previously been lacking in software development. They will facilitate the rapid development of new applications and easier maintenance of such applications, once they have been written. More important, they will create a market for *class libraries*. In the future, developers will create applications by assembling appropriate class objects drawn from libraries much as hardware developers create new computers by assembling them from various chips that they buy from other vendors.

Objects accept messages as inputs and, if appropriate, generate other messages as outputs. A *message* is a request for an object to perform some procedure or return some value. When an object receives a message, it looks at its collection of methods (i.e. its procedures and functions) to see which one corresponds to the message it has received. If the object doesn't have a method to handle a specific message, it checks with its parent to see how to handle the message. If the parent doesn't have a method to handle the message, it checks with its parents' parent, etc.

Consider our animal hierarchy. Suppose we start the program by sending a message to the instance object, Fred Fox, that a rabbit is in the vicinity. Fred Fox doesn't have a specific method to handle that message, but its parent, class object, fox has. The method calls for the object to begin to move in widening circles in search of a rabbit. Assume further, that this action, in turn, sends a message from Fred Fox to any neighboring rabbit objects. Bugs and Mortimer both get the message that a fox is in the neighborhood and is searching for rabbits. Bugs and Mortimer each examine the method stored in their common parent-class object, rabbit. There each finds a procedure for responding to foxes, which happens to be a procedure to run away as quickly as possible. As Bugs and Mortimer each begin to execute this procedure, they each move away from Fred Fox.

Message passing is the key to enforcing encapsulation. Each object communicates with every other object by sending messages. No object directly accesses the data associated with any other object. Instead, one object sends a message to another object which, in effect, asks that object to use one of its own methods to access its own data. It sounds a bit round-about, but it provides a very important benefit. Whenever you decide to modify an object you are guaranteed that all of the procedures that will be affected by your modification are contained within the same object. Thus, you can avoid the source of many problems in conventional programs and be sure that a change in one or more data items will also lead to the systematic modification of any relevant procedures.

In addition, since each object contains its own methods and data, you can create a program by focusing on one object at a time. This means you can be more structured in your development of an OO application than anyone could when they used a structured methodology with a conventional language.

### A LITTLE HISTORY

The first object-oriented language (OOL) was Simula, a direct descendent of ALGOL (see Figure 2). Simula, which introduced the ideas of classes and inheritance, was developed by Kristen Nygaard and Ole-Lohan Dahl at the Norwegian Computing Center in the early Sixties. Simula I was a dedicated simulation language, but the ideas that Simula I's developers were exploring soon resulted in Simula 67, a general programming language based on the idea of objects.

### SMALLTALK, EIFFEL, ETC.

Alan Kay is generally credited with the initial development of the ideas that ended up as the language Smalltalk, which he began while a graduate student at the University of Utah in 1970. Kay was interested in interface design, read about Simula 67, and decided that the object concept could be applied to the problem of interface development. In the mid-Seventies, Kay moved from Utah to the Xerox Palo Alto Research Centers (PARC), and, working

with Adele Goldberg and Daniel H.H. Ingalls, proceeded to refine his ideas and combine them with some ideas derived from the Lisp language (e.g. dynamic binding). The first language that resulted from this collaboration, in 1976, was called Smalltalk-76; a later refinement was called Smalltalk-80. (Most people in the U.S. learned about OOP by reading about Smalltalk-80.)

Smalltalk is a pure OOL in the sense that it was written in assembler and is designed from the ground up to be an OOL. All the objects in Smalltalk, for example, derive from a single root object that defines what it is to be an object. Smalltalk also includes dynamic methods and uses garbage collection to handle memory, ideas that were borrowed from Lisp.

Several other people, following the Simula 67 and Smalltalk models, have developed pure object-oriented languages. Some of the better known examples include Eiffel and Actors.

**FLAVORS, LOOPS, AND CLOS**

At about the same time that Smalltalk-80 was being developed at Xerox PARC, AI researchers realized that they could use OO techniques to implement complex knowledge hierarchies. In the AI world, people talked about experts conceptualizing the world in terms of frames, high-level concepts that humans use to group facts about the world. Frames was a conceptual idea that could be easily represented via objects.

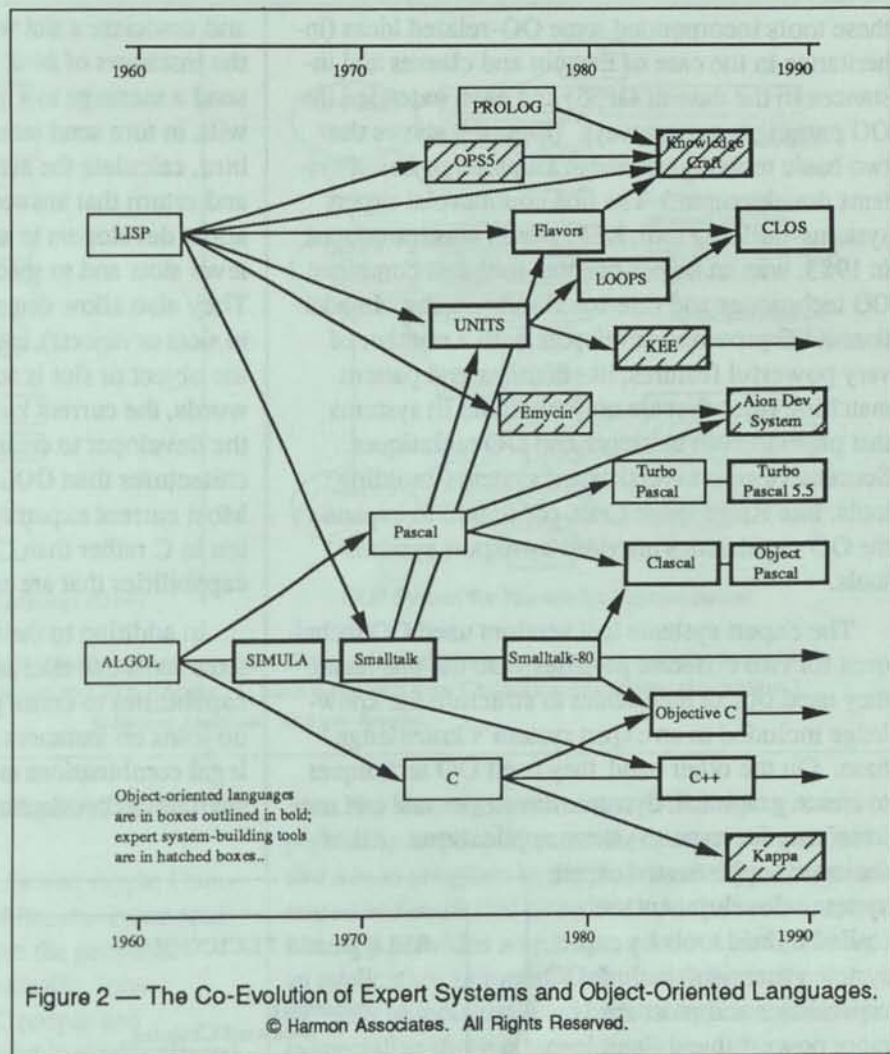


Figure 2 — The Co-Evolution of Expert Systems and Object-Oriented Languages. © Harmon Associates. All Rights Reserved.

Xerox AI people, who were used to programming in Lisp, combined ideas from Simula 67, Smalltalk, and an early AI frames language called UNITS to produce a hybrid, Lisp-based OOL called LOOPS. Other AI people at MIT created an OOL/Lisp hybrid called Flavors.

Recently, Lisp programmers have standardized on a common OO version of Lisp, called CLOS (Common Lisp Object Standard) which is popular among AI researchers.

The earliest research in expert systems development was done with rule-based tools like Stanford's Emycin and Carnegie-Mellon's OPS5. Each of

these tools incorporated some OO-related ideas (inheritance in the case of Emycin and classes and instances in the case of OPS5) and each extended the OO paradigm in new ways. (Figure 3 shows the two basic techniques used in knowledge-based systems development.) The first commercial expert systems-building tool, KEE, which was introduced in 1983, was an object-oriented tool that combined OO techniques and rule-based inferencing. In addition, KEE provided developers with a number of very powerful features, like demons and pattern matching rules that are only available in systems that provide both inference and OO techniques. Successive commercial expert systems-building tools, like Knowledge Craft, continued to expand the OO capabilities provided by expert systems tools.

The expert systems tool vendors used OO techniques for two different purposes. On the one hand, they used object hierarchies to structure the knowledge included in an expert system's knowledge base. On the other hand, they used OO techniques to create graphical, dynamic developer and end user interfaces for expert systems applications. All of the more sophisticated expert systems-development tools (called hybrid tools by expert systems theorists) include OO capabilities and most are more powerful and flexible than the current crop of OOLs, including Smalltalk, Objective C and C++.

Figure 4 compares the standard capabilities of C++ with the capabilities of an expert systems tool like IntelliCorp's Kappa. Where an OOL like C++ limits the ability of the developer to create unique class-level slots and methods, Kappa allows it. Thus, Kappa programmers can create a class object, *bird*,

and associate a slot with *bird* whose value is all of the instances of *bird*. Then, the programmer can send a message to a method attached to *bird* that will, in turn send messages to all of the instances of *bird*, calculate the number of instances in existence, and return that answer. Knowledge system tools allow developers to associate constraints with class-level slots and to specialize both slots and methods. They also allow demons (methods that are attached to slots or objects), and automatically fire whenever the object or slot is accessed or changed. In other words, the current knowledge system tools allow the developer to create much more complex OO architectures than OOLs like Smalltalk and C++. Most current expert systems-building tools are written in C rather than C++ because they require OO capabilities that are easier to program directly in C.

In addition to their OO capabilities, expert systems tools can take advantage of their inferencing capabilities to create pattern-matching rules that can do joins on instances of classes and thus search for legal combinations more effectively than similar searches in conventional relational database systems.

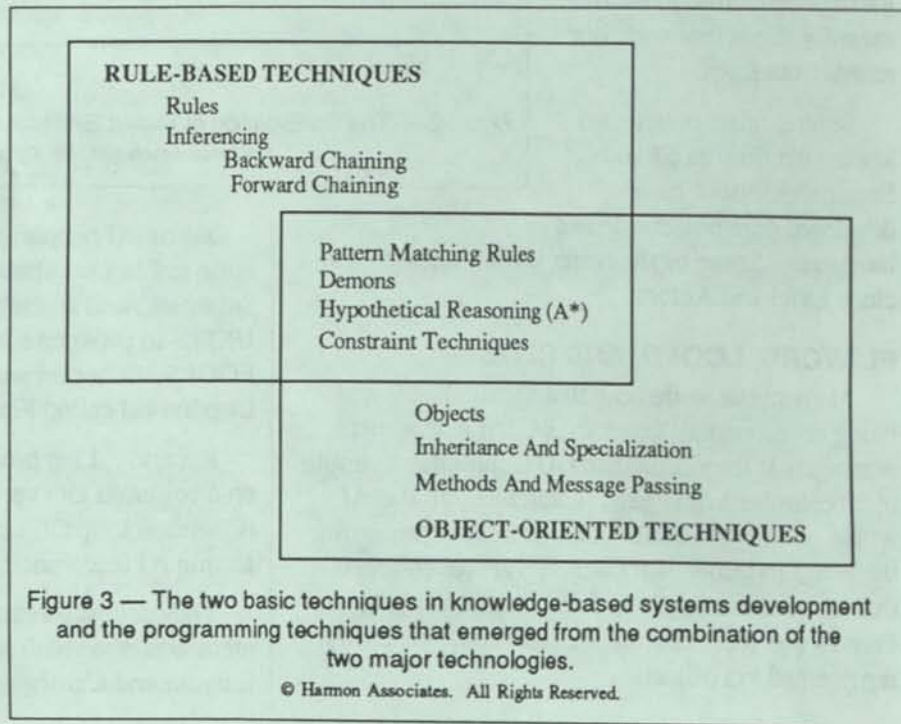
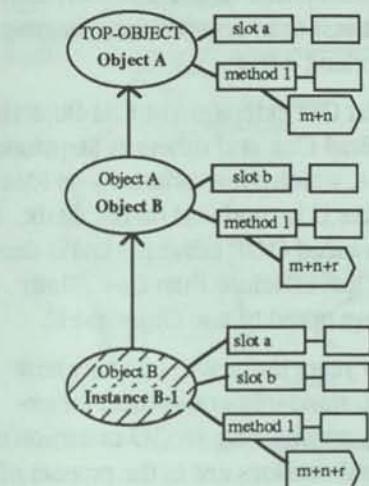
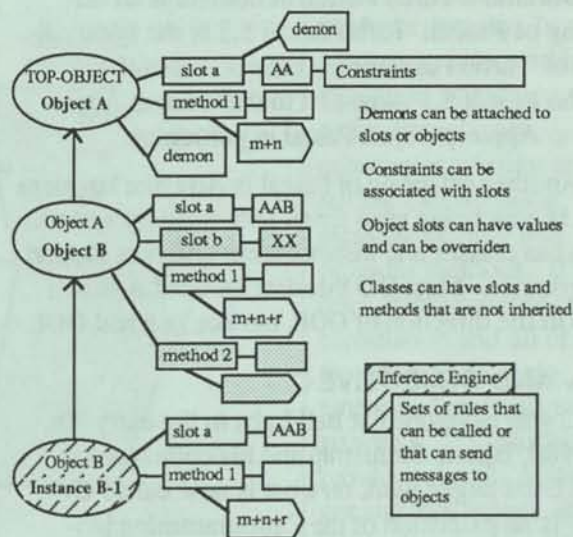


Figure 3 — The two basic techniques in knowledge-based systems development and the programming techniques that emerged from the combination of the two major technologies.

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Features of a Conventional OOP Language (C++)



OOP System for Knowledge Representation

Figure 4 — A comparison of the features typical of an object-oriented language like C++ and the features available in a knowledge-based tool like Kappa. (These diagrams use ObjectVision graphical notation.)

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## CLASCAL, OBJECT PASCAL, MACAPP, AND HYPERCARD

In the late 70s, Steven Jobs, then of Apple Computers, visited Xerox PARC and became enamored with the wonderful interfaces that the people at PARC had developed using Smalltalk. Jobs proceeded to hire several PARC people and develop a small, commercially viable product based on OOP techniques.

Apple's initial OOP group began by working with Niklaus Wirth (the creator of Pascal) to modify Pascal so it could be used to develop an OO environment for the Lisa and then for the Macintosh. Their effort resulted in Clascal (Pascal with classes) and, later, in a language called Object Pascal. The Macintosh operating system is largely written in Object Pascal.

To help developers create Macintosh programs, Apple developed MacApp, an OO development environment that provides developers with a library of classes that they can use to develop their programs.

Most OO theorists assume that OOLs will grow in popularity as people learn how much more productive it is to program in them because objects can be reused and modified as needed. At the moment, MacApp provides a nice example. Anyone writing an application to run on a Macintosh begins with the class objects provided by MacApp and proceeds to specialize those classes to provide the functionality and the interface they will need for their specific application.

To help non-programmers create Macintosh applications, Apple later developed a limited, but very friendly OOP environment called Hypercard. Unlike MacApp, which provides the developer with some two dozen different class objects, Hypercard limits the developer to a few (the card and some buttons) and will let you create class hierarchies that are only four levels deep. In spite of its limitations, many people with no programming skills are creating very interesting and highly graphical applications in Hypercard.

Borland's Turbo Pascal, of course, is an offspring of Pascal. Turbo Pascal 5.5 is the latest edition of Turbo Pascal and it incorporates OOP. Turbo Pascal 5.5 owes a lot to the work at Apple and to Apple's Object Pascal in particular.

Another offspring of Pascal is Ada, the language that is now being used for all U.S. military systems. Ada has classes and instances, but does not support inheritance. Most OO theorists think of Ada as a step in the direction of OOP, but not as a real OOL.

### C++ AND OBJECTIVE C

C was developed at Bell Labs in the early 70s. In 1980, Bjarne Stroustrup and his colleagues at Bell Labs began work on what is now called C++. C++ is an extension of the C programming language and thus, a hybrid OOL. C++ was designed to incorporate OO concepts into C at the same time as it introduced a number of non-OO improvements in C. C++ is currently the most popular of the hybrid OOLs, but the development of OOLs is really just beginning. C++ seems likely to emerge as the major commercial OOL since it allows companies to continue to use their existing C code and it makes it easy for C programmers to learn C++ by simply learning the additional syntax involved. (We'll return to this issue later; in some sense it is so easy to move from C to C++ by simply learning some new syntax, that many C programmers learn to write C++ code but don't really change their approach to programming and thus simply use C++ to write procedural applications, thereby losing all of the advantages of an OO approach.)

AT&T developed C++ and Stroustrup's book on C++ provides the "official" description of C++. (An ANSI committee has been formed and has begun standardizing C++.) AT&T developed a translator which converts C++ code to C code, which can then be compiled with a C compiler. Several vendors have developed C++ compilers, as well as debuggers, linkers and other programming tools.

Borland's Turbo C++ is both an editing environment and an incremental compiler that is fully compatible with the AT&T standard. (A Borland

representative recently claimed that the Borland Turbo C++ introduction had resulted in more unit sales and more interest than any previous language introduction in Borland's history.)

Another popular OO extension of C is Objective C, developed by Brad Cox and others at Stepstone Corp. Unlike C++, which drew primarily on ideas in Simula, Objective C is modeled on Smalltalk. It includes more advanced OOP concepts and is thus more flexible and less efficient than C++. Both IBM and NeXT have opted to use Objective C.

In the next few years there will be many new OOLs. A COBOL standards committee, for example, is currently considering an OO extension of COBOL and several vendors are in the process of developing OO versions of their favorite language. In addition, several vendors are developing specialized OO tools, like MacApp, that are designed to help developers create interfaces for environments like Windows 3.0 and Presentation Manager.

Other vendors are offering tools that facilitate OO application development. There are, in effect, specialized CASE tools that will evolve into generic CASE tools as the software development community increasingly adopts an OO approach to systems analysis, design, and development.

### SO WHAT MAKES A PRODUCT OBJECT-ORIENTED?

Having briefly discussed the basic concepts and the history of OO techniques, you might be tempted to ask what products really deserve to be called "object-oriented." We've summarized our personal view in Figure 5.

The horizontal axis of the figure runs from products that are not object-oriented, on the left, to products that have more features that most people associated with OOP, on the right. The products near the bottom of the chart are languages while the products near the top are software tools.

We suggest that the common features of Smalltalk and C++, taken together, define the core concepts that a product must have to claim it is



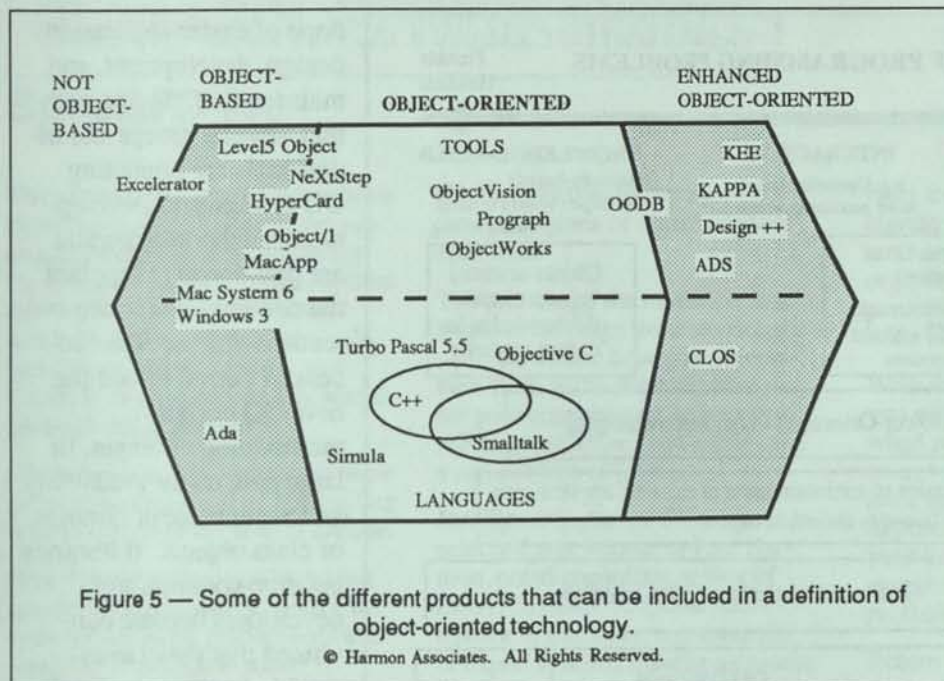


Figure 5 — Some of the different products that can be included in a definition of object-oriented technology.

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“object-oriented.” In other words, the system must have classes and instances, must support inheritance, and must use methods and message passing. Anything less, like Ada (which has classes but does not support inheritance, yet incorporates some OO techniques), is not properly called an OOL. Anything much more complex, like CLOS, which substitutes generic functions for message passing, and the various expert systems-building tools with their demons and pattern matching rules, should be considered something more than “normal” object-oriented products. Tools that facilitate OO application development, like ObjectWorks, Prograph and ObjectVision, are properly called object-oriented. CASE tools like Excelerator, The Design Generator, and operating systems, like Windows 3.0, which use some OO techniques but are written in conventional languages and basically support structured methodologies or conventional programming, should probably be classed with Ada.

It will become more confusing, before it gets better, since most software marketing people can't seem to resist using hot new terms (like “object-oriented”) in their product brochures, regardless of

the actual features their products contain. In our opinion, at least within the expert systems tool niche, the primary criterion is whether or not the tool supports message passing and provides methods. If it does, it can provide encapsulation and all of the editing and maintenance advantages that go with it. If the tool only provides classes, instances and inheritance, then it is an incomplete OO environment and will not be able to provide the advantages that we expect from OO systems.

## THE MARKET FOR OO PRODUCTS

OO techniques can be packaged in many forms. Before considering the various product categories, let's take a broader view of the types of programming problems developers face (see Figure 6).

The continuum across the top of Figure 6 runs from batch processing problems on the left to knowledge-based problems on the right. Batch problems, by their nature, can be analyzed into an algorithm and programmed in procedural languages like COBOL, Fortran, or C.

Knowledge-based problems are very fuzzy problems. They require a network of facts and heuristic rules. Their solution depends on logic and an inference engine that can dynamically create a decision tree, selecting which heuristics are most appropriate for the specific case being considered. Knowledge-based systems can be developed in languages like Lisp, Prolog or C, but, to date, most developers have elected to use expert systems-building tools to create applications.



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and debugging facilities. At the moment there are at least three groups of products: conventional CASE tools, knowledge-based system development tools, and OO application development tools that are all moving in this direction. We expect that developers will come to prefer tools to languages and that the tools that will prove successful over the course of the next 10 years will combine the best features of CASE, expert systems, and OO development environments. (In other words, the real contest isn't between C++ and Objective C, but between tools like ObjectWorks and ObjectVision.)

Let's consider these products and others in a more systematic way. Figure 7 lists most of the OO software products we know about. We have divided the products into nine general categories, which we'll consider separately. (Language/code each tool generates appears in parentheses following tool listed in Figure 7.)

### OO PROGRAMMING LANGUAGES

The OO language vendors can be divided into two groups, based on whether or not the language was written as an OO language (a pure OOL), or whether the language was a pre-existing language that has been adapted to incorporate OO features (a hybrid OOL). The dominant hybrid OOL, and the one likely to dominate the OOP language market for the foreseeable future, is C++. Another way to divide the OOLs is to separate those that can be compiled from those that are interpreted. As a generalization, interpreted languages are more flexible and compiled languages execute applications faster.

### OO APPLICATION DEVELOPMENT ENVIRONMENTS

In addition to the language vendors, there are a number of vendors that are offering OO application development tools. In our opinion, these products will play the same role in the OO market that expert systems-building tools play in the expert systems market. They make application development much more efficient. Some of the OO application development tools are languages; in this case you develop the application in the tool and then field it

in a runtime version of that tool (e.g. Prograph). Other OO application development tools only provide a development environment but then generate code so that the developer can compile the application in an OOL (e.g. ObjectWorks and ObjectVision). If we are right, the interpreted languages will lose out to interpreted OO development tools. Developers will create applications within the OO tool and then the tool will generate a compiled language, like C++, for actual runtime use.

At the moment, most of the OO Development Tools are being sold by small companies and are closely tied to OO languages like Smalltalk and C++. As the market matures and developers want more powerful OO development tools that will run in mainframe environments, expert systems-building tool vendors will enter this market niche and offer specialized versions of their current tools to OO programmers. (IntelliCorp has already made the first moves in this direction by sending out brochures that position their low-end tool, Kappa PC, as a tool for OO application development rather than a knowledge system tool.) The best of the expert systems-development tools are much more powerful than any of the OO Development Tools we have seen. As programmers become accustomed to OOP, they will find out about the advantages of class slots with values and constraints, demons, and pattern matching rules, and they will demand them. The current crop of OO development tool vendors will proceed to add these features, but they will probably not be able to add them as rapidly as the expert systems tool vendors will modify their tools for the OOP market.

As OOLs and OO Application Development Tools become established, OO libraries will appear in the market. These libraries will provide classes that other developers can use in their applications. (Pre-developed classes are like the pre-developed functions available in some languages, but they will play a much more important role in the world of OOP.) Some language vendors and some independent vendors are already offering early OO libraries. Initially, class libraries will necessarily

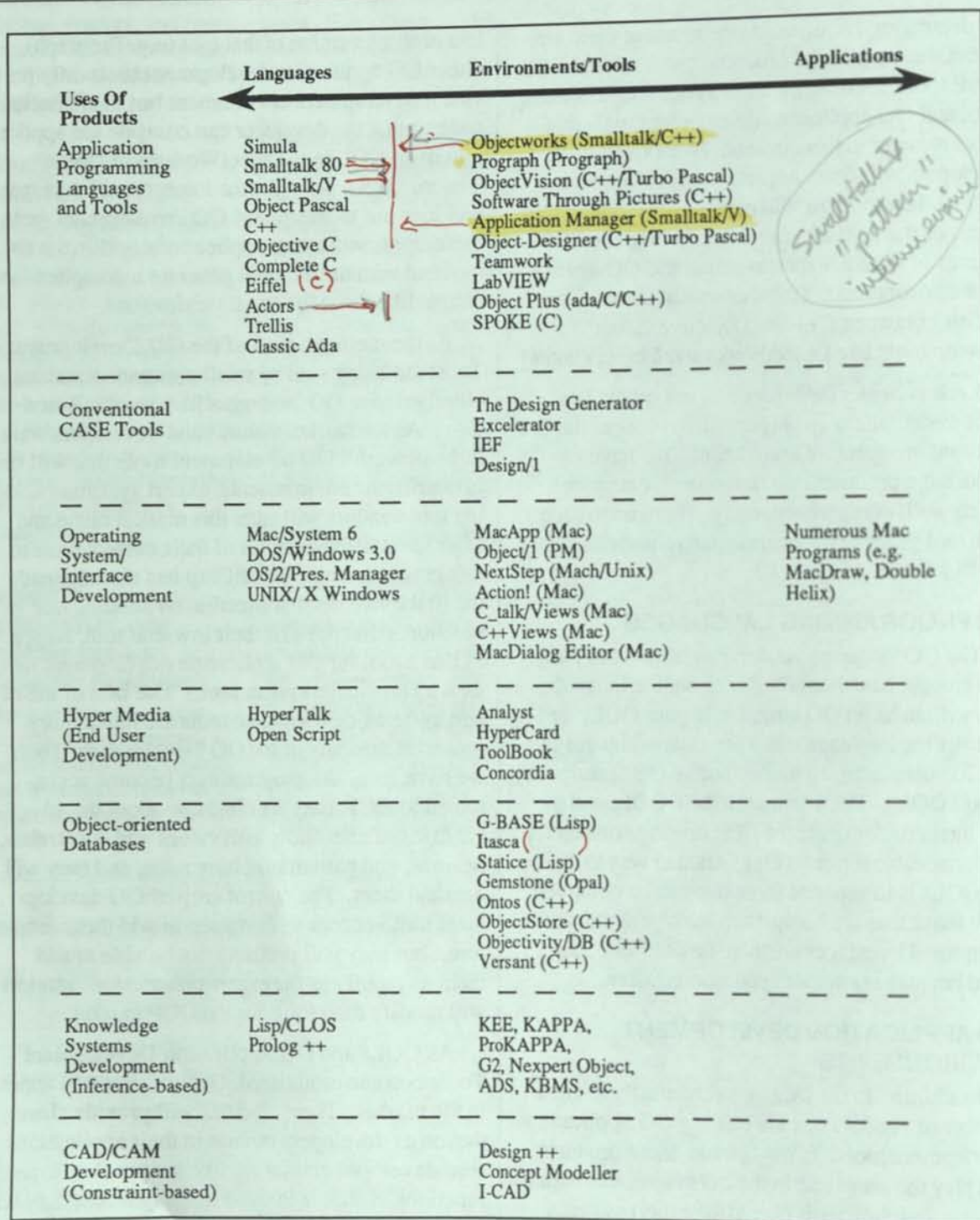


Figure 7 — Object-Oriented Software Products.

These products — as well as any new ones shown at OOPSLA — will be described in detail in part two of this article, which will appear in the next issue.

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follow language sales and be closely associated with specific languages, but eventually, we predict that companies specializing in vertical markets like banking and factory automation will offer class libraries specialized for vertical applications.

### OO-BASED CONVENTIONAL CASE TOOLS

Figure 7 shows a category for Conventional CASE tools that use OO techniques. We are omitting those tools from this review since we are in the process of preparing another newsletter article on CASE tools, where we will consider the OO and inference techniques used in those tools. We expect a battle in the next few years as conventional CASE vendors try to introduce more OO techniques and OO application development tools vendors try to position themselves as intelligent CASE tools.

### OO INTERFACE DEVELOPMENT TOOLS

There are a number of OO-based operating systems or windows-based environments that run on top of established operating systems (collectively called GUIs or "graphical user interfaces"). Thus, Macintosh System 6 is an OO-based operating system, while X Windows is a windows-based environment designed to run on top of UNIX.

Unfortunately, most of the current windows-based environments are limited OO systems and are hard to program for (unlike Smalltalk and Lisp, each of which can serve as both an operating system and programming language). To help developers overcome some of the difficulties involved in creating applications that will run in the current crop of GUIs, a number of vendors are offering tools that facilitate interface development. (The operating system/environment intended for interface development appears in parentheses following the tool listed in Figure 7.) Most of these tool kits include libraries of interface objects. Most of these tools do not allow the developer to write the application in the tool, but assume that the application has already been written in an OOL and that the tool is being used to create the interface for the application.

### HYPER MEDIA END USER DEVELOPMENT TOOLS

Hyper media products are limited OO programming environments. Some, like Hypercard and ToolBook, are embedded within their own graphical interface and have their own underlying OOL (i.e. HyperTalk, Open Script). Most hyper media products are aimed at end users. Some vendors are selling libraries or products written in the various hyper products.

We have listed only a few on the chart to illustrate the category. We have not listed any hyper applications that are being offered for sale.

It will be interesting to see if end users become so familiar with the hyper products that they will become permanently established as end-user programming environments or whether improvements in OO-based operating systems and OO databases, with their own development languages, will replace the current generation of hyper products. A good example of this would be NeXTStep, the "interface builder" that comprises a large part of NeXT's operating system. You could easily classify NeXTStep as an interface development tool that NeXT application developers would use, just as Mac developers use MacApp and OS/2/PM developers use Object/1. On the other hand, while Mac System 6 and Windows 3.0 are object-based GUI systems, they are not full OO systems and are not that easy to use. NeXT's operating system is more OO than either the Mac, DOS, or PM systems, and a non-programmer using NeXTStep is working in an environment that is, in many ways, closer to a powerful version of HyperTalk than a version of MacApp. As operating systems evolve and incorporate OO techniques into their core, products like HyperCard and MacApp will tend to merge. Eventually, end users may be able to develop simple applications by using OO tools incorporated in the operating system itself.

### OO DATABASE MANAGEMENT SYSTEMS

A number of vendors are selling OODBMS systems. In effect, these vendors are offering OODBs

as a replacement for an existing relational database. There are distinct advantages that OODBs bring to applications that involve lots of complex datatypes (e.g. graphics, OO knowledge bases, video). (The Data Management Language appears in parentheses following the OODBMS listed in Figure 7.) At the moment these vendors are primarily selling their products to individuals or groups that are developing standalone applications on workstations. Thus, CAD/CAM development tools and expert systems can run much more efficiently when coupled with an OODB.

Once the OODB vendors move beyond individual sales and propose that corporations replace their relational databases with OODBs, however, the sale becomes much more difficult. The future of OODBs is hard to predict. Clearly the relational database vendors will modify their products to enable them to handle the more complex datatypes that will increasingly be used in the applications that will be developed throughout the 90s. There will be a battle between the relational database vendors and the OODB vendors. If the relational database vendors can adapt fast enough, they will win, since no corporation wants to deal with the hassles involved in moving from one database to another if it can help it. On the other hand, if the relational database vendors prove unwilling or unable to incorporate the necessary OO features into their products, they will eventually be replaced by the OODB products that will offer significant advantages to companies with applications written in OOLs.

#### KNOWLEDGE SYSTEM DEVELOPMENT TOOLS

As we have already noted, most object-oriented programmers do not think about knowledge-based systems when they think about OOP, and vice versa. In the future, however, the two fields will gradually merge, since inference-based techniques, combined with current OOP techniques found in C++, provide a much more powerful and flexible program development environment. This merger could occur in different ways; we predict it will occur when expert systems tool vendors decide to reposition their tools and actively sell their products

to programmers who are interested in developing large, complex OO applications

We have not listed all of the expert systems tool vendors in Figure 7. (If you want a complete list of the expert systems tool vendors, see the July issue of *ISS* (Vol. 6, No. 7).) We have listed only the expert system tool vendors who provide a complete or nearly complete OO programming environment and who are, in our opinion, likely to play an increasingly important role in the OO development tools market.

#### CAD/CAM DEVELOPMENT TOOLS

There are several highly-specialized tools that combine OO techniques, constraint programming techniques, and some graphical interfaces to provide developers with tools that allow fast CAD/CAM design and rapid revision. (We'll be considering constraint languages and their uses in more detail in an upcoming issue of *ISS*.) Several of these vendors started out in the expert systems market because they were using OO techniques that in the early 80s were being sold only by the expert systems tool vendors. Since these tools combine OOP with constraint techniques rather than inferencing techniques, however, they really form a niche of their own.

The CAD/CAM tool vendors are included, primarily, to remind readers that lots of highly specialized OO tools will be offered during the 90s that will, in effect, function as CASE tools for vertical markets.

#### OBJECT-ORIENTED PRODUCT VENDORS

The interest in OO products is as hot now as the market for expert systems was in 1985, and lots of new companies are entering the market each day. In part two of this article — which will appear in the next issue — we will provide a detailed listing of the OO software vendors and the products they are offering.

#### FOR ADDITIONAL INFORMATION

For those interested in developing their knowledge of OO technology, the following books, conferences, journals, and magazines might be helpful.

**Books:**

There are an awful lot of books on OO techniques. Here are some of the best:

Booch, Grady. *Object Oriented Design With Applications*. Benjamin/Cummings Publishing Co. Inc., Redwood City, CA. (dist. by Addison-Wesley), 1990.

This is the best book available on the problems of object-oriented design. Earlier books by Coad & Yourdon and Shlaer & Mellor are too tied to Structured Methodologies and lose the essence of OOP. Earlier work by Booch provided the basis for a popular OO design notation, but it was centered in Ada design problems and was too structured to handle the more dynamic aspects of OO design. In this book, Booch has encompassed the entire range of OO techniques from Smalltalk and C++ to CLOS. This book will be the standard introduction to OO design market for the next few years.

Cox, Brad J. *Object Oriented Programming: An Evolutionary Approach*. Addison-Wesley, Reading, MA, 1986.

This early book on OOP is still very popular. It provides lots of comparisons with non-OOP languages. It is written by the author of Objective C.

Harmon, Paul and Brian Sawyer. *The Object-Vision Manual: A Graphical Programming Tool for Object-Oriented Applications*, Addison-Wesley, Reading, MA, 1990.

This book is the manual that comes with the ObjectVision software product, but it is also sold separately in bookstores. It provides a graphical, basic introduction to OOP and the problems of developing OO applications. (Your editor thinks this is an outstanding way to learn about how to develop OO applications, but he wrote this book, so you will have to take his enthusiasm with a grain of salt.)

Meyer, Bertrand. *Object-Oriented Software Construction*. Prentice Hall, NY, 1988.

This is a technical review of OOP for advanced readers. The book is written by the author of the Eiffel language and contains a detailed description of that language.

Mullin, Mark. *Object-Oriented Program Design, With Examples in C++*. Addison-Wesley, Reading, MA, 1989.

This book provides a nice overview of the actual process of developing a commercial C++ application. The author does not provide a systematic design methodology but does discuss lots of practical heuristics.

Parsaye, Kamran, Mark Chignell, Setrag Khoshafian and Harry Wong. *Intelligent Databases*. John Wiley & Sons, New York, NY, 1989.

This book provides a basic introduction to object-oriented databases and to hypermedia.

Payne, Edmund and Robert McArthur. *Developing Expert Systems: A Knowledge Engineer's Handbook for Rules & Objects*. John Wiley & Sons, 1990.

This book is the best available hands-on introduction to developing hybrid expert systems. It assumes that one will be combining objects and rules in every example. The book provides a nice review of the OO capabilities of the various expert systems tools. The authors of this book sell an expert systems building tool, EntryPaq, which is listed in the expert systems tools chart. EntryPaq is too slow for commercial applications, but used in conjunction with this book, it provides the best possible introduction to using object-oriented techniques to structure the knowledge in an expert system.

Schmucker, Kurt J. *Object-Oriented Programming for the Macintosh*. Hayden Books, Indianapolis, IN, 1986.

This book, by a senior researcher at Apple, provides an overview of OOP and the various OO products that run on the Macintosh, including a nice review of the MacApp environment.

Tello, Ernest R. *Object-Oriented Programming for Artificial Intelligence*. Addison-Wesley, Reading, MA, 1989.

This book provides a general survey of the use of OOP among expert systems developers with special emphasis on how the different expert systems use OOP.

Wiener, Richard S. and Lewis J. Pinson. *An Introduction to Object-Oriented Programming and C++*. Addison-Wesley, Reading, MA, 1988.

This book provides a systematic introduction to OO concepts and the process of developing an OO application in C++. Richard Wiener gives seminars on OOP and is the editor of the *Journal of Object-Oriented Programming*.

Winblad, Ann L., Samuel D. Edwards and David R. King. *Object-Oriented Software*. Addison-Wesley, Reading, MA, 1990.

This book provides a general overview of the OO field and an introduction to its key concepts. The book surveys OOLs, databases, user interfaces and applications. Unfortunately, it does not consider expert systems tools and the role they might play in the coming OO market. Ann Winblad is a well-known venture capitalist who specializes in funding software companies.

#### Conferences:

There are lots of conferences that have sessions on OO technology. (All expert systems conferences, for example, include sessions on OO techniques.) The major U.S. conference on OO technology, however, is OOPSLA (Conference on Object Oriented Programming Systems, Languages and Applications). This annual conference, sponsored by the ACM, is the major meeting place for people interested in the theoretical aspects of OOP,

OOLs, etc. For information, contact: The Association for Computing Machinery, 11 W. 42nd Street, New York, NY, 10036; (212) 869-7440.

This year's meeting of OOPSLA is a joint meeting between OOPSLA and ECOOP (European Conference on Object-Oriented Programming). It will be held on October 21-25 in Ottawa, Canada. (To register, contact Joanne Doody, Conference Aide, Convention Services Ltd., 275 Bay Street, Ottawa, Ontario, Canada K1R 5Z6; (613) 238-4079, Fax: (613) 238-3805.

#### Magazines and Journals:

Again, most software magazines have articles on OO techniques these days, but the best magazine devoted entirely to OO technology is the *Journal of Object-Oriented Programming*. It is published bi-monthly by SIGS Publications, Inc., 310 Madison Ave, Suite 503, New York, NY 10017; (212) 972-7055. Subscriptions cost \$49/year.

#### OO STANDARDS GROUPS

Several hardware and software companies have joined together to develop some common standards for OO products. Corporations and OO vendors might want to contact Chris Stone at the Object Management Group (OMG), Framingham Corporate Center, 492 Old Connecticut Path, Framingham, MA 01701; (508) 820-4300, Fax: (508) 820-4303 for more information on the work of this organization.

## TRENDS AND NEWS BRIEFS

### TIRS, SOFTWARE ARTISTRY AND IBM'S AD/CYCLE REPOSITORY

IBM has been demonstrating its new knowledge-based tool, TIRS (The Integrated Reasoning Shell), for the past several months and has been hinting that it will play a key role in its AD/Cycle/Repository development efforts. Last week IBM briefed analysts on how that evolution might occur, and announced a new relationship with Software Artistry that further demonstrated its intentions.

TIRS is an expert systems tool, like Aion's ADS or Inference Corp's ART. TIRS has an inference engine and facilities for storing rules and frames. (We've used "frames" to mean different things in the past, but for our purposes here — and in keeping with IBM's usage — a frame is an entity that has slots for data and can inherit data from other frames. Frames lack methods or procedures. Thus, they are not objects, as we have used that term throughout this issue and they can not support encapsulation.

In effect, a frame is a primitive object, like an entity in OPS5.)

A TIRS application can be compiled. The actual code that results is the high level language used in TIRS, called KRL (Knowledge Representation Language). IBM suggested that the syntax of KRL was a first cut at a definition of the items that would be stored in the Knowledge Based Systems section of the AD/Cycle/Repository.

At the same time, IBM announced that it would be entering into relationships with vendors who would develop tools that would run on top of TIRS and announced that Software Artistry had signed an agreement with IBM and would be revising its tools so that they could run on TIRS. (See Figure 8.)

Software Artistry currently offers two tools: PC Expert Professional and Application Software Expert (ASE). The former is a structured rule tool that runs in DOS and PS/2 and sells for \$495. The latter

is a rule-based tool that runs on AS/400, RS/6000, PCs and IBM 4680 and 4684 machines and sells for anywhere between \$5,000 and \$36,000.

We assume the announcement means that Software Artistry would keep its current user and developer interfaces, but gut their current tools so that code generated by these tools, at some point in the future, would be KRL code. This means that an application written in Software Artistry's Application Software Expert could be run on a runtime version of TIRS and that a knowledge base developed in Application Software Expert could be stored in the AD/Cycle/Repository.

Since TIRS now runs on most IBM SAA hardware (and is being ported so that it will run on all SAA machines), this means that the Software Artistry tools will, via TIRS, run on more IBM machines. Also, to the degree that TIRS is more sophisticated than Software Artistry's tools, these tools will be enhanced to provide TIRS functionality.

In a sense, Software Artistry's agreement to modify its tool to sit on top of TIRS is similar to AICorp's recent announcement that it would modify KBMS to incorporate the code being developed by the IMKA initiative. In the last issue of the newsletter we noted that if IBM did not join IMKA, the initiative would have great difficulty establishing itself as a standard. IBM would seem to be announcing, in effect, that it will be promoting its own standard, based on TIRS. (At the moment, of course, IMKA is focused on Unix hardware and IBM is focused on SAA hardware, but IBM intends to port

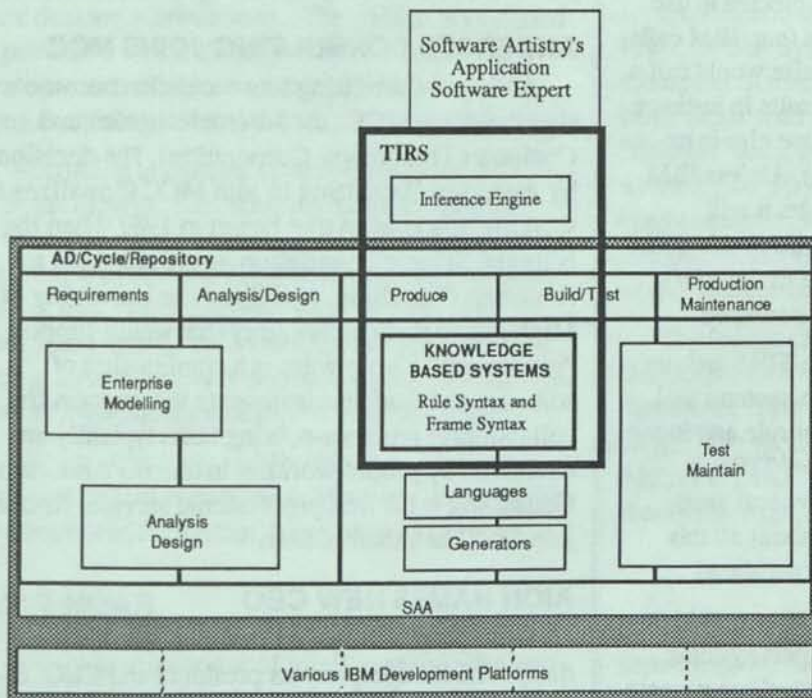


Figure 8 — IBM's TIRS and its relationship to the AD/Cycle/Repository and to Software Artistry's tools.

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TIRS to its AIX machines and IMKA intends to expand its standard to include IBM mainframes, so conflict seems certain.)

IBM was careful to state that it was not offering TIRS as an open standard and that other vendors could be AD/Cycle compliant by using the Repository syntax without having any interface with TIRS, as such, and without using the TIRS inference engine.

We will be doing a detailed review of TIRS in the near future. (We'll compare it with the IMKA proposal at the same time.) At this point, suffice to say that it is not a very powerful tool. It is probably two to three years behind Aion's ADS 6.0 in sophistication. For example, TIRS uses frames and does not support object-oriented programming or methods.

Fortunately, IBM is still in the early stages of defining both TIRS and the syntax of the Knowledge Based Systems module of the AD/Cycle/Repository. We hope they will be in no rush to finalize it until they have enhanced TIRS. IBM has elected to use certain words in totally unique ways (e.g. IBM calls certain TIRS elements that anyone else would call a frame or class, "instances." This results in instance hierarchies — an approach that no one else in expert systems or OOP has ever used.). Unless IBM changes its totally idiosyncratic usage, it will guarantee that everyone trying to write or talk about the knowledge base systems module of the AD/Cycle/Repository will become very confused.

Moreover, given the limits of the TIRS architecture and syntax, if the leading expert systems tool vendors were to modify their current rule and frame syntax to match the current version of TIRS, it would set the whole industry back several years. Let's hope someone at IBM thinks about all this much more carefully before they move ahead.

In addition to its other announcements, IBM announced that it has developed an expert systems methodology some tools that help developers create TIRS applications. The methodology and the set of tools are collectively known as "Target and DARTS." These tools (in the AD/Cycle vocabulary, they are

Analysis & Design tools) are based on a problem-specific approach to developing a knowledge-based system. Each specific DART is appropriate for a particular type of problem. Thus, one tool is designed to help people develop diagnostic systems while another is designed to help with scheduling systems. The tools are all tied to TIRS. Given TIRS limitations, this means that the problem solutions must, in many cases, be arbitrarily constrained.

So far, IBM has used the tool internally and with a few selected Beta clients. Once the tools are more developed, IBM plans to offer courses based on the Target and DARTS development methodology.

The good news is that IBM is still very interested in becoming a major player in the knowledge-based systems market. The bad news is that they still don't have a good tool. And, worse, that they seem to be moving toward promoting knowledge-base standardization, via the AD/Cycle/Repository, based on a limited, inadequate model of what's necessary for effective knowledge-based systems development.

#### ANDERSEN CONSULTING JOINS MCC

Andersen Consulting has decided to become a shareholder in MCC (the Microelectronics and Computer Technology Corporation). The decision by Andersen Consulting to join MCC formalizes a working relationship that began in 1989 when the National Science Foundation awarded a grant to Andersen Consulting, MCC and the University of Michigan to study technology that would support "groupware" (Groupware is a combination of software and work environments that support the collaborative problem-solving tasks typically encountered by people working in teams.) Andersen Consulting is the first professional services firm to join MCC as a shareholder.

#### AION NAMES NEW CEO

Aion Corp. announced that James R. Gagnard has joined the company as president and CEO, effective immediately. Reinstein, who was serving as CEO, will remain as chairman of the board. Larry Cohn, the current president will assume the newly

created position of executive vice president of technical operations.

Gagnard joins Aion from Pansophic Systems where he was the senior vice president and general manager of Pansophic's System Life Cycle Division, which markets and develops CASE products for IBM mainframes and workstations.

### **SYNTELLIGENCE BUYS NEW COMMERCIAL LENDING MANAGEMENT SYSTEM**

Syntelligence has just announced its acquisition of domestic and international rights to the Newbury & Molinare Relationship Management System/500 — a new, micro/mainframe software system for commercial lending.

The RMS/500 is an end user task management system that enables bank relationship managers and account officers to handle all their daily operating responsibilities — credit management and monitoring, marketing, and administration, etc. — from their desktop workstations. The system is designed to provide a means through which commercial lenders can easily access all needed bank applications, including internal and external databases.

According to Donald L. Steele, chairman and CEO of Syntelligence, the company plans to integrate and market the system along with Syntelligence's Lending Advisor and Lending Examiner products, adding that "when coupled with the Lending Advisor and Lending Examiner, this new system will enable us to effectively support, through automation, virtually the entire commercial lending process."

John H. Newbury and Roderick A. Molinare, the principals of Newbury & Molinare, Inc. and the developers of the system, have been retained by

Syntelligence on a long-term consulting basis. Their employees have joined Syntelligence.

For more information, contact: Syntelligence Inc., 1000 Hamlin Ct., P.O. Box 3620, Sunnyvale, CA 94088; (408)745-6666.

### **IAKE OFFERS FIRST-EVER CERTIFICATION EXAM FOR KNOWLEDGE ENGINEERS**

The International Association of Knowledge Engineers (IAKE) announced that it will be offering the first examination leading to professional certification in knowledge engineering on October 6, 1990 in San Francisco, California.

IAKE says the exam is intended to assess the "basic professional" breadth for practitioners or those who are preparing to become practitioners in the field of knowledge engineering.

Two versions of the exam are available at the candidates's option: one for those with a systems orientation; the other for those with domain orientation.

Qualifications to sit in for the exam are as follows: for the "systems" area, a Bachelors degree in Computer Science, Engineering, MIS, Business, or other fields with system integration; in the "domain" area, a graduate degree in domains such as Medicine, Physics, Art, or Music, and at least 12 credit hours of course work in knowledge engineering and related fields, or four or more years of professional knowledge engineering experience.

The fee for certification, including examination, is \$225 for IAKE members (\$295 for non-IAKE members). Test applications can be obtained from IAKE. For more information, contact: Tom Mierzwa, IAKE, 11820 Parklawn Drive, Suite 302, Rockville, MD 20852; (301)231-7826.

### **CALENDAR**

A complete calendar of intelligent software conferences and meetings is published three times a year, in January, in the summer, and in November. The complete calendar is mailed to subscribers under

separate cover. In between mailing out the complete calendar, we print new conference information in the newsletter immediately following our receipt of the announcement.

We have received the following new announcements in the past month:

## EXPERT SYSTEMS CONFERENCES

### NORTH AMERICA

Oct. 28-31. **Artificial Intelligence and the Help Desk Symposium.** Orlando, Florida. Sponsor: The Help Desk Institute. Contact: Help Desk Inst., 1755 Telstar Drive, Suite 101, Colorado Springs, CO 80920; (800) 248-5667; Fax: (719) 531-6522.

Oct. 22-23. **Second Annual Expert Systems Insurance Conference,** Omni Parker House, Boston, Massachusetts. Conference will include speakers from such companies as Aetna, Travelers, John Hancock, and Country Companies, etc. Also included will be application case studies, from development to delivery. Contact: IBC USA Conferences Inc., 8 Pleasant Street, Bldg. D, South Natick, MA 01760; (508) 650-4700; Fax: (508) 653-1627.

## CASE CONFERENCES

### NORTH AMERICA

Dec. 5-8. **CASE '90, Fourth International Workshop on CASE.** This conference will be held in conjunction with the ACM's SIGSoft '90 SD symposium in Irvine, California. Contact: CASE '90 Fourth International Workshop, P.O. Box 1300, Cambridge, MA 02142; (617) 494-8200 ext. 198.

## OBJECT-ORIENTED CONFERENCES

### NORTH AMERICA

Oct. 28-31, 1991. **The Object-Oriented Approach in Information Systems.** Quebec City, Canada. Sponsored by IFIP (Working Group 8.1). Contact: Mr. Frans Van Assche, Conference IFIP-Quebec'91, James Martin Assoc., Genevestraat 10 B4, Brussels, Belgium. Fax: (32) 2-242-1592.

## INTERNATIONAL

Nov. 28-30. **Tools Pacific '90, Technology of Object-Oriented Systems, International Conference and Exhibition.** Darling Harbour, Sydney, Australia. Included will be tutorials, invited presentations, submitted papers, panel discussions, and an exhibition of industrial and research object-oriented tools. Contact: Myriam Wever, Victoria P/L, 8 Jane Street, Balmain, NSW Australia 2041; +61/2 810-2502, Fax: +61/2 810-3726.

Nov. 15-16. **Third Annual North Carolina Symposium on AI.** Research Triangle Park, North Carolina. Contact: Connie McElroy-Bacon, Division for Lifelong Education, N.C. State University, Box 7401, Raleigh, NC 27695-7401; (919) 737-2261.

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# INTELLIGENT SOFTWARE STRATEGIES

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THE MONTHLY NEWSLETTER ON EXPERT SYSTEMS, OOP, CASE, NEURAL NETWORKS & NATURAL LANGUAGE

Editor: Paul Harmon

## THE NEED FOR INTELLIGENT TEXT-BASED MANAGEMENT SYSTEMS AND THE ROLE OF EXPERT SYSTEMS IN IMPLEMENTATION

Expert systems have been used to solve a wide variety of problems. Some of the more familiar types of problems include diagnosis, monitoring, configuration, planning, and scheduling. A new and increasingly popular use of expert systems involves the management of text-based information.

### The Need for Text-Based Management Systems

To say there is a real need for text-based management systems is an understatement. A tremendous amount of information is maintained in a textual format. Some of it exists in hardcopy form — books, manuals, and files — stored in con-

ventional filing cabinets. Increasingly, however, most textual information is stored on computers, as files in databases that reside on mainframes or on PCs. Still other information is stored in files that are available from online subscription services.

Many companies are now using scanner techniques to digitalize hardcopy texts and store them in computer databases. This may help diminish the problems involved in storing and accessing hardcopy textual materials, but it will only increase the problems involved in classifying, accessing, and retrieving computer-based textual information. The efficient storage and access of electronic text files is already a monumental task. Moreover, it is a task that is beyond the capabilities of most traditional database systems. Traditional databases handle textual information by employing keyword search systems. While this is certainly faster and more cost-effective than manual text processing, the use of keywords can limit the depth and complexity of a search. Moreover, keyword search systems do not achieve the accuracy or precision expected from a computer-automated system.

For the most part, where text-based database systems have been implemented, their methods for classifying the maintained information and the degree of knowledge or skill required for their use has effectively limited their use to employees who are very familiar with the storage system. In addition, much of the textual information that is available in electronic form is widely dispersed,

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making merely locating it extremely difficult. Moreover, once a user locates a particular document, it may or may not contain information that is needed. And the sheer volume of data needed to be searched in order to acquire the relevant information often "drowns" the user.

### The Role of Expert Systems in Text-Based Management

The integration of expert systems with text-based management systems (TBMS) will play a major role in solving some of the fundamental problems associated with the TBMS. Expert system techniques, for example, can make classification, structuring, and searching much easier for users.

The classification of typed or scanned documents is of utmost importance if those documents are to be of use to anyone else in the organization. Expert systems can be particularly useful in assisting people with these tasks. In varying degrees, many of the present library science methods for classifying and indexing documents could become rules in a rule base of an expert system that would assist in the assignment of topic headings and indexes, etc.<sup>1</sup>

By lending expertise to the assignment and classification of electronic information, expert systems can help enforce company standards for document/subject classification of textual data. For example, where some degree of confusion existed as to a particular subject assignment, "intelligent" prompts could suggest to the user appropriate headings.

These same "intelligent" prompts, which would include messages and graphics, could also help the user streamline his search for relevant information. Because the information has been structured into meaningful and associated fields, "hypertext" linkages of relevant text would allow the user to jump from one piece of pertinent information to another while performing a search.

By combining natural language, hypertext (OOP), and rule-based inference, companies will soon be able to access text via much friendlier user interfaces. Natural language commands would do much to help ease the present difficulties associated with text-based searches. For example, natural language interpretation of a user's search commands will help eliminate the need for using restrictive keywords. By allowing a greater number of keywords and by moderating the interaction between the user and the system, this would help expand the system's search capabilities and allow the user to concentrate on the information at hand.

These interfaces will not only be "intelligent," but also "universal." In other words, they will allow links not only to internally maintained information, but also to information available from a variety of the different online services. This would provide for the use of one standard interface for any internal or external application (including online subscription systems), thereby reducing much of the time required for learning new systems. This use of natural language has already driven most of the sales of natural language frontends for corporate databases.

The use of expert system technology will also allow for the development of "smart" TBMS that will not only provide the user with the most frequently accessed information on a given subject, but will also "learn" from the user's search strategy, whereby it (the system) will help streamline a given search by providing information in a most relevant structure.

### Some Early Examples

At the present time there are several text-based management systems in operation that illustrate the application of natural language, inference, and OOP techniques.

Carnegie Group, for example, has developed a system for Reuters, the news service people. Known as Construe, the system uses natural language and

<sup>1</sup> Christopher Locke, Intelligent Technology Group, Inc., "TBMS: An Intelligent TBMS for Capturing, Maintaining and Retrieving Knowledge Resources," (see listing above).

AI techniques to assign indexing terms to news stories according to their context.

Carnegie Group developed the system using their own Text Categorization Shell (TCS). The system took approximately two years to get up and running and is now operating on DEC VAX stations. Prior to system implementation, news story indexing was done by people and entailed a 24 to 48 hour delay between receiving and indexing. Now, indexing is done in minutes, with an accuracy of recall and precision rates of 94% and 84% respectively for assigning index numbers to country reports. In addition, the system is expected to reduce operations costs by \$752,000 in 1990.

Carnegie Group has also developed an application for HRB Systems that automatically filters message traffic for government analysts. Analysts were being swamped. For each sentence or phrase that was relevant, the analyst would have to read 10 to 20 irrelevant sentences. The new system reduces

the amount of irrelevant material received by analysts to less than 10%.

Intelligent Technology Group (ITG) is also marketing a TBMS along with its consulting services. In addition to being a full-featured TBMS, IntelliText also incorporates such features as semantic network representation and hypertext linkages of relevant information. ITG is presently using IntelliText to develop a real-time news story classification system for a major newspaper.

TBMSs are great examples of how combining and integrating inference and knowledge-based techniques, OOP, and natural language with conventional database technology can help solve major corporate problems.

For additional information on text-based management systems, contact Carnegie Group, Inc., Five PPG Place, Pittsburgh, PA 15222; (412) 642-6900; and Intelligent Technology Group, Inc., 115 Evergreen Heights Dr., Pittsburgh, PA 15229; (412) 931-7600.

## TRENDS AND NEWS BRIEFS

### Digitalk and IBM Announce Development and Licensing Agreement

Digitalk and IBM have entered into a joint development and licensing agreement for use of Digitalk's Smalltalk/V technology on OS/2 and other platforms. Under the terms of the agreement IBM has licensed Digitalk's OS/2 implementation of Smalltalk/V, and future products for prototyping and product development. Both companies will work together to enhance Smalltalk/V products in the OS/2 and Microsoft Windows environment.

IBM has used Smalltalk/V Presentation Manager extensively (Digitalk introduced Smalltalk beginning in 1985), both as a programming tool and for ongoing development projects. In effect, use of Smalltalk/V PM has provided IBM with a direct route to application delivery. Rather than developing high-function prototypes and then converting

them into shippable products in a different language, IBM has used Smalltalk/V PM to produce prototypes quickly and get them into production code.

Earl Wheeler, IBM senior vice president and general manager for Programming Systems, sees significant benefits for IBM: "This agreement with Digitalk allows IBM to make the benefits of object-oriented programming available to IBM developers today. Smalltalk/V provides a solid foundation for developing Common User Access (CUA)-compliant applications in Systems Application Architecture (SAA) cooperative processing environments."

Digitalk representatives feel that the agreement with IBM should enable the company's products to evolve more rapidly, providing corporate

developers with greater capabilities on both OS/2 and Windows 3.0. Digitalk representatives foresee several enhancements to their products, including a set of visual programming tools, increased AD/Cycle integration and SAA compliance, and

access to the power of database Manager and SQL Server.

For more information on Digitalk products, see tables.

## Software Artistry's ASE, IBM's TIRS and the AD/Cycle Repository

In the last issue of the newsletter, we reported that Software Artistry's tool, Application Software Expert (ASE), would sit on top of TIRS and use the TIRS inference engine, as well as its rule and object syntax, as defined by TIRS knowledge representation language (KRL). To do this, we suggested, Software Artistry would eliminate its own inference engine. In fact, Software Artistry will retain its existing inference engine and syntax, and simply add a translator that will convert ASE code to TIRS's KRL. This means that Application Software Expert users could create and run applica-

tions within the Application Software Expert, or they could create an application within Application Software Expert and then port the application into KRL. Once ported, the application would run on TIRS and it could be stored in the IBM AD/Cycle Repository (to the extent that KRL does, in fact, define the Knowledge Based Systems section of the Repository). Thus, the diagram we presented as Figure 8 in the September issue of *ISS* is only accurate in cases in which an application developed in Application Software Expert has been converted into KRL.

## IMKA, the AD/Cycle Repository and KRL

Separately, we have suggested in past issues of *ISS* that there was a potential conflict between the IMKA standard being developed by DEC, TI, Ford, US West and Carnegie Group and the knowledge based systems standard being defined by IBM for the AD/Cycle Repository. In fact, although the current IMKA standard is more sophisticated than TIRS's KRL, IMKA's chairman, Ted Smith, has

announced that IMKA will do whatever is necessary to assure that the IMKA technology will generate KRL code. Thus, IMKA is offering to create a knowledge representation standard while simultaneously assuring IMKA users that they will adhere to whatever standard IBM establishes for the Knowledge Based Systems module within the AD/Cycle Repository.

## OBJECT-ORIENTED SOFTWARE PRODUCTS

In the last issue of *Intelligent Software Strategies*, we gave an overview of object-oriented theories and techniques, and examined the market for object-oriented products. In this issue we feature a follow-up to that article, whereby we provide detailed tables describing the various commercially

available OO products and vendors. Although this list is by no means complete — with new companies and products entering the market each day — we hope we have provided a good overview of what is being offered in the OO world. The tables appear on pages 5-15.

Table 1.1 Object-Oriented Programming Languages

Name of Product (Vendor)	Price	Hardware (Operating System)	Comments
<b>Actors</b> (Whitewater Group)	\$695	IBM PC or compatibles; requires MS Windows.	Interactive OOP language for developing applications in the MS Windows environment.
<b>Classic Ada</b> (Softwr. Product. Solutions)	varies widely	DecVAX, MicroVAX, Sun (Unix), Apollo (DOS).	Lang./toolset with inheritance and dynamic binding capabilities; automatic Ada source code translation.
<b>Domain C++</b> (Apollo)	varies widely	Apollo, Dec, HP, IBM, Sun (Unix).	Features: symbolic debugging, AT&T class library support, and inter language calling, etc.
<b>C++ MPW</b> (Apple Computer)	\$175	Mac with 2 mb RAM and hard drive; 4 mb recommend.	Fully supports AT&T C++. Full Macintosh toolbox access. Ability to call O Pascal functions/procedures
<b>C++</b> (AT&T)	varies widely	All Unix-based platforms.	OOP platform: class mechanism and inheritance; C++ source code to C source code translation.
<b>Turbo C++</b> (Borland)	\$99.95	IBM PC (DOS) and PS/2 compatibles.	Fully AT&T C++ compatible. Includes C++ compiler, C++ class libraries, and Virtual Memory manager.
<b>Glockenspiel C++</b> (Glockenspiel Ltd.)	varies widely	IBM PC (DOS), IBM 6000, HP 9000, SUN, DEC, DEC VAX.	AT&T C++ compatible.
<b>C++</b> (Guidelines Software)	\$395	IBM 286 PC and compatibles; requires MS C compiler.	Superset of ANSI C. Includes classes, inheritance, member functions, data hiding/abstraction.
<b>C++</b> (Hewlett-Packard)	varies widely	Apollo and HP (UX) workstations.	Fully AT&T C++ compatible.
<b>Intek C++</b> (Intek)	\$249 - \$495	IBM 286/386 (DOS), 386 (Unix), OS/2.	MS Windows compilability. Works with any standard C compiler. Full library support.
<b>Green Hills C++</b> (Oasys)	\$2,000	386 PC (Unix), Sun (Unix), AVIION 8800.	AT&T compatibility. Has classes with scope, data abstraction, cross compiler for embed. applications.
<b>Oregon C++</b> (Oregon Software, Inc.)	\$2,000	Sun (Unix), VAX/VMS, HP, 386 (Unix)/(Xenix) VAX/Ultix.	Includes C++ compiler, source-level debugger, C/C++ libraries compatible with AT&T C++ I/O.
<b>Zortech C++</b> (Zortech, Inc.)	\$200	IBM PC or compatibles (DOS).	Native code optimizing to AT&T C++. ANSI C compiler. Source level MS C/Windows compatible.
<b>Objective C (4.0)</b> (Stepstone Corp.)	varies widely	286 PC (DOS), Apollo, IBM RISC 6000, Sun, DecVAX, HP 9000 Series 200/300.	OO superset of ANSI C. Allows you to modify or add to existing code; adds data abstraction capabilities, object data typing, message expression, and class definitions, etc.
<b>Complete C</b> (Complete Computer Corp.)	\$449	IBM 286/386 (DOS).	For OO C development. Has application dictionary, debugger, translator from Compl. C to ANSI C.
<b>Think C</b> (Symantec Corp.)	\$249	Mac with 1 mb RAM (2 mb for debugger); hard disk recom.	For OO C development on the Macintosh. Think C library implements standard Mac interface.

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Table 1.2 Object-Oriented Programming Languages

Name of Product (Vendor)	Price	Hardware (Operating System)	Comments
<b>Mac Allegro Com. Lisp</b> (Apple Computer)	\$495	Mac SE, SE/30, Mac II; hard drive and 2 mb RAM recom.	Full CLOS implementation. Standalone application generator; MultiFinder compatible.
<b>Procyon Common Lisp</b> (Expertelligence)	varies widely	Mac II, MicroExplorer.	Full CLOS implementation with 1800 built-in functions — customizable editors, window debugger.
<b>Allegro CL Lisp (4.0)</b> (Franz, Inc.)	varies widely	Unix-based workstations: Sun, Silicon Graphics, IBM, Dec.	Full CLOS compliance. Has RT generator, enhanced gener.-scavenging/garbage-collection.
<b>Lucid Common Lisp (4.0)</b> (Lucid Lisp)	varies widely	386 PC, Sun, Apollo, IBM MF, DecVAX, Dec, HP 9000.	Full CLOS compliance. Has Delivery Tool Kit, development in X window environment.
<b>Top Common Lisp</b> (Top Level, Inc.)	varies widely	Wide variety of hardware and operating systems.	Full CLOS compliance. Has external and window-based source level debugger. X window develop.
<b>Eiffel</b> (Interactive Software Eng.)	varies widely	386 PC, Sun, Apollo, Mac, Avion, Dec, SPARCstations.	OO design/programming and C compiling. Has library classes, multiple inherit., dynamic binding, etc.
<b>Object Pascal MPW</b> (Apple Computer)	\$150	Mac with min. 2 mb RAM, 128K ROM, and hard drive.	OO extensions to Pascal, optional code generation, and supports source level debugging.
<b>Turbo Pascal 5.5</b> (Borland)	\$100- \$150	IBM PC/AT (DOS), Mac.	Complete integrated environment, includes compiler, editor, debugger. (Mac) compatible with MPW.
<b>Just Enough/Think Pascal</b> (Symantec Corp.)	\$249	Mac with 1 mb RAM (2 mb recom.); hard disk recom.	OO Pascal development on the Macintosh. Think C library allows implementation of stand. Mac interface.
<b>Simula PC</b> (Simula A.S.)	varies widely	286 PC and compatibles (DOS), (Unix), (Xenix).	Developed at Norwegian Comp. Cntr. as ALGOL-based lang. Hierarchical prog. and virtual attributes.
<b>LAP Prolog</b> (ELSA Software)	varies widely	Sun 3 & 4; requires 8 mb RAM and 6 mb disk space.	OO environ. built on top of Quintus Prolog with auto. inheritance, mess. passing, and data encapsulation.
<b>Prolog++</b> (Logic Programming Assoc.)	varies widely	386 PC, Sun (Unix).	OO extension to Quintus Prolog. Has message passing, compiles Prolog++ to Prolog, demons.
<b>Smalltalk/V</b> (Digital, Inc.)	\$100 - \$500	IBM PC (DOS), Presentation Manager (OS/2), Mac.	For developing applications with highly interactive user-interfaces. Intelligent PC/Mac portability.
<b>Smalltalk-80</b> (ParcPlace Systems)	varies widely	386 PC (DOS) Sun 3,4, and 386i, HP 9000, Apollo, Mac.	OO language/toolset. Has various browsers for modifying class libraries, dynamic cross referencing, user defined primitives for defining/calling external subroutines, etc.
<b>Trellis</b> (Digital Equipment Corp.)	varies widely	VAX/VMS, Ultrix, and DECstation 3100.	Strongly-typed OO language supporting multiple inheritance, abstract data types, and encapsulation. Has extensive type library, interface to file system, I/O capabilities and DECWindows user interface.

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Table 2.1 Object-Oriented Application Development Tools

Name of Product (Vendor)	Price	Hardware (Operating System)	Comments
<b>Application Manager</b> Smalltalk/286 Smalltalk/VPM Smalltalk/V-Mac (Softpert Systems Ltd.)	\$129.95 \$195.95 \$129.95	IBM PC 286 and compatibles, Macintosh.	For developing Smalltalk/V applications. Includes functions to allow developers to view and access the subset of classes and methods which are considered part of an application package; provides software engineering support for application development.
<b>LabVIEW</b> (National Instruments)	\$1,995	Mac with 4 mb RAM; 80 mb hard drive recommended.	Graphic programming language for developing instrumentation applications. Features hierarchical menus, wirestretching, and complete clipboard capabilities. Includes graphical compiler for generating optimized machine code from block diagrams, ability to link-in external code routines.
<b>Object-Designer</b> (Chen & Associates)	NA	IBM PC/AT and compatibles; requires 640 K RAM and EGA/VGA graphics.	Available in three language versions: Turbo Pascal 5.5; C++; and C++ & Turbo Pascal 5.5. Features: object hierarchies; object variable definitions and object method specifications; integrated data dictionary; continuous error checking; automatic code generation.
<b>ObjectPlus</b> (Easyspec Inc.)	\$995 - \$4,500	IBM PC/AT or compatibles (DOS); requires MS Windows.	OO analysis and design tool and code generator operating in Windows; available for Ada, C, C++, and Object Pascal code generation. Features include full cycle support, and DB integration with Oracle, dB2, ,etc.
<b>ObjectVision</b> (ObjectVision, Inc.)	\$399	IBM PC/AT or compatibles (DOS); VGA/EGA graphics.	Allows users to develop OO Programs visually by "drawing" a program's objects, flow, interface, and DB connections on screen. These diagrams can be automatically converted to compilable C++ or Turbo Pascal 5.5 code. Features include predefined interface objects — such as buttons and switches, and capabilities for library development.
<b>Objectworks/Smalltalk</b> <b>Objectworks/C++</b> (ParcPlace Systems)	\$3,500 \$3,000	386 PCs (DOS), (Windows), Apollo, Sun, HP 9000 series 300 (Unix), DECstation, Mac, Sun SPARCstation. C++ version available only for Sun 3 & 4 and Sun SPARCstation.	Programming language/Toolset. Supports portability of source code, objects, and binary code. Features include: wide range of application portability; reusable class library; complete source code to the class library. C++ version supports creation of abstract and concrete classes; supports traditional C data structures and procedures; type checking; multiple inheritance, dynamic memory allocation; and data abstraction.
<b>Prograph v. 2.0</b> (TGS Systems Ltd.)	\$395	Any Mac with 2 mb RAM.	OOP environ. that allows developer to "draw" application. Includes: graphical dataflow lang. and built-in source code debugger for building "clickable" applications; interpreter/compiler; WYSIWYG editor for associated methods; customizable interface elements; full single-inheritance support.

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Table 2.2 Object-Oriented Application Development Tools

Name of Product (Vendor)	Price	Hardware (Operating System)	Comments
<b>Software Through Pictures</b> (Interactive Development Environments)	varies widely	DecVAX (VMS), Sun and Apollo (Unix) workstations.	OO structured design tool for Ada application development.
<b>SPOKE</b> (Expertelligence Inc.)	\$13,000	Sun SPARCstation.	OOP environment with multiple inheritance, dynamic classes, generic functions. Written in C and generates C code. May be used in conjunction with Expertelligence's Action! interface builder.
<b>Teamwork</b> (Cadre Technologies, Inc.)	varies widely	Available on a wide variety of operating platforms.	Modeling and design tool available for several application development areas: Information modeling — helps systems analysts and DB designers model the entities, relationships, and attributes of all application data at the conceptual level; Systems analysis — for real-time structured analysis; and Systems design — for employing structured design techniques.

Table 3.1 Object-Oriented Interface Development Tools

<b>Action!</b> (Expertelligence)	\$1,995	MicroExplorer, Macintosh, Sun SPARCstation. Planned releases: PS/2 and Motif versions.	Based on ExperObject Code — a Lisp code containing the Flavors definition of each of the 13 objects found in the standard Macintosh interface, windows, menus, keyboard events, etc.
<b>C_talk/Views</b> (CNS Inc.)	\$450	IBM PCs or compatibles; min. 512 K RAM. Requires MS C compiler, MS Windows 2.1 or later, MS Develop. Kit. Works with most C compilers.	For MS Windows program development in C. The most common elements of Windows programs are packaged as reusable software components. Allows Window functions to be converted into standard C code.
<b>C++/Views</b> (CNS Inc.)	\$495	IBM 286, 386 or compatibles; requires MS Windows 3.0 and SDK, C++ compiler/preprocessor 2.0.	For developing Windows 3.0 applications in C++. Features: 65 C++ classes encapsulating Windows functionality; class hierarchy browser supporting single and multiple inheritance; source/file editing; multiple rooted hierarchies; adding/deleting classes; application/library management, automatic make file, and class generation and documentation.
<b>MacApp</b> (Apple Computer Inc.)	\$275	Mac Plus, SE or II with 2 mb RAM and hard drive. Requires Mac Programmer's Workshop (MPW) 3.0 and MPW Pascal 3.1, or MPW C 3.1 and MPW C++ 3.1 or Think Pascal 3.0.	OO toolkit consisting of an object library from which users may modify existing objects for creating Macintosh applications, including scrollable, resizable windows, and multi-page printing. Applications "inherit" the look and feel of standard Mac-based applications directly from the MacApp code. Includes tools for source code browsing and creating and editing windows and dialog boxes. Operates on all Mac hardware and runs under MultiFinder and the A/UX operating system.

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**Table 3.2 Object-Oriented Interface Development Tools**

Name of Product (Vendor)	Price	Hardware (Operating System)	Comments
<b>MacDialog Editor</b> (Quintus Computer Systems)	\$325	Mac +, SE or II; MacOS 6.0, MacProlog 6.0 or later. Hard disk recommended.	Mouse-driven development tool for creating interfaces for Mac-based Prolog applications, including: radios, buttons, checkboxes, menus, text fields, edit fields, icons, picture buttons, and picture checkboxes. Supports multiple scrollable menus.
<b>NeXtStep</b> (NeXT Inc.)	NA	NeXt machine, IBM PS/2 and RT 6000.	Window-based development environment consisting of four components: Window Server and Workspace Manager — for file and system navigation; Application Kit — a set of approx. 25 software classes that define interactive objects such as windows, buttons, and scrollers; and Interface Builder — uses previously created software objects to develop user interfaces. Uses Display PostScript system for both screen display and printing.
<b>Object/1</b> (MDBS Inc.)	\$995	IBM AT or 386; OS/2 and Presentation Manager; 4 mb RAM, EGA/VGA, mouse.	For developing graphical interfaces for OS/2 Presentation Manager applications and MS DOS Windows 3.0 applications. Includes OOP language rooted in C, nearly 300 classes, 3,000 methods. Applications may operate stand-alone using TBL DB engine (KnowledgeMan and GURU DB), or the client side for M Soft/Sybase SQL Server, MDBS IV.

**Table 4. Hyper Media End-User Development Tools**

<b>Analyst</b> (Xerox Special Information Systems)	varies widely	PC 386 (DOS), Mac II, Sun 3 & 4, Sun SPARCstation, HP, Apollo, Dec 3100.	Integrated set of "Hypercard-like" applications. Hypermedia consists of spreadsheets, charts, map, outlines, and sound. Has full DTP capabilities, including page layout and Postscript printing.
<b>Concordia</b> (Symbolics, Inc.)	\$10,000 - Site: \$40,000 - \$50,000	Symbolics machines (Lisp), Sun, MicroExplorer, or Mac II with Maclvory co-processor system.	Hypertext environment for producing and delivering printed and on-line documentation. Allows project collaboration. Consists of authoring and viewing components.
<b>HyperCard</b> (Apple Computer)	\$49.95	All Macintosh computers with 1 mb RAM.	For integration and manipulation of text, graphics, audio, animation, into applications known as "stacks." Features: programmable objects; real-world metaphor; HyperTalk programming language; extendable English language commands; and animation support.
<b>Tool Book</b> (Asymetrix)	\$395	IBM or compatible 286 and 386 machines (DOS) with 2 mb RAM.	Software construction set for Windows 3.0. Possible applications include: on-line tutorials for training and education, prototyping and simulating applications, creating graphical front-ends for DBs, and multi-media presentations employing full-motion sound and video.

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**Table 5.1 Object-Oriented Database Management Systems**

Name of Product (Vendor)	Price	Hardware (Operating System)	Comments
<b>G-BASE/W</b> (Object Databases, Inc.)	NA	Single-user, Lisp-based workstation version: Sun, Apollo, Symbolics, TI MicroExplorer and Explorer, Mac.	Heterogeneous, client-server architecture for CAD/CAM, CIM, CASE, etc., and high-speed transaction processing applications. Features: multiple inheritance for code reusability; abstract data modeling; decision support — for "what-if?" scenarios; G-LOGIS — a logic programming facility combining PROLOG and Lisp functions for complete DB inferencing; fault tolerance and simultaneous, on-line back up. In addition, various add-on packages are available, such as G-BASE/SQL; allows shared, common DB access via an Oracle server.
<b>G-BASE/GTX</b> (Object Databases, Inc.)	\$10,000 - \$100,000	Multi-user, Lisp-based version: Vax/VMS, Sun 3 & 4. OS/2 version scheduled for 1991.	
<b>GemStone (ver. 2.0)</b> (Servio Logic Corp.)	\$12,000 - \$92,000	Sun 3 & 4, DecVAX (VMS), and IBM RS6000 platforms; IBM PC, Mac II, and VT100 workstations. Also supports TCPP/IP and DECnet protocols.	Multi-user, client-server architecture for same or heterogeneous configurations. Features: ability to store both slot and method descriptions together; data definition and data manipulation languages for supporting applications in C, C++, Smalltalk, and COBOL; a graphical tool for creating class definitions. Implementation in X Windows/OSF Motif provides mouse-driven interface for direct manipulation of relationships between classes; user can define classes and their instance variables, create and manipulate class hierarchies, and define sets for holding objects.
<b>ITASCA</b> (Itasca Systems Inc.)	\$3,995	Apollo, HP, Sun, and Silicon Graphics workstations; requires 8 mbs RAM, 16 mbs recommended.	Based on ORION prototype developed by MCC. Execute routines written in C, Fortran, and Lisp. Applications written in C or Lisp can call Itasca via interface routines. Features: dynamic schema modification; enables network-wide DB access while changes, like adding or removing classes, changing class hierarchies or inheritance are made at any site; Implicit security authorization — users authorized to read data at certain security levels automatically have access to new objects at that level or lower; dynamic binding of version references — allows one object to dynamically "point to" the most recently released or another designated version; support for private and shared DBs — objects may be "checked out" of shared DBs for use in private DBs, where their access then approaches single-user system performance.
<b>Objectivity/DB</b> (Objectivity Inc.)	\$30,000	Sun 3 & 4 (Unix), DECstations. Presently being ported to PC-386, DECstation 3100, VAXstation, and Sony workstations.	Allows integration of design and language tools for network-based, multi-user applications. Has extendable set libraries, including aggregates such as sets, lists, dictionaries, and arrays. Supports C and C++. Objects residing in DBs may be translated into "in" memory C++ objects. Extended SQL support allows querying of objects with common properties. Provides capabilities for nested and shared transactions.

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Table 5.2 Object-Oriented Database Management Systems

Name of Product (Vendor)	Price	Hardware (Operating System)	Comments
<b>ObjectStore</b> (Object Design)	\$25,000	Sun 3 & 4 (Unix); additional platforms/systems under development: HP, OS/2 (X-Windows), and MS Windows 3.0.	Allows integration of existing C libraries and applications with new ones written in C++. Features: Schema Designer — an interactive, graphical tool for developing and manipulating large class matrices; supports source-level debugging and has a graphical, DB browser/query capability for facilitating development — query optimizer helps minimize number of objects examined in response query. Version and configuration supports allows developers to maintain different versions of a design at the individual object level.
<b>Ontos</b> (Ontologic Inc.)	\$15,000	Sun 3, SPARCstations, Apollo and OS/2 platforms. Other versions planned for release: VAX/VMS, DECstation/Unix, HP 9000 series, 386 Unix and MS-DOS/Windows 3.0.	Allows storage of different types of information: data, text, graphics, pictures, voice, and video, etc. Provides: interfaces for C++, C, SQL, and DB administration — object language support and graphical utilities for schema design tools; DB configuration and interactive editing — binding to C++ eliminates need for DML and embedded DDL. Supports network applications consisting of multiple clients and servers and multiple DBs.
<b>Stattice</b> (Symbolics, Inc.)	\$10,000, site: \$40,000 - \$50,000	Symbolics machines (Lisp).	Persistent storage allows objects to be stored outside of virtual memory, enabling applications running on different workstations to share the same objects. Allows modular sharing and flexible reuse of code. Has methods for attaching procedures to types, thereby associating programs and data. Full commonality with the Genera-Lisp environment allows integration with other Lisp applications, such as Symbolic's Joshua expert system programming language.
<b>Versant</b> (Versant Object Technology Corp.)	\$15,000	Sun 3 & 4 workstations (Unix), IBM RS 6000.	Intended for application areas such as engineering and office automation, etc. Objects may be created to contain data that can be closely linked to applications; objects (software modules) are reusable and easily modified. Consists of four modules: Versant — a distributed object manager and object storage system for handling objects and performing I/O functions; a C++ class library and set of tools which include a schema utility that allows C++ programs to access a DB; a C library; and Versant View — a development tool for browsing DB objects and classes.

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**Table 6.1 Expert System Building Tools with Significant OOP Capabilities**

Name of Product (Vendor)	Price	Hardware (Operating System)	Comments
<b>Aion Development System (ADS 6.0)</b> (Hybrid) (Aion Corp.)	\$7,000 - \$97,500	IBM PCs and Mainframes S/370 (MVS/TSO, CICS, IMS, DB/DC, VM/CMS, MS-DOS, OS/2) (Pascal, COBOL, C).	A PC/Mainframe knowledge tool with a complete OO environment, plus demons, constraints and pattern matching rules.
<b>ART-IM (Hybrid)</b> (Inference Corp.)	\$8,000 - \$160,000	IBM PC/AT, PS/2 and compatibles (MS-DOS); IBM Mainframes (MVS), Sun 3 & 4 (Unix); DEC (VMS), Apollo (Unix), TI Explorer I & II, Symbolics 3600 series, HP, IBM RISC/6000, Data General (Unix).	A PC/Unix/mainframe tool with a limited OO environment, but with constraints and pattern matching rules and database objects.
<b>EntryPaq</b> (Inferencing/OOP) (Albathion Software)	\$79.95	Mac (Hypercard).	A Mac tool written in HyperCard with demons, constraints and pattern matching rules.
<b>G2 Real Time Expert System</b> (Gensym Corp.)	\$18,000	Mac II, Compaq 386, DEC workstations, Symbolics 3260, TI Explorer, Sun, Dec VAX, (Lisp).	A Workstation tool designed for real-time process control problems. Complete OO environment plus demons, constraints, pattern matching rules, and time tags on objects.
<b>KAPPA PC</b> (Intellicorp)	\$3,500	IBM 286/386 PCs, PS and compatibles (MS-DOS), Unix workstations, Mac.	A PC tool with a complete OO environment plus demons, constraints, pattern matching rules and dynamic graphics.
<b>KBMS (Hybrid)</b> (AI Corp., Inc.)	\$5,000 - \$90,000 - 250,000	IBM PCs 286 & 386 or compatibles (MS-DOS & OS/2) IBM Mainframes (MVS/XA, MVS, VM, CICS, TSO, IMS/DC, CMS), (C).	A PC/mainframe tool with a limited OO environment, but with constraints, pattern matching rules, database objects, and dynamic couplings.
<b>KEE (Hybrid)</b> (Intellicorp)	\$9,000 - \$98,000 or \$4,900/mo.	VAX, Apollo, Sun, Symbolics, Explorer, MicroExplorer, 386 PC (Lisp), Mainframe (MVS) — access via PC.	A Lisp-based tool with a complete OO environment plus demons, constraints, pattern matching rules, and dynamic graphics. The most powerful OO environment available.
<b>KES II/KES/VE (Structured Rule)</b> (Software A&E, Prime Comp., Unisys, Control Data)	\$4,000 - \$60,000	IBM PCs and compatibles (MS-DOS), Workstations, Minis, Mainframes (NOS/VE, MVS/TSO, CICS, IMS and VM/CMS).	A PC/Unix/mainframe tool with a limited OO environment plus demons and constraints.
<b>Level5 Object (Hybrid/Object-oriented)</b> (Information Builders Inc.)	\$995	IBM PCs and compatibles, (MS-DOS/Microsoft Windows).	A PC tool with a limited OO environment, plus demons, constraints, and dynamic graphics. Integrated with FOCUS (4GL).

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Table 6.2 Expert System Building Tools with Significant OOP Capabilities

Name of Product (Vendor)	Price	Hardware (Operating System)	Comments
<b>Nexpert Object (ver. 2.0)</b> (Hybrid) (Neuron Data)	\$5,000 - \$8,000	Wide range of hardware, including: IBM PC/AT, PS/2, 386 and compatibles (DOS), (OS); Mac +, SE and II, DECstations (VMS and Ultrix), IBM RT, Sun Apollo, HP, VAX (Unix); Mainframe (delivery)—(VM),(MVS), NEXT, (C).	A PC/workstation tool with a complete OO environment plus demons, constraints, pattern matching rules, and dynamic graphics. May be connected to the Ontos (Ontologic) OODBS via currently available bridge — thereby allowing mapping of OO data structures maintained in DB.
<b>ProKAPPA</b> (Intellicorp)	\$9,995	Sun 3 (Unix) and Sun SPARCstation.	A workstation tool with a complete OO environment plus demons, constraints, and pattern matching rules. Generates C code.
<b>TIRS</b> (IBM)	\$11,000 - \$60,000	IBM RT/PC, PS/2; IBM Mainframes, (MVS/CICS, MVS/TSO, VM/CMS) (C).	A PC/mainframe tool with a limited OO environment but with constraint and pattern matching rules.

Table 7. CAD/CAM Constraint-Based Development Tools

<b>Design ++</b> (Design Power Inc.)	\$35,000	Sun 3 & 4, SPARCstations, MicroExplorer, (KEE), (Lisp).	For developing product-specific expert systems for automating the design process. Design/product knowledge can be represented as relations between objects and as structural and functional rules. Design components/assemblies can be described as objects; components and properties of various assemblies are described as attributes of the objects. Domain/product knowledge can be attached to these attributes. Features: automation of graphic designs and revisions via interface facilities with AutoCAD; supports concurrent engineering through automation of proposals and textual documentation via interface with Interleaf.
<b>I-CAD</b> (ICAD Inc.)	\$20,00 - \$95,000	Sun 4/110 & 4/260, SPARCstations, MicroExplorer Symbolics 36xx, HP 9000 series 300 (Lisp).	Knowledge-based ICAD system for mechanical design and manufacturing engineering. Rule and constraint-based programming allows engineers to develop product models that describe engineering, design, and manufacturing processes in one model.
<b>Concept Modeller</b> (Wisdom Systems)	varies widely	Sun 3 & 4 (Unix), Sun SPARCstations, Apollo, HP 9000 series, DECstations (VMS), DecVAX (Ultrix), and Silicon Graphics workstations.	Modelling tool for concurrent engineering, comprised of a tree structure of parts and subparts. C architecture — but all functions are through objects and CLisp commands; runs in X Windows. Features: inheritance; dependency backtracking; customizable interface — user can reference/output design info. to CAD, bill of materials, etc.; interfaces to other languages — FORTRAN analysis programs, SQL DBs, MRP, and CAD systems.

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## CALENDAR

A complete calendar of intelligent software conferences and meetings is published three times a year, in January, in the summer, and in November. The complete calendar is mailed to subscribers under separate cover. In between mailing out the complete calendar, we print new conference information in the newsletter immediately following our receipt of the announcement.

We have received the following new announcements in the past month:

## EXPERT SYSTEMS CONFERENCES

## North America

Oct. 24-26. **Users.PRL, Fourth Annual User Conference (Level5)**, Orlando, FL. Contact: USERS.PRL, P.O. Box 361262, Melbourne, FL 32936-1262; (800) 444-4303.

Oct. 23-27. **Tenth Int.'l Workshop on Distributed AI**, Bandera, TX. Sponsors: AAAI and MCC. Contact: Michael N. Huhns, MCC 3500 W. Balcones Ctr. Dr., Austin, TX 78759; (512) 338-3651.

Oct. 28-31. **AI and The Help Desk**, Orlando, FL. Presented by the Help Desk Institute. Keynote speaker Avron Barr. Contact: Help Desk Inst., 1755 Telstar Dr., Suite 101, Colorado Springs, CO 80920; (800) 248-5667; Fax: (719) 531-6522.

Nov. 14-16. **1990 Aion User Conference — "Reshaping the Business Process,"** San Francisco, CA. Contact: Catlin Walker, Aion User Conference, 101 University Ave., Palo Alto, CA 94301; (415) 328-9595; Fax: (415) 321-7728.

Nov. 15-16. **AIDA 90, Sixth Conference on AI and ADA**, Reston, VA. Sponsors: George Mason Univ. et al. Contact: AIDA 90, Computer Science Dept., George Mason Univ., 4400 University Dr., Fairfax, VA 22030; (703) 323-2630; Fax: (703) 323-2630.

## International

Nov. 7-9. **Computer World 90, Multimedia Technology and AI, Kobe Chamber of Commerce and Industry**, Kobe, Japan. Sponsors: Hyogo Prefectural Government, Kobe City, Kansai Inst. of Info Systems. Contact: Secretariat, Computer World 90, Kansai Inst. of Info Systems, Osaka Ekimae the 1st Bldg. 8F, 1-3-1-800, Umeda, Kita-ku Osaka 530, Japan; (+81) 6-346-2841; Fax: (+81) 6-346-2443.

Dec. 26-27. **Seventh Israeli Conference on AI and Computer Vision**, Tel Aviv, Israel. Contact: A. Bruckstein, Faculty of Computer Science, Technion, 32000 Haifa, Israel; or Shmuel Peleg, David Sarnoff Research Center, CN 5300 Princeton, NJ 08543-5300; (609) 734-2284.

## OBJECT-ORIENTED CONFERENCES

## North America

Dec. 4-5. **Object-Oriented Systems Conference**, Chicago, IL. Focus will be on applying OO techniques to analysis, design, and DB management. Sponsor: Digital Consulting, Inc. Contact: Digital Consulting, 204 Andover St., Andover, MA 01810; (508) 470-3880; Fax: (508) 470-0526.

## CASE CONFERENCES

Nov. 14-16. **AppliCASE 90**, The Marriott, Cambridge, MA. Sponsored by *Information Week* and Ernst & Young. Contact: AppliCASE, P.O. Box 72, Mountain Lakes, NJ 07046-0072; (201) 299-7650; Fax: (201) 299-8908.

Dec. 3-7. **Toulouse 90: Software Engineering and Its Applications**, Toulouse, France. Sponsored by Cigref, SEE, and Syntec-Informatique. Contact: Jean-Claude Rault, EC2, 269-287, rue de la Garenne, 92024 Nanterre Cedex, France; (33-1) 47-80-70-00; Fax: (33-1) 47-80-66-29.

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THE MONTHLY NEWSLETTER ON EXPERT SYSTEMS, OOP, CASE, NEURAL NETWORKS & NATURAL LANGUAGE

Editor: Paul Harmon

## AUTOMATING KNOWLEDGE FLOW AT THE HELP DESK

*As readers know, we rarely run articles by anyone other than your editors. In this case, we are making an exception because of the high level of interest we thought readers would have in this article prepared for ISS by Avron Barr. Avron Barr is the President of Aldo Ventures, as well as an independent consultant, writer, and public speaker on knowledge systems in business. He co-edited the four-volume Handbook of Artificial Intelligence and is writing Knowledge Distribution Systems to be published in 1991 by Addison-Wesley. Mr. Barr's current half-day seminar, "The Evolution of Expert Systems in MIS," is generating interest from MIS managers worldwide. Aldo Ventures offers a*

*planning service to help desk managers looking at technology alternatives for improving their operations. The following article by Avron provides an overview of the current state of expert systems and help desks. — Paul Harmon*

"Information is not knowledge until and unless it is applied effectively."

Dan Burrus, *Futureview*, 1989

As anyone who has spent an hour vainly looking through a manual for the answer to a question would testify, information is not knowledge. Modern knowledge systems, applying expert systems in conjunction with other software and communications technologies, are helping many companies turn information into knowledge.

While expert systems were originally introduced commercially as large, problem-solving programs, the proper nurturing and cultivation for this technology's development at this time is found in automating current efforts to distribute corporate knowledge. The natural home for this technology is in the support of existing knowledge distribution activities like training, employee policy handbooks, regulatory compliance guidelines, system and product documentation, troubleshooting guides, new product bulletins, procedures manuals, and help desks.

In recent years, expert systems tools and techniques have proven effective in the automation of customer support as well as internal, e.g., data center, help desk activities. This reflects a maturation of expert systems technology and the real benefits achieved by those pioneering companies that identified and

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pursued help-desk applications in their search for uses for the technology. In the last year, several vendors have come forth with task-specific programming products designed for this market niche, and there are more to come. This article reviews the need for automation at the help desk, the role of expert systems technology in systems solutions, and what kinds of products are available now.

### KNOWLEDGE FLOW AT THE HELP DESK

Every help desk operation has different problems, for different reasons. For some, the high turnover of staff and enormous time and cost of training new customer support representatives (CSRs) results in a nearly disabling productivity problem and often low-quality advice. For others, the size of the product line they support, frequency of changes and additions to the products, and complexity of problems and interactions in the field make the job difficult even for well-trained, experienced personnel.

Some of the typical help desk problems (e.g. technical product support that meets detailed customer specifications), are best dealt with by conventional information systems. But many of the difficulties that help desk operations face are inherently knowledge problems. For example, a new CSR cannot use the information available to him or her in manuals, notebooks and meetings without extensive training on the products, documentation, and databases. But even experienced and talented CSRs have trouble integrating into their telephone troubleshooting the new problems that customers present (amorphously) every day and the fixes that engineering figures out.

Similarly, troubleshooting guidance is sometimes needed to keep up with new products, releases, and repair procedures. This is especially important when the CSR is trying to schedule properly equipped field service visits that will fix the customer's problem without requiring a second trip. And in addition to the often troublesome task of figuring out exactly what the customer is talking about, the CSR must conform to the company's

emergency response guidelines or product return policy.

### KNOWLEDGE FLOW ANALYSIS

Much of the value of building computer systems solutions to business problems lies in the analysis necessary to specify the problem and design an adequate solution. For knowledge systems, this involves understanding what people need to know to do the job right. I call this knowledge flow analysis, resulting in an identification of knowledge problems, some of which may then be addressed by knowledge systems solutions.

Knowledge flow analysis is like data flow analysis in that it examines the flow of something around an organization. But unlike data or information, knowledge is intangible. Despite the common usage of the word, knowledge does not exist in books, manuals, databases, or knowledge bases. Knowledge is used to describe people's behavior. Knowledge flow analysis involves looking at people's experiences and behavior and inferring what goes on in their heads. The issue is not what information is or should be available, but rather who can answer the questions, today, under these specific circumstances, given the customers' particular, confused presentations of their situations. With the proviso that every help desk operation is different, let's look at some of the elements of a knowledge flow analysis.

The nodes in knowledge flow are people faced with situations. Do they act knowledgeably? Optimally? The CSRs for instance, when dealing with incoming calls, must take into account their customers' products, operational environments, technical capabilities, and attitudes, in order to behave properly. They must also be familiar with the entire product line, including the common glitches and their various manifestations. Often this involves some acquaintance with products from other vendors with which the customer might be interfacing. They must recall, given that they have identified the problem, what the possible fixes are, if any. They must adhere to their own company's

policies and priorities, like the things you never say ("the carpet isn't really stain-proof"), the relative importance of different customers, and the critical issues which must be addressed immediately, for example, safety equipment needed for emergency response. They also must know about each others' knowledge, about what specialists to call in for different kinds of unsolved problems, and to whom one refers irate customers.

Add to this their knowledge of how to use existing database and textbase tools, their knowledge of the documentation on their desks, and their knowledge about inter-human communication protocols, and it is no wonder that training time for new CSRs is so long.

### A SYSTEMS PERSPECTIVE

But the story doesn't end there. The analysis involves all the people in the knowledge chain. The customers have knowledge about their problem, working environment, and about the products in question. Engineering has knowledge about design decisions, other vendors' interfaced products, design changes, new products and releases, what causes problems, and why certain fixes work sometimes and not others. And management, marketing, documentation, distributors, and field service people also have relevant knowledge or knowledge needs. To maximize customer satisfaction, all of this knowledge may have to flow through the help desk.

Generally, where there are knowledge problems there have been prior attempts at solutions: manuals, bulletins, documentation, troubleshooting guides, CSR notebooks, CSR and customer training, weekly information exchange meetings, and access to the experts. When the operation has been automated, there may be call-directing, database, and textbase technology in place. These efforts must also be examined in the knowledge flow analysis to see what works, what doesn't, and why. The output of the knowledge flow analysis is a determination of who could do a better job if they could get better access to relevant information, and what is the best way to get that information there.

Once the critical knowledge problems are properly identified, the best knowledge distribution strategy can be determined. The effort may take the form of new documentation, communication or training, or it may involve a knowledge system. The solution may be targeted for the CSRs or field service technicians, given (or sold) to distributors or customers, or even integrated into future products. It may be built by the customer support department, engineering, documentation, or by all of them.

Keeping an open mind about how information should be disseminated will facilitate your getting the biggest impact. Besides the help desk operation, your documentation, marketing communications, and training organizations should also become familiar with the technology and its implications to their functions. Ultimately, for most organizations, a full-time knowledge base maintenance capability will be important to the success of this technology, as was the case with database technology.

### CONVENTIONAL AUTOMATION AT THE HELP DESK

Many service and support organizations have already invested in some kind of automation, in most cases call forwarding and database and textbase systems. Several new products have been introduced in the last year that employ intelligent database and text retrieval technologies, rather than expert systems, to address help desk problems. A recent extensive survey of service and support management systems by AIM Consulting and Crescent Project Management examines 90 software products aimed at this market. The Help Desk Institute has also surveyed the current support systems in this area and has proposed some new directions.

These products offer automation for the following kinds of activities:

1) Call Management: Answering and queuing incoming calls for the right CSR. Sometimes this is completely automated, so that the call is answered by a prerecorded voice and forwarded by the phone trees characteristic of automatic call directing (ACD) technology. The information given to the

phone system (by pressing the touch tone buttons in response to prerecorded questions) should be passed on to the CSR.

2) Customer tracking: What equipment does a customer have? Have they called before about this problem or other problems? Access control is also provided, since many companies sell their customer services requiring the CSRs to identify the callers. Some systems even automate updating the billing database by CSR "connect time."

3) Field service management: Scheduling and tracking the dispatch and status of field service representatives. Advanced systems help determine which FSR should go and what tools and spares she should take along. Some even keep track of the spares inventory.

4) Help desk management: Keeping track of what kinds of calls are coming in from whom, which ones get answered when, and how many callers each CSR handles per hour.

5) Product problem tracking: Which products are most troublesome and why? What are the unresolved customer problems, who is working on them, and which customers are waiting for answers?

6) CSR notebooks: Sharing problem/symptom/solution knowledge among CSRs by allowing them to enter descriptive text, later retrieved by keyword searches. This is the most sophisticated kind of support currently available, and the kind most requested by CSRs.

Some of these systems are quite sophisticated, well beyond the typical database application, especially in the area of the CSR's shared notebook. Answer Computer's Apriori, for example, uses graphic user interfaces and sophisticated indexing and retrieval schemes to allow CSRs to share information about current problems, how customers describe them, and what the fix is. (Table 1 details some Help Desk application/tools mentioned in this article.) The system actually learns, real-time, as CSRs are dealing with a call, and makes the infor-

mation available, via networked UNIX workstations, to every CSR immediately.

Another sophisticated system is Lysis Corp.'s Support Information System. In this system, the CSRs do not enter information as free form text, but rather use "semantic primitives," reminiscent of Roger Schank's early-AI conceptual dependency theory, to develop a canonical underlying schema to uniquely capture problems and their descriptions. Companies considering building their own customized versions of "intelligent textbase systems" might look at the new groupware and textbase tools like Lotus's Notes and Verity's Topic.

#### WHY ARE EXPERT SYSTEMS NEEDED?

With all this technology available to bring to bear at the help desk, where do expert systems fit in? First of all, they better fit in. That is, the expert system component should either duplicate conventional facilities for automating help desk record keeping, information exchange, and integration with databases and textbases, or should (preferably) be fully integrated with other database products on the market.

I have seen the following additional benefits, beyond database and textbase solutions, of knowledge-based systems (observed on help desks in, for example, emergency response centers, data centers, product complaint hot lines, and sales and technical support centers). They can:

1) Automate, completely, the resolution of repetitive kinds of calls, often handling 30-60% of the incoming call volume without human intervention. This involves integration with the phone system's ACD capability, so that for "simple" problems the caller simply answers a series of pre-recorded questions by typing the appropriate number on her telephone. In those remaining situations when the system can't solve the caller's problem, it serves as a triage analyst, gathering all the information that the CSR will eventually want to see on the screen.

2) Support novice CSRs who simply can't find their way around the documentation or the database or textbase tools. These systems may also dramatically

Table 1. Some Commercial Help Desk Applications & Tools

Name of Product (Vendor)	Price	Hardware (Operating System)	Comments
<b>Adept</b> (Symbologic)	\$695	IBM PC, PS/2 and compatibles (DOS); runs under Windows 3.0.	Procedural expert system tool using decision tree structures.
<b>Apriori</b> (Answer Computer)	\$20,000 - \$30,000	Sun 3 & 4, SPARCstations; 16 Mb RAM and 100 Mb hard drive recommended (Unix).	Customer support/internal help desk system. Presents info to user in a "most frequently" handled manner, automatically adjusting according to frequency of access; maintains text, graphics, application code, and data files.
<b>CAIS</b> (ROSH Intelligent Systems)	\$50,000 - \$150,000	IBM PC/AT with minimum 640 K RAM (DOS).	Troubleshooting environment for service organizations; provides diagnostic advice, electronic service manuals, product history data, etc.
<b>Enterprise/Dx</b> (Coherent Thought)	\$42,000 - \$300 K	Wide range of platforms, including: PCs, minis, workstations, and mainframes.	Intended for high-tech customer service and support; for developing and embedding diagnostic applications.
<b>Help Desk Assistant</b> (Advantage KBS)	\$35,000	Operates standalone on IBM PC or LAN configs. with MF access; implemented using ADS/OS/2.	Problem management facility including KBs to solve IBM network and PC hardware/software problems. Knowledge editor allows users to add new knowledge.
<b>KLUE</b> (IntelliCorp)	\$5,000	IBM PC/AT (DOS); 2 Mb RAM recommended for Windows 3.0. Also requires KAPPA/PC.	Allows non-programmers to develop diagnostic/help desk KB applications for sharing and maintaining information. Development/maintenance is by means of interactive decision graphs.
<b>LogicTree</b> (CAM Software)	\$495	IBM PC and compatibles (DOS).	Rule-based expert system development tool employing decision trees. Allows access of information in textual and graphic form.
<b>Mahogany Help Desk</b> (Emerald Intelligence)	\$10,000	IBM PC/AT, Windows; Mac with 1 Mb RAM.	Development and deployment tool for diagnostic/service applications. Uses decision-tree structures.
<b>Notes</b> (Lotus Corp.)	\$62,500	IBM 286/386 PC; requires Windows 3.0 or Presentation Manager. Runs under DOS or OS/2 for client side; OS/2 for server.	Group commun. system for creating/distributing info on PCs and LANs. Applications include customer tracking, status reporting, and project management, etc. Allows interconnection of DOS and OS/2 workstations on LAN; supports Ethernet, Token Ring, Novell, 3Com, and IBM networking systems.
<b>Path Builder</b> (Aion)	\$695/995	IBM PC, PS/2 and compatibles (DOS) (OS/2), IBM mainframes; implemented with ADS.	Task-specific tool utilizing diagnostic representation in decision network form. Aids non-programmers in developing help desk/client service applications.
<b>Support Information System</b> (Lysis, Inc.)	\$3,000 - \$50,000	IBM PC or network (DOS), VAX (VMS).	For such applications as call tracking, answer retrieval management, and report generation.
<b>TechSys</b> (IntelliSystems, Inc.)	\$36,000	386-based systems with digitized voice hardware.	Automated tech. support system combining voice technology with a rule-based expert system. Allows callers to do their own problem diagnosis. Diagnostic sessions may be saved for future use.
<b>Topic</b> (Verity)	\$25,000 - \$30,000	DecVAX and RISC-based platforms (VMS/Ultrix), Sun, HP 9000, Mac.	Document retrieval system for networked/heterogenous environments. Ranks documents by relevance according to query. Integrates with Word-perfect, Word, Interleaf and other tech. publishing systems, and with SQL-based RDBMS.

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reduce the amount of training needed before a CSR becomes effective on the job. When the problem is that the CSR doesn't know what questions to ask, then an expert system's Q&A style interaction, with explanation of the line of reasoning, may bring something to game. In other situations, the use of an expert system as a front end to a textbase, capturing the knowledge more experienced users have about what information is where, can be of great assistance.

3) Implement standard diagnostic procedures to provide uniformity and consistency, or support CSRs who must deal with many pieces of complex equipment which heretofore only experienced engineers could troubleshoot. Sometimes these systems are used to help non-technical CSRs ask the right questions so that they can schedule field service visits with the right repair person carrying the right tools and right spare parts on the truck, thus reducing the annoyance and cost of repeat visits.

4) Package information in a more useful form for distributors or customers. For some companies, these software "advisors," which can provide service guidelines, step through diagnostic procedures or index into on-line documentation, are a new source of revenue. For others, the troubleshooting knowledge base is incorporated into the product itself. The effect on the help-desk, of course, is to reduce the volume of "simple" calls that come in.

5) Enforce corporate policy about how things must be phrased and sequenced over the phone. For example, in an emergency response center hot line, there is no room for individual variation in the advice given.

6) Facilitate maintenance of the diagnostic procedures and other knowledge. This is sometimes accomplished by offering decision-tree-like programming tools to the CSRs themselves. The goal is to reduce current knowledge updating costs and keep everybody better informed. In situations where there are tens of thousands of possible problems, the diagnostic procedures can be too complex to sort out in any other medium. The modularity of the knowledge base, often using

knowledge representations specifically designed to capture diagnostic knowledge, allows information to be added incrementally and automatically indexed and organized into troubleshooting procedures by the system.

### A SURVEY OF THE KINDS OF EXPERT SYSTEMS PRODUCTS ON THE MARKET

As vendors see these opportunities, they are responding with new products. This involves molding and extending expert systems technology to the systems developers and users in this market niche. It also requires integrating the relatively small expert systems component with the user interface, textbase, and database software that is already in use. I will attempt to illustrate here some of the kinds of help desk systems incorporating knowledge base techniques appearing on the market. Although most run on several standard IBM and DEC platforms, some only run on UNIX, Macintoshes, or even Apollo workstations. And the price range is all over the map.

### INTEGRATED WITH ACD

Perhaps the most novel customer support system product involving expert systems is IntelliSystems' TechSys. TechSys is designed to integrate with ACD technology to automate, completely, the "call screening and directing" task. In addition, the most common "nuisance" problems can be diagnosed and handled by the system, over the phone, without CSR intervention. In the more difficult cases, the system helps the caller organize all the required information before passing the call on to a CSR. Among TechSys's installed base was the system which handled my distress call about Windows 3.0 this week. (The alternative to working with the automated system, I was told in its first pre-recorded message, was to wait approximately 30 minutes for the first available CSR.)

TechSys' knowledge base representation and total integration with ACD technology, voice mail, databases, billing systems, and the human technical support operation show it to be a well-thought-out system.

## SPECIAL PURPOSE SHELLS AND OVERLAYS

Another feature of TechSys, which is common to all of the expert systems entries in the help desk arena, is that the knowledge representation scheme is specifically designed for customer support tasks. TechSys's knowledge base, for instance, is organized around products, symptoms, and problems. A number of so called task-specific shells, designed for modeling support-related tasks like checklists and equipment diagnosis, are now appearing. Some are designed for organizations already into expert systems, some for very complex diagnostic situations, while some use decision-tree interfaces to facilitate "end-user programming" of diagnostic procedures by the CSRs themselves.

One such tool is the Mahogany HelpDesk from Emerald Intelligence. Emerald's MahoganyPro tool was just another entry in the low-end shell game for PCs and Macs, with some novel features for an inexpensive tool like point and click user interface, simple-to-use knowledge base editing facilities, automatic integration of rule parameters with an object-oriented database, and pattern-matching rules over that database. But the Mahogany HelpDesk product goes well beyond that. Its Help-Builder module is designed to support end-user development, that is, programming the knowledge base by the CSRs themselves, by offering a decision-tree-like developer's interface.

## GRAPHIC USER INTERFACE

Mahogany's HelpStation runtime module allows full integration with graphics, scanned photographs, and even video or animation. As Pam McGaha demonstrated many years ago in a help desk application she built at Texas Instruments, it is often the case in supporting CSRs that the "user interface," the visual screens that the CSR sees, must be carefully designed to allow the CSR to take into account the level of sophistication of the caller. In other words, a traditional expert systems dialogue, which asks all the questions in the appropriate order modeling the expert's diagnostic thinking, may be

too constraining for use by the CSR. Graphics and pictures, from which the CSR can phrase her own questions, can sometimes be very effective.

## BEYOND END USER PROGRAMMING

There are limits as to how much programming to expect from the end users. And expert systems are programs. The simple decision-tree development environment offered by the Mahogany HelpDesk and similar tools like Symbologic's Adept and CAM Software's LogicTree, will only go so far. If the trees get too big, or if they need to be changed too often, or if they must be maintained by several different CSRs, they can become more of a nuisance than an aid. Furthermore, if data needs to be drawn in from a database, a programmer must get involved.

The Mahogany HelpDesk, like other low-end products, will be offering a Customizer option to allow programmers to integrate the decision-tree-created knowledge bases with other code, user interfaces, and databases. Another overlay tool designed for end users in conjunction with professional programmers is the new Path Builder product from Aion, now in beta-testing. This task-specific overlay for Aion's best-selling ADS mainframe shell allows convenient representation of diagnostic decision trees. Path Builder can produce an ADS export file, which can then be integrated with other, programmer-produced ADS code using ADS's Version Maintenance feature.

Advantage KBS has gone one step further with its Help Desk Assistant (see *ISS*, Vol. VI, No. 7). This task-specific help desk tool, again based on Aion's ADS, is designed for data center support operations. The system offers problem management facilities and integrates with IBM's Info/Man product and NetView. What is novel about this offering is that you can buy some "knowledge modules" along with the tool. Knowledge Editor lets you update and maintain knowledge bases as your hardware, software, or procedures change. This enables the user to modify and add new knowledge using point-and-click interfaces. Programming knowledge of the underlying development

tool is not required. Currently modules for network and PC problems are available. Obviously every data center will have its own knowledge about its own networks and PCs, but these knowledge products might be tremendous accelerators for organizations just starting to automate the help desk with knowledge systems.

### HEAVYWEIGHT ENTRIES

It remains to be seen how far one can go with end user programming for the help desk. In addition to the inherent complexity of large decision trees, there are attitudinal issues involving CSRs as programmers. And there are technical issues: most importantly, how do you integrate a bunch of decision trees built by specialist CSRs on networked PCs into a logically consistent knowledge system offering all the relevant advice for every situation?

Whatever the eventual solution to this technical problem is, the end user programming model will not cover all situations. In particular, when offering

service aid for suites of complex equipment with tens of thousands of possible problems and rigorous diagnostic procedures, we are back in the realm of professional knowledge engineering. Several entries — for example, ROSH Intelligent Systems' CAIS, IntelliCorp's KLUE, and Coherent Thought's Enterprise/Dx (see *ESS*, Vol. 6, No. 6 for more on Enterprise/Dx) — now offer workstation-based, task-specific tools for knowledge engineers faced with this level of diagnostic complexity.

### SOLD WITH CONSULTING

Several general-purpose shell vendors and systems-integration consulting firms now have service offerings specifically designed for help-desk applications, based on their experience, and often code, from other client's help-desk applications. The vendors specifically addressing help desks whom I met at the recent AAI meeting in Boston include IBM, AICorp, Bell Atlantic, Software Artistry, IntelliCorp, Andersen Consulting, and Technology Applications.

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## CONCLUSION

Just as database software tools changed people's ideas about computers in the 1950's, this technology for embedding and debugging knowledge in software will change the way businesses use computers. Networked knowledge systems will emerge as a new communications medium. And, just as payroll applications years ago showed that data processing technology was non-optional for business organizations, so help desk applications will blaze the trail for networked knowledge systems. Ultimately, the medium will find use outside of the corporate world, in political arenas where the sharing of knowledge is most difficult.

Knowledge, the AI theorists tell us, is an "ascribed" property. We attribute it to people,

programs, or robots, depending on how they behave. These researchers then go on to confuse the issue by talking about "representing" knowledge in data structures, but that is another story (see Barr, *The Representation Hypothesis*, 1979). In moving expert systems technology into the networked systems or groupware arena, we will see the real nature and power of knowledge, as a social enterprise, transforming the way we work and the way we think. If we can successfully automate knowledge flow at the help desk, we can change the way companies and people know.

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## WHAT'S HAPPENING IN EUROPE: PART 1

### OVERVIEW

European companies are very interested in Expert Systems. From the perspective of an American, it's about 1987 in Europe, with some significant differences. European companies have discovered expert systems and have produced a wide variety of sophisticated applications, enough to convince corporations that there really is something worth investing in. On the other hand, the mainframe tools are just beginning to show up in Europe. That in turn, means that corporate MIS departments don't currently have any effective way to develop knowledge-based systems, which they can integrate with their existing systems.

It's not that the U.S. mainframe vendors aren't there and making some sales, but the Europeans still seem to be primarily focused on PC and workstation-based tools. They are also still interested in Lisp-based tools. Indeed, the only thing keeping the U.S. Lisp vendors alive, at this point, is their European sales.

Unfortunately, it's like 1967 in the U.S. in the sense that many of the expert system tool vendors are in trouble. 1991 will probably see a shakeout that

will eliminate lots of the small Lisp and Prolog-based tool vendors and usher in a much greater emphasis on C and mainframe-based tools. Ignoring the recession which Europe may or may not experience, we expect the shakeout to be over quickly, since the C and mainframe tools that corporations will increasingly demand are already available — from the same U.S. vendors that have emerged from the transition in the U.S. We predict that 1991 will be the year of the mainframe expert system tool in Europe.

There are more, popular domain- and problem-specific tools in Europe than in the U.S. Moreover, although Texas Instrument's TestBench and Gensym's G2 are both popular, most of the interesting domain-specific tools are of European origin. Some of the best of these tools, including Design ++ and Maintex, are already being marketed in the U.S. and we will be surprised if we don't see several more European domain/problem-specific tools being sold in the U.S. in 1991 and 1992.

The other thing that impresses me is the number of methodologies and knowledge acquisition tools available in Europe. Clearly the Europeans are interested in learning how to systematically develop

complex expert systems. Indeed, in one interesting conversation in Avignon this year, I was asked where I thought Europe stood, relative to the U.S. I said that, overall, Europe was 2-3 years behind. I justified that by citing the fact that they have not begun to take mainframe expert system tools seriously, which, in turn, means that corporate IS people can't get involved in expert systems in any serious way. The move to mainframe tools happened in 1987-88 in the U.S. My interviewer made the following comment: "You Americans are always so interested in getting some kind of practical results. You have trivialized the technology in order to build small systems on mainframes that you can integrate into existing applications. But you are not preparing to build the larger systems that will really revolutionize how corporations do business in the 90s. We Europeans are more interested in the long run and are laying the groundwork we will need to really take advantage of AI."

I didn't wholly concede to my interviewer (I really do think most of the Lisp and Prolog tool vendors will disappear soon), but I think there is some truth to what he said. In the U.S., we are ahead in the sense that IS departments have bought mainframe tools and are training their programmers to use inference techniques and build knowledge bases into complex applications. But most of the mainframe efforts to date have been pretty limited. Moreover, although centralized IS departments and their mainframes are still very important, the world continues to move toward a decentralized workstation/PC/network approach. If the trend continues, mainframe vendors who are succeeding today may find they lack the tools necessary for the workstation-dominated market that seems likely to evolve in the 90s. In the U.S., companies that have built large, powerful systems on workstations are just beginning to see the kind of changes that will justify even larger investments in really significant expert systems. As this movement gains momentum over the next few years, U.S. companies may very well find that they are turning to European com-

panies for software to help structure and manage the acquisition of knowledge.

I don't have either the breadth of knowledge or the linguistic competence to do a systematic review of what's happening in Europe. Instead, I offer the following impressions gathered from a few brief visits and many conversations.

## HARDWARE

Most European knowledge systems are being developed and fielded on PCs and Unix workstations. The European vendor that made the biggest effort at Avignon this year was Bull, the large French hardware vendor that has also made a major investment in AI software, which we'll consider in a minute.

The vendor that dominated the Avignon show, however, was Sun. Sun machines were everywhere and Sun did a great job of seeing that their signs were in every booth that was using a Sun — it added up to a very impressive show of strength on Sun's part. In some cases vendors were running applications written in Lisp or Prolog on Sun machines. In other cases they were showing off C applications.

The other vendor that was everywhere was Apple. Macs were being used with Lisp co-processors, with Prolog, with C running in Apple's Unix and as just plain Macs.

## LANGUAGES

Relative to the U.S., Europeans are still much more interested in symbolic languages. Lots of Lisp is being sold in Europe, and, indeed, several U.S. language vendors are now selling European language products in the U.S. (e.g. ExperTelligence is selling Procyon Lisp and Quintus is selling Logic Programming Associates' Flex).

The most interesting symbolic language development in 1990 was the introduction of Prolog III, the newest version of Prolog from Alain Colmerauer from the University of Marseilles. Prolog III replaces the backward chaining inference engine that had been embedded in previous versions of Prolog (unification) with a constraint satisfaction

system. This move is in keeping with lots of academic research that suggests that inferencing problems can be conceptualized more elegantly as constraint satisfaction problems. Prolog III will probably not make Prolog any more acceptable in commercial environments, but it provides a better platform to explore a number of cutting edge problems in knowledge-based systems design. In the U.S., constraint languages and tools seem to be developing almost independently of the expert systems community, while in Europe, they seem to be better integrated.

Still, for all the interest in symbolic languages, Lisp or Prolog, we have the strong feeling that by 1991 or 1992 Europe will have switched to C-based tools, just as the U.S. already has. As we review the tool vendors below, note how the more sophisticated are already making the transition.

Object-oriented programming is hot in Europe, as it is in the U.S., but, like in the U.S., the OOP vendors tend to meet in their own conferences. One exception is Alectel-ISR, who is promoting its object-oriented language/environment, SPOKE, as an AI tool. SPOKE provides an OO development environment and also contains an inference system and can handle forward and backward chaining.

Another new object-oriented language is LAP, a Prolog-based OOP that was created and is sold in France and is being distributed in the U.S. by Quintus.

### GENERIC TOOLS

The most universally available generic tools in Europe are those offered by U.S. vendors. Tools like Neuron Data's Nexpert Object, MBNA's Guru and IBI's Level5, Gensym's G2, Aion's ADS, and IntelliCorp's KEE are popular in all of the major European countries. There is no equivalent European tool; the most popular tools in England are not popular in France or Germany and vice versa. There is a lot of talk about how the 1992 unification of Europe is going to make European companies more European, but there aren't many signs of it yet, at least in the expert systems software market.

As far as we could tell, the best selling European tools of 1989 are still holding their own. In the small tools, it's Crystal and Flex in England and Instant Expert Plus in France. In the midsize range, it's GSI-TECSI Intelligent Service II, KOOL, and Framentec's Maintex in France. In England, it's Xi Plus (see Trends) and Creative Logic's Leonardo. In the mainframe area, there's Software AG's Natural Expert (Germany) and Telecomputing's TOP-ONE (in the U.K.). Epitool (in Sweden) and KOOL (France) are popular Lisp tools.

The European tools that especially impressed us this year included the following.

### WORKSTATION TOOLS

Bull computers showed KOOL, its hybrid tool. A casual look suggests that KOOL is somewhere between Kappa PC and ProKappa in its power, having a full object-oriented capability, quality graphics and full inferencing capabilities. Bull started out working with Lisp and Prolog tools. There is a version of KOOL in Le-Lisp, and there is some Prolog in KOOL, but there is now also a version of KOOL in C. Bull has systematically improved KOOL and moved it to other platforms. KOOL not only runs on Bull Unix workstations, but on Sun and HP machines and on Bull's mainframe (DPS7) platform. There are English and French versions of KOOL and documentation in both languages. With a little more time, Bull will probably move KOOL completely over to C. If they also put it on IBM mainframes and chose to push it in the U.S., we expect that KOOL could easily compete with the top U.S. hybrid tools.

An emerging UK company, Creative Logic, is having some success with a tool called Leonardo. In its most advanced version, Level 3, Leonardo provides a very complete OOP capability and runs on PCs, VAX, Apollo and Sun machines. Creative Logic anticipates offering OS/2 and IBM mainframe versions of Leonardo before the end of 1990. Leonardo has good editing and knowledge acquisition capabilities. Leonardo 3 sells for £1,995. Leonardo sells primarily in the UK market

where Leonardo 2 competes with Xi Plus and Crystal while Leonardo 3 competes primarily with Nexpert and GoldWorks.

This concludes Part I of What's Happening in Europe. Part II of this article will appear in the next

issue of *ISS* and will provide some additional insights into the European expert systems market, including a look at some mainframe and domain-specific tools, as well as some knowledge acquisition tools and methodologies.

## MERLIN: A FACTORY KNOWLEDGE-BASED SYSTEM FOR FORECASTING PRODUCT DEMAND

Merlin is a knowledge-based system being developed at Hewlett-Packard's (HP's) Networked Computer Manufacturing Operations to forecast the factory's product demand. It is presently being used to analyze and forecast a yearly schedule for over 500 products and product options in about an hour. Merlin uses embedded knowledge bases, which enables it to make predictions based on current information and the reasoning processes of the company's forecasting experts. In addition, it features a simulation mode which enables forecasters to improve the system by allowing them to test new forecasting algorithms and analyze the results via metrics displayed in graphical format.

### BACKGROUND

In the world of just-in-time manufacturing, the accurate forecasting of product demand is of utmost importance. Parts and supplies must be on-hand to meet customer purchasing demands. However, stiff competition in the manufacturing environment — even more so in the case of computer manufacturing — is forcing manufacturing operations to become more flexible in order to meet finicky customer purchasing habits. Often, customers order products long after the deadline for acquiring the parts and supplies necessary for filling their orders has past. More accurate forecasting of product demand can help alleviate this problem. However, product forecasting, or any kind of forecasting for that matter, is a difficult process that is further complicated by the presence of many variables.

### REASONS FOR DEVELOPMENT

Analysts at HP deemed the development of Merlin necessary because the prior product forecasting

system (which was a basic DB system that provided your usual reports and screens) was proving too cumbersome to work with and difficult to improve. For example, forecasters were unable to improve forecasting accuracy by adding new algorithms because the system had no means for incorporating them. And, because there was such a large number of products to forecast (about 500), and with many of the forecasting tasks being manually intensive, there was little time remaining to try and improve the system using other means. Forecasters were further hindered in their efforts because all automated forecasting functions dealt exclusively with historical orders and could not be supplemented with the latest "real-world" information.

### DEVELOPMENT AND KNOWLEDGE REPRESENTATION

Development of Merlin is an on-going process that began approximately two and a half years ago. It consists of three phases, of which phases one and two have been completed:

- ◆ Phase 1 dealt with developing the actual forecasting system, developing and integrating the DBs, and replacing the former system with the new;
- ◆ Phase 2 led to the development of a tool that the forecasters would feel comfortable using and which would produce results they would consider accurate and reliable for forecasting Top-Dollar products (i.e., products generating the greatest yearly revenue);
- ◆ Phase 3 will involve the improvement of forecast performance with the goal of an

unprecedented gradual decrease in forecast error. This is accomplished by forecast analysis using built-in simulation ("What if?") capabilities; rules are modified, simulations run, metrics analyzed, and improvements are slowly incorporated into the system.

The Initial development was done on HP 9000 workstations running HP/UX (HP's implementation of Unix). The majority of the code was written in Informix's 4GL — a high level programming language that generates C code; C is the underlying language for the entire system, including the SQL standard relational database system.

The system's knowledge base was developed using Software A&E's KES development environment. Merlin contains two knowledge bases: a Standard knowledge base and a Simulation knowledge base, which are composed of approximately 80+ rules and 200 forward-chaining demons. Backward chaining also occurs, making production rules an integral part of the knowledge base structure. The Standard knowledge base holds the present working set of knowledge about analyzing and predicting a forecast. The Simulation knowledge base resembles the Standard knowledge base; however, it is here that new forecasting ideas are tested.

## FORECASTING

During the actual process of developing a forecast, Merlin obtains data from and passes data to DBs residing on HP minicomputers; it uses past order history data as well as product information supplied by forecasters to drive the expert system. The Standard knowledge base is used for this process and is cycled through twelve times — one cycle for each month — to develop an entire year's forecast. During any particular month, forecasters have the option of re-running the forecast as new information becomes available. Forecasters can also manually adjust a forecast giving them the final say.

The simulation function, provided by the Simulation knowledge base, gives forecasters the capability to run "What If?" experiments for analyzing and/or improving a forecast. Running a simulation encom-

passes several steps. First, demons and rules residing in the Simulation knowledge base are modified to test the effect on forecast accuracy. Then, a simulation is run over the past month or year of target cycle to generate simulated forecast results. Finally, forecast metrics are analyzed to compare the results of the Standard and Simulation knowledge bases. Should the Simulation knowledge base prove to forecast more accurately than the Standard knowledge base, it then becomes the operational model, and replaces the former.

Merlin is accessed through the user's 286/386 PC via HP's Starlan local area network (LAN). The interface resembles Lotus-like menus and drives four major functional areas:

- 1) Knowledge Base Functions — allows for modifications and structural analysis of knowledge bases;
- 2) Forecasting and Simulation Functions — for running forecasting and simulation scenarios;
- 3) DB Functions — for querying and updating DBs; and
- 4) Report Functions — runs forecast reports and metrics graphics.

Because the KB functionality is embedded (all source code eventually compiles to C object code), overall system performance is greatly enhanced.

From the beginning, HP analysts decided to limit the possible number of variables the system would use in developing a forecast. The products they wished to forecast helped in keeping the number of variables involved manageable.

Merlin analyzes data to forecast product demand for three product categories:

- 1) Low Dollar products;
- 2) Medium Dollar products; and
- 3) Top Dollar products.

HP, like all companies, is primarily interested in the Top dollar and Medium Dollar products — the ones that generate the most revenue. Therefore, these are the product categories designated to

receive the most attention, both human and automated.

However, in order to receive a realistic picture of the overall product demand, the Lower Dollar product category must still be forecast. This category, however, is traditionally comprised of a large amount of products (i.e., add-ons for systems, etc.). Consequently, this means that a huge amount of data must be compiled to accurately predict demand for these products, data that human forecasters simply do not have the time to acquire.

Merlin's developers decided to alleviate this problem by incorporating statistical algorithms to completely automate the forecasting of these Lower Dollar products, thereby allowing their predictions to be made without the assistance of a human forecaster. This enables forecasters to concentrate on the top dollar generating products by allowing them more time to incorporate relevant data and to experiment with different forecast scenarios. Erland Renslo, who developed the system along with co-worker Betty Harker, made clear HP's intentions for developing the system, stating that, "development of the system was undertaken not with the intention of replacing human forecasters, but to provide them with a powerful tool to help increase their forecasting accuracy."

#### REPORTS AND GRAPHICS

Merlin also generates various product reports and graphics for product groupings. These may be used for checking forecasting accuracy or for other management purposes. Graphics on forecast

metrics are generated by Splus, a statistical software package sold by Statistical Sciences. A user may access this program from the system's main menu. This function produces various metrics on forecast accuracy, which include percent error and forecast vs. actual for individual products, as well as average percent forecast errors for product groupings.

In addition, the grouped average forecast errors can be weighed by total units or by total revenue generated. Each graph can also display errors comparing the Standard knowledge base predictions vs. the Simulation knowledge base predictions.

#### BENEFITS REALIZED

Merlin became operational in February 1990. It is presently being used by HP's NCMO forecasters and planners, with about six direct users. The major benefit of the system thus far has been that the very last generation of forecasts closely resemble those produced by human forecast analysis. The system is now behaving much like the human experts. Eventually, increased forecast accuracy will lead to reductions in parts inventory, production holds, late shipments, and order cancellations.

Development of the system continues, and is currently in phase 3 of the implementation process. The system's knowledge bases continue to be updated to increase forecasting accuracy, with the main goal being to achieve an appreciable drop in forecast error rate over time. HP officials say that depending on the future effect on forecast error, the system could pay for itself in less than one year.

#### TRENDS AND NEWS BRIEFS

### IBM ANNOUNCES SUPPORT FOR AN OBJECT-ORIENTED AD/CYCLE/REPOSITORY

IBM announced that it intends to adapt its AD/Cycle/Repository architecture to an object-oriented programming environment and that it will provide more information about this in the first half of 1991.

Cliff Reeves, IBM's manager of Common User Access architecture at their Cary, North Carolina, lab, also announced that IBM will enhance its relational database systems to accommodate objects.

In addition, Reeves said that IBM would be using OOP extensively in its internal systems development efforts. For example, Reeves cited the fact that IBM had used Smalltalk during the development of its Officevision product. (IBM has recently signed licensing and development agreements with both Parcplace Systems and Digitalk, the two major vendors of Smalltalk. Reeves suggested that a first step in incorporating Smalltalk into AD/Cycle would be for IBM to designate Smalltalk as an SAA language, a move he predicted would occur in the first half of 1991. Beyond that,

IBM will extend the entity-relationship data model currently supported by the AD/Cycle Repository Manager to accommodate objects.

Reeves suggested that IBM is considering developing an object-oriented database, but that in the near term, it will focus its efforts on extending its relational databases to handle objects. (We will be doing an issue on relational and object-oriented databases in the Spring, and will consider the options that IBM and users face in some detail at that time.)

## INFERENCE CORP. ACQUIRES EXPERTECH TO GAIN A SIGNIFICANT EUROPEAN PRESENCE

Inference Corp. has announced the acquisition of Expertech Ltd., a British-based expert systems company. Expertech is a privately held six year-old company that is one of the top British expert systems companies.

Alex Jacobson, president and CEO of Inference, summed up the acquisition, saying: "the formation of Inference Europe, Ltd. is an important step in our plan to aggressively expand our position as a major player in the European expert systems marketplace."

Expertech markets two products: Xi Plus and Expertech Egeria. Xi Plus is a PC-based tool that has the look, feel and general capabilities of Texas Instrument's Personal Consultant Plus. Xi Plus is written in C. Egeria is an object-oriented programmer's tool that runs on workstations and mainframes.

In addition to its products, Expertech was an established consulting company with some 25 employees. Expertech was founded by several leaders in English AI and has an impressive client list, including companies like British Steel, British Telecom, British Airways, and Barclays Bank. In addition, Expertech has some 3,000 customers in England and throughout Europe.

Expertech will be renamed Inference Europe, Ltd. Inference Ltd and the U.S. parent company, Inference Corp. will both market Xi Plus and continue to support Xi Plus. The main thrust of the acquisition, however, is to provide Inference Corp. with a well established distribution system in Europe.

As we noted in the article on Expert Systems in Europe, the European market for expert systems products continues to heat up and the transition from PC and workstation products to mainframe products is just beginning. Thus, unlike in the U.S., where Inference is trying to catch up with the more established mainframe tool vendors, Aion and AICorp, Inference hopes to get in on the ground floor of the European mainframe tool vendors' market.

This seems like a very smart move and is just another sign that Inference Corp. is not only alive but intends to be a major player in the mainframe market.

For more information, contact: Inference Corp., 550 North Continental Blvd., El Segundo, CA 90245; (213) 322-0200.

## CARNEGIE GROUP AWARDED GRANT FOR PLANT MANAGEMENT INFORMATION MANAGEMENT SYSTEM

Carnegie Group has been awarded a \$119,000 grant from the Ben Franklin Technology Center of Western Pennsylvania for the research and development of a text-based management system (TBMS) for plant maintenance information.

The purpose of the proposed project will be to develop a generic Plant Maintenance Information System (PMIMS) that will make the storage, retrieval, and analysis of maintenance documents, such as technical manuals, etc., much easier for technicians and engineers.

The system will be based on Carnegie Group's text processing technology for automatically analyzing and indexing documents — the company is presently marketing the Text Categorization Shell (TCS) and has fielded several TBMS applications, including a news indexing system for Reuters and a message filtering system for the U.S. government. (For more on TCS see *ISS*, Vol. VI, No. 10.)

Alcoa Aluminum will also be a partner in the development of the system. Alcoa Labs has been working on a hypertext system for the company's Tennessee Operations North Plant since 1986. With 15,000 pages of the 40,000 page system completed, Alcoa officials have decided that the only way to reduce the cost of further development is to incorporate automated text processing capabilities.

Partnership with Alcoa will not only provide additional text-processing technology and experience, but also a Beta site for testing the proposed system's ability to handle actual plant maintenance information.

Separately, Carnegie Group has developed a diagnostic expert system that will be deployed by the U.S. Army in Saudi Arabia. PRIDE (Pulse Radar Intelligent Diagnostic System) is designed to help soldiers troubleshoot and recommend repairs for problems occurring in the radar of the HAWK surface-to-air missile (SAM) system. Present army diagnostic techniques consist of using support

manuals that require technicians to wade through hundreds of pages of documentation. PRIDE will provide air defense regiments with an expert system that integrates textual diagnostic information with digitized pictures and other graphics. Company officials say the system will considerably reduce the "down-time" of SAM batteries deployed in Operation Desert Shield.

For more information, contact: Carnegie Group, Inc., Five PPG Place, Pittsburgh, PA 15222; (412) 642-6900.

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# INTELLIGENT SOFTWARE STRATEGIES

FROM CUTTER INFORMATION CORP.

TM

THE MONTHLY NEWSLETTER ON EXPERT SYSTEMS, OOP, CASE, NEURAL NETWORKS & NATURAL LANGUAGE

Editor: Paul Harmon

## CONSTRAINTS

Constraints have been around for a long time. (Some theorists cite Ivan Southerland's 1963 SKETCHPAD program as the earliest constraint program. Macsyma, developed in the early 80s, is a much better-known constraint-based system.) They have been the subject of intensive research by AI, computer graphics, and operations research theorists. Sometimes called constraint satisfaction or constraint propagation, the use of constraints imply that programming is a declarative task.

A constraint system has a predefined set of relations that apply to a set of variables. Once the user provides information about the variables, the system

uses the predefined relations to infer things about the variables. These techniques, combined with an inference engine to apply the relational operators in an effort to attain a goal, provide a powerful declarative programming paradigm.

In operations research systems, constraints tend to be quantitative. They are based on algorithms, like the Simplex algorithm, that optimizes that value of some function, subject to some constraints. AI researchers, on the other hand, have focused mainly on inference-based systems that use symbolic constraints. Theorem provers, production rule interpreters, and labeling procedures like those found in truth maintenance systems are all good examples of AI efforts. (There were a number of papers on constraints presented at AAAI this year.)

Constraints are routinely used in expert systems that do configuration, planning, and scheduling, and they play a major role in intelligent CAD/CAM systems. In effect, rules combined with backward or forward chaining provide one way to implement constraint programming. Unfortunately, they constitute a relatively weak and inefficient implementation.

In the past six months, we've been thinking a lot more about constraints for two reasons. First, we attended an IBM internal symposium at which Mark Fox (a professor at Carnegie-Mellon University and a founder of Carnegie Group) gave a speculative talk in which he suggested that constraint propagation systems might eventually replace most expert system-building tools. (We followed up on Mark's talk by interviewing him at AAAI this summer, and several of his remarks are included in this article.)

## IN THIS ISSUE

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Constraint techniques have been widely used in expert systems, are the heart of intelligent CAD/CAM systems, and are increasingly being incorporated into languages. This article reviews the use of constraints . . . . . 1

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Following hard on Mark's remarks, we attended the Avignon '90 conference in May of this year and heard Alain Colmerauer, (a professor at the University of Marseille and the developer of Prolog) give the keynote talk on Prolog III, a new version of Prolog which is based on constraints rather than backward chaining. All of this made us think we should know more about constraints.

Among other things, Fox argued that "Throughout the 80s, the range of problems for which constraint-based approaches are appropriate has expanded very rapidly. We now see that truth maintenance, temporal reasoning, spacial reasoning, and problems like diagnosis, configuration, and scheduling can all be conceptualized as constraint labeling problems. In the near future, we will probably see a steady shift from the tools and languages of today to more rigorous constraint-based approaches."

## CONSTRAINTS IN EXPERT SYSTEMS

Let's begin with what we are most familiar with; the constraints that are routinely used in expert systems.

At the simplest level, rules are constraints. Consider the following rule:

IF the car's headlights will not light, AND the car's engine will not turn over (or crank),

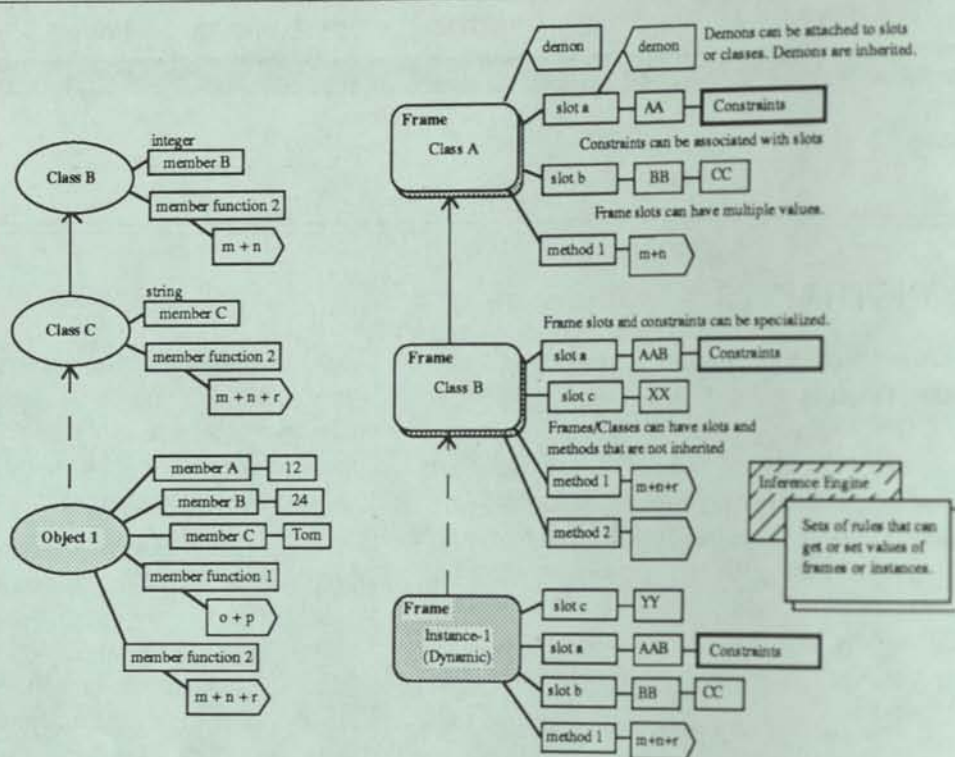


Figure 1 — The left hand diagram shows a C++ system. The right hand diagram shows a typical frame/object system found in most expert system tools. Notice that the expert system allows the developer to associate constraints with slots. (Modified Object Vision Diagram.)

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THEN the car's problem is an electrical problem.

The two If-clauses of the rule constrain the nature of the car's problem. If both constraints are satisfied (true), then we can reach a conclusion. Pattern matching rules with variables also apply constraints, though at a more abstract level. In a rule-based system we use a forward or backward chaining inference engine to move from rule to rule and to reach any conclusion we can.

In hybrid systems, constraints are also associated with the slots of frames or objects. (See Figure 1.) When the developer places limits on the values that the slot can take, he or she is in effect establishing constraints on the value the resulting instances can take. When rules are written that take their values from slot values, these slot constraints become rule constraints as well.

Conventional object-oriented systems (systems built in C++ or Smalltalk) do not support constraints on the values that can be associated with an object's attributes. (Indeed, in C++, class attributes can not take values at all; only instances can have values associated with their attributes, and the values taken by the instances are only constrained as to type. The only sense in which a C++ object can have constraints associated with it is if the variable was given a numerical type that allowed for the specification of a range of possible numbers.)

In the object or frame systems found in most expert system tools, each slot is, in reality, an object in its own right. In effect, the slot object has its own attributes and values. Thus, an attribute can have multiple values, default values, and specific constraints. Indeed, since most hybrid systems allow the developer to associate demons with slots, the developer can attach procedures or rules to constrain slot values. Using these techniques, you can establish demons to assure that a slot doesn't take a value if some other slot does, or does not, already have a value. You can also assure that if a slot takes a particular value, other slots will be given values consistent with the constraints established by the demons.

When hybrid systems use truth maintenance to modify a reasoning path when a subsequent error is encountered, constraints can become a very important and dynamic element of the system. Imagine an intelligent CAD/CAM system whose underlying knowledge about building apartment houses is maintained in an object-oriented network. If I tell the system that I want to place a 6-inch I-beam across a gap 20 feet wide, the system might interrupt and warn me that 6-inch I-beams can only be used for gap no wider than 18 feet. Accepting this constraint, I might then decide to use an 8-inch I-beam. My system accepts the 8-inch I-beam, but now it checks other values that have been assigned to see if they are still valid. Earlier, I had told the system that the uprights would be concrete blocks. Now, since I've switched to 8-inch I-beams, the system retracts my earlier decision, and informs me

that I will need reinforced concrete posts, etc. In effect, my knowledge base constitutes a model of the possible apartment buildings I could create. As I fill in some values, the system checks other values and insists that they take specific values or values within ranges specified by the constraints of the model that is implicit in the overall collection of objects, slots, demons, rules, and constraints.

In the development of configuration, planning, and scheduling systems, we often get more explicit about the functions of sets of rules. Many developers, for example, conceptualize planning and scheduling systems as "hypothesize and test" systems. In effect, there is a system objective and two sets of rules. One set of rules works to satisfy the system objective by generating a hypothesis — a schedule for the next week. The second set of rules works to test the schedule to be sure it doesn't violate any of the company's scheduling constraints captured in the test rules. In many cases demons and methods are used to generate solutions and slot constraints are used to limit the solution, even as it is being assembled.

Sophisticated systems sometimes add rules to relax constraints under certain circumstances. Thus, for example, there might be a special rule that would establish different constraints if there were only two shift supervisors available for a given period. These rules capture constraints on constraints. In addition, most expert systems trace consultations and provide justifications for why rules or consultations fail. If the system can't provide a specific recommendation, it can usually provide a human with information about the specific nature of the conflict that prevented the system from reaching a conclusion.

Given all of these uses of constraints within conventional expert system tools, why would anyone talk about using constraints rather than expert system tools? To answer this question, we will need to consider what some people mean when they talk about constraint-based systems.

## WHAT CONSTITUTES A CONSTRAINT SYSTEM

Technically speaking, a constraint system is a system in which variables are defined and constraints are placed on the values those variables can take. Once the initial data is provided to such a system, the system can apply rules for transforming the statements in the system to identify any possible outcome. Such a system can be defined as a pure declarative system. In other words, such a system can solve a problem by applying logic rather than using a procedural approach.

Consider what that means if you have a statement like:

$$a + b = c$$

Using a procedural (or imperative) language, processing moves in one direction. Thus, in a procedural language, I would not be able to get the value for  $c$  until I had first obtained the values for  $a$  and  $b$ .

In a declarative language, I don't really care which way I move. Given the equation, once I know any two of the terms, I can obtain the third term by applying the basic rules of algebra.

What would it mean to have a constraint language to solve algebra problems? It would mean that I would need to have a description of the types of things my system would manipulate, rules for manipulating the things, and some inferencing strategy for applying the rules. In the example above, I might declare that the things to be manipulated were integers, that one rule would be:

$$\text{IF } a + b = c, \text{ THEN } c - a = b.$$

Notice that in this case, my rules are very general rules of algebra that are true of all integers. I would also need an inference strategy to apply the rules. Obviously I could use a strategy like backward chaining or forward chaining, but they would not be very efficient in this case. Theorists in constraint languages talk about inferencing strategies like "local propagation," "relaxation," "graph transformation," and "augmented term rewriting." Just like expert systems developers, constraint theorists are

eager to keep the inference engine separate from the rules. In some cases, they are also concerned with using pattern matching strategies and truth maintenance techniques to increase the efficiency of their approaches.

Constraint satisfaction systems can be broadly divided into two classes: numerical constraint systems and logical constraint systems. (Using this analysis, most expert systems are a subset of logical constraint systems.) An excellent introduction to numerical constraint languages that explores the role of AI techniques in developing such languages is Wm Leler's *Constraint Programming Languages: Their Specification and Generation*.

Another way of talking of the different types of constraint systems is to talk about the domains they are designed to deal with. Some of the domains include: reals, integers, trees, booleans, and lists.

Numerical constraint systems have long been a concern of operations research people. AI people, on the other hand, have been primarily concerned with logical constraint systems, but during the 80s all that began to change. AI techniques are important to any constraint solving system. Moreover, as Fox remarked, a number of important AI problems are in the process of being redefined as constraint satisfaction problems. Obvious examples are expert systems that do configuration, planning, and scheduling. Other examples include truth maintenance, temporal reasoning, spacial reasoning, and natural language. In other words, the AI folks in robotics and natural language, as well as the expert systems theorists, are increasingly interested in the possibility that constraint-specific rules and inference engines might provide them with more effective ways to deal with the problems they face.

## LOGICAL CONSTRAINT PROGRAMMING LANGUAGES

Alain Colmerauer developed the first implementation of Prolog based on Alan Robinson's unification algorithm. The unification algorithm lies at the heart of Prolog and performs backward chaining. Prolog is a logical language; one makes statements

of fact and writes rules. Then one asks questions and Prolog, using unification, sorts through the facts and rules (constraint statements) to see if it can offer an answer. In effect, a Prolog application uses logical operators to arrange and rearrange the statements it has in order to search for one that completes the user's query. The problem with the existing version of Prolog (and Prolog II as well) is that more and more external procedures have been introduced, thereby diluting the descriptive core of Prolog. For example, a whole collection of procedures have been added to handle numerical processing.

Prolog III is Colmerauer's effort to significantly improve Prolog by introducing a more sophisticated approach to constraints that will eliminate the procedural elements that have crept into Prolog. In Colmerauer's words:

*In order to improve this state of affairs, we have fundamentally reshaped Prolog by integrating at the unification level: 1) a refined manipulation of trees, including infinite trees, together with a specific treatment of lists; 2) a complete treatment of two-valued Boolean algebra; 3) a treatment of the operations of addition, subtraction, multiplication by a constant, and of the relations  $>$ ,  $\geq$ ,  $<$ ,  $\leq$ ; 4) the general processing of the relation  $\neq$ . By doing so, we replace the very concept of unification by the concept of constraint solving in a chosen mathematical structure. (Colmerauer, 1990)*

In other words, Colmerauer has added specific constraint satisfaction systems to Prolog. Now, instead of having to use rules and unification to process a Prolog knowledge base, one applies various constraint systems to different aspects of the problem and uses backward chaining only when all else fails.

Jacques Cohen, in an excellent article on Constraint Logic Programming Languages, (Cohen, 1990) summarizes the four domains and the classes of operators used in Prolog III, as follows:

infinite trees Equal, not-equal.

rationals Systems of linear equalities, inequalities, and disequalities using the operations plus, minus, and multiplication.

booleans The basic boolean set-theory operators.  
lists Equalities and disequalities of lists. Concatenation, whose left operand is a list of known length. Transformation of lists into trees and vice versa.

Many people expect Prolog III to replace Prolog, just as C++ is replacing C. If this happens, the tool vendors will soon be writing expert system-building tools in Prolog III and offering their users more elegant and powerful approaches to problem-solving than do the current generation of Prolog tools. (A commercial version of Prolog III is currently being distributed by PrologIA.)

Another example of a constraint programming language is CPL(R) a language implemented by IBM at Yorktown. (See Jaffar, J & S Michaylov, 1987) In addition, other European and Japanese groups are currently working on the design of CLP languages.

Constraint systems have been written in both Lisp and Smalltalk.

### CONSTRAINT PROGRAMMING TOOLS

Just as one can develop an expert system using Lisp or Prolog or C, one can develop an expert system using a tool. The first and only general purpose constraint tool that we know of at the moment is Charme, a C/Unix/X-Windows tool sold by Bull. (A module written in Charme can be called by any other applications written in C.)

Charme is designed to solve discrete combinatorial problems. It is based on a proprietary constraint propagation mechanism which uses an original technique for equation solving from the domain of integer arithmetic. Bull has been positioning Charme as a domain-specific tool that is appropriately applied to constrained search problems, including task planning and resource allocation, space optimization, manpower management, and route optimization.

Renault uses Charme to generate experiment plans. RATP (French rapid transit authority) uses Charme to create bus route timetables, and Marriott uses Charme to assign catering units to aircraft on the

ground. (For more information, contact Bull, address in the European vendors table, p. 11.)

Design ++ is an Intelligent CAD/CAM Tool designed for engineers and architects. It is based on KEE and uses KEE object-oriented capabilities to represent its basic knowledge of the construction domain. In addition, it uses a constraint-based inference engine to assist designers in the development of diagrams.

When you consider that many expert system tools already use constraints, if constraint satisfaction systems and languages become hot buzzwords, it's easy to imagine that many vendors will be stressing the constraint capabilities of their tools. The key to classifying constraint tools and gaging their capabilities is to be clear about the type or types of variables the system can take, the nature of the constraints (e.g. the types of rules), and the inference strategy the system uses to explore what is implicit in the variables.

#### WHAT KIND OF AN IMPACT AND WHEN?

We asked Mark Fox what kind of impact he expected and when he would expect it. Fox suggested that we should begin to see the first tools in 3 or 4 years, and powerful constraint tools would begin to replace today's expert system tools a little later. We mentioned Charme, and Fox said he was pleasantly surprised that Bull was already beginning to commercialize a constraint tool.

We asked Fox why constraint tools would replace the current tools and what role, if any, would be left for the current generation of tools. He responded that constraint propagation was more elegant, more efficient, and ultimately more automatic. Backward and forward chaining rule-based systems represent a kind of first-generation constraint system. The constraint tools of the future will be developed on a more principled basis, he claimed, and they will eventually replace existing tools for all the structured problems for which the latter are currently being used (e.g. scheduling, configuration). The domains that will be left for the current tools will be the really ill-structured problems; problems for which we can't identify constraints.

An additional consideration is that constraint systems may be easier to run on parallel processing hardware, a feature that will become more important as parallel systems begin to become more common in the late 90s.

When you consider that current object-oriented languages and tools don't provide constraint capabilities, this suggests that constraints are going to have an even bigger impact on the thinking of OO theorists than on the expert systems people who at least provide some constraint techniques in their current object systems.

In coming issues of *ISS* we will begin to analyze constraint-based tools in more detail and develop a classification system for the constraint tools that we expect to see in the 90s.

#### CONTACTS AND ARTICLES

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PrologIA (Prolog III), Luminy - Case 919, 13288 Marseille Cedex 09, France; (33) 9126 8636, Fax: (33) 9141 9637.

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Wm Leler, *Constraint Programming Languages: Their Specification and Generation*. Addison-Wesley, Reading, MA, U.S., 1988. A good technical introduction to numerical (non-Logic) approaches to

developing standalone constraint programming languages.

Vasant Dhar and Nicky Ranganathan, "Integer Programming vs. Expert Systems: An Experimental Comparison" in *Communications of the ACM*, vol. 33, no. 3, March 1990. This is a good article that discusses how an expert system compares with an integer programming formulation in determine college course schedules. The work was done with MCC's PROTEUS.

Steven Minton, Mark D. Johnson, Andrew B. Philips, and Philip Laird, "Solving Large-Scale Constraint Satisfaction and Scheduling Problems Using a Heuristic Repair Method" in *Proceedings: Eighth National Conference on AI (AAAI-90)*, vol. 1, pp. 17-24. This paper reports the derivation of a heuristic from a neural network that scheduled the use of the Hubble Space Telescope.

## WHAT'S HAPPENING IN EUROPE: PART II

In the last issue of *ISS* we began a general review of expert systems in Europe. This article is the second and final part of that review. In the last issue we considered hardware, languages, and PC and workstation tools. We continue with our discussion by considering the status of mainframe tools in Europe.

### MAINFRAME TOOLS

All the U.S. mainframe tool vendors: Aion, AICorp, IBM, and Inference are very active in Europe (see Trends for a note on Inference's latest move to gain a better distribution channel in Europe). The market hasn't really taken off yet and the vendors are primarily working to position themselves and develop distribution systems.

The one European vendor that seems prepared to make a major move in the mainframe area is Software AG, a large German software vendor who is mainly known for its CASE and 4th Generation software packages. At the moment, Software AG is actively expanding its Natural 4GL product to incorporate expert systems technology.

The Software AG approach is very ambitious. The company is embedding an inference system within its existing products that can be called from any Natural application. Its knowledge representation system includes both objects and rules. The company is, in effect, developing its own strongly typed functional language. (It's as if Software AG is reinventing Lisp from the perspec-

tive of a C programmer.) The current version of Natural Expert already represents four years of work. Natural Expert is currently being enhanced to improve its inheritance and its ability to incorporate procedures in objects. As you would expect from a 4 GL company, Natural Expert runs on IBM mainframes in all of the major operating systems and relates to the various mainframe databases. It is not yet on PCs, but should soon be on OS/2 machines. The company expects to get Natural Expert on DEC and Unix machines during 1991. An MVS version of Natural Expert starts at around \$120,000. Given Software AG's background, Natural Expert might compete with IBI's Level5 Object, but it seems just as likely that we'll see it competing with TIRS, Aion, and KBMS.

### DOMAIN SPECIFIC TOOLS

There are a number of interesting European domain/problem specific tools.

Framentec was originally established with help from Teknowledge, one of the first U.S. expert systems companies. In the course of time Framentec has sold French versions of S.1, M.1, and Copernicus. At the moment, however, the company is placing most of its emphasis on Maintex, a DOS-based, problem-specific tool designed to create diagnostic systems. Framentec has systematically tailored Maintex for a variety of specialized applications ranging from process control diagnosis to hardware maintenance problem-solving.

Charme is a problem-specific tool developed by Bull. Charme is specialized to handle constrained search problems in domains like manufacturing, transportation, telecommunications, and defense. In other words, Charme is a constraint propagation tool designed to tackle problems like inventory management, production chain optimization, and task planning and allocation of resources. Charme is written in C and runs on Bull Unix machines using X-Windows.

Two other interesting problem-specific tools that are sold in the UK but have yet to show up in the U.S. in significant numbers are Intelligent Applications Ltd.'s Synergist, a system that provides fault diagnosis and automatic test procedures for board-level circuits, and Sira Ltd.'s Genesis, a tool specialized for shop-floor planning and scheduling of continuous or semi-continuous processes.

In addition to the European domain/problem-specific tools, there are several U.S. vendors that are doing very well in Europe. Foremost, probably, is Gensym, that sells G2, a tool tailored for real-time process control applications. Gensym opened an office in Munich, Germany in May of this year, and had a large and very popular booth at Avignon.

#### KNOWLEDGE ACQUISITION TOOLS AND METHODOLOGIES

The best known methodology in Europe is Boolesian's Structured Knowledge Engineering (SKE). This methodology is derived from work resulting from an ESPRIT project centered at the University of Amsterdam, whose methodology is called KADS. Both KADS and SKE are widely regarded as a little too academic, but they have both received a lot of attention anyway, because they provide a systematic approach to knowledge engineering. KADS and SKE are both based on the idea that you begin by breaking the overall problem into specific problems, like diagnosis, monitoring, and scheduling, and then proceed to follow a well-defined, step-by-step approach appropriate to each specific problem type.

Boolesian was at AAAI this year and has been offering courses in the U.S. (Boolesian has recently agreed to support Aion's ADS in Europe and will be offering Aion's new Aion Development Methodology course, in addition to their own course in Europe.)

We saw two very interesting tools designed to facilitate knowledge engineering at Avignon this year. One was Cap Gemini's knowledge acquisition product called Shelley, which is designed to automate the KADS methodology. IBM has been working with Cap Gemini to refine Shelley. Although the tool wasn't finished as of May 1990, it was a very interesting first cut at automating knowledge acquisition. Shelley is written in Prolog and runs on a Sun workstation.

The second tool that captured our interest at Avignon was KOD (Knowledge-Oriented Design), a workstation tool designed to automate a theory of knowledge acquisition derived from anthropology and linguistics. The theory underlying KOD was developed by Claude Vogel, a researcher at CISI Ingenierie, a major French software consulting firm. The actual implementation of the KOD methodology was carried out by ILOG, a leading French AI firm that sells Le-Lisp (the most popular Lisp in France because it is very compact) and a hybrid tool called Aida. KOD is written in Lisp. The two companies intend to work together to develop and market the product. The manual version of the KOD methodology is currently being used in some 50 sites. The automated version of the methodology (KOD) sells for approximately \$10,000. (We plan to do a detailed review of these two methodology tools in the spring of 1991.)

One interesting thing about both of these tools, each offered by a major French software/consulting company, is that they are written and documented in English. In each case I asked if they had done that in order to sell the tools in the U.S. In both cases, they insisted that it had been done in order to make it easier to sell them throughout Europe. This is a significant effect of European companies' preparing for a united Europe in 1992. No matter what the developers intended when they created the inter-



face and the documentation in English, the result is that these tools can be sold in the U.S. The French have created many very interesting expert system products that are being sold in the U.S. without most Americans being aware of it, because they are being sold by U.S. companies that have translated and repackaged the products. In the near future, we may see a lot more French software companies marketing their products themselves in the U.S.

A separate knowledge engineering effort is being developed by Marc Eisenstadt and his associates at The Human Cognition Research Lab at The Open University in England. The Open University has developed a tool called MIKE (Micro Interpreter for Knowledge Engineering) which is written in Prolog and runs on an IBM PC. MIKE is sold with an Open University course: Knowledge Engineering (PD624) which includes video and audio cassettes and a workbook. The examples in the course are drawn mostly from medicine. The course itself is a little academic and is focused on logic, but it is thorough and systematic and covers all of the common knowledge acquisition techniques, including grids, interviews, verbal protocols, and so forth. Unlike the KADS/Boolesian, and other problem-based approaches, however, this course lacks a systematic analysis of the problem types involved in expert systems and detailed advice on how to approach each of the different problem types.

Still, the combination of MIKE, a very nice hybrid tool that serves as a good introduction to developing rule and frame-based systems, and the course materials, which are a nice introduction to all of the basic knowledge engineering techniques, together provide quite an attractive training package. (The course and tool, including source code and Edinburgh-syntax Prolog interpreter cost £450, plus tax.)

#### **APPLICATIONS, CONSULTANTS, AND GOVERNMENT ENCOURAGEMENT**

A number of interesting applications have been developed (using both European and U.S. expert system building tools). Some of the applications that were presented at this year's Avignon expert

systems conference and caught our attention are described briefly, below. Several are presently being sold as end-user systems or are being considered for marketing.

Infosys is marketing an expert system for relational database design. SECSI is intended for automating the different steps involved in database design: constraint acquisition; data modeling, and acquisition. The system derives a normalized database schema from an informal description of the application, which is expressed using either Natural Language (in simple French or English sentences), or in graphical form.

Lysia Ltd., a London-based specialized management consulting firm, is selling a number of financial advisory applications. The Business Strategy Review (BSR) for Financial Institutions and the BSR for Manufacturing Institutions, are intended for developing high-level strategic reviews of a firm's operations. The systems pose a comprehensive range of questions into all areas likely to affect the health of a financial or manufacturing institution. Strategic Market Planner (SmartPlan) provides a dynamic framework with which a business manager can develop and review a business marketing plan. Other advisory systems being marketed include: Mergers and Acquisition Model (MAC), The Marketing Audit, and the Product Portfolio Audit Manager (PPAM).

MARS is a second generation expert system for creating restoration plans after a failure on a power transmission network. The system was developed in a joint project by Laboratories de Marcoussis and Electricite de France. Organized around a blackboard, the system integrates multiple planning knowledge sources containing restoration expertise, a qualitative model to predict the results and potential dangers of a restoration plan, and a quantitative model to verify the correctness of the plan. MARS was developed using SPOKE on DEC and Sun workstations.

Ramses is an application for international banking message analysis and routing, developed by

Odys'sia for the Caisse Nationale de Credit Agricole. Ramses, developed using VAXOPS5 (DEC), analyzes the unbroken stream of messages which are not routed by automated channels. The system uses syntactic as well as semantic analysis methods to determine the name and financial partners of an incoming wire transaction. Ramses has been operating since June 1989. It is being proposed as an off-the-shelf, on-line system intended for operations where message understanding problems are encountered.

Ship Planner R is an application billed as a design support tool for creating loading plans for containerized cargo ships. Systemia presented "the shipping company-oriented expert system" at the Avignon '90 expert systems conference.

There are also a number of European development efforts being sponsored by various governmental agencies. The ESPRIT project, set up several years ago to encourage advanced technology projects by industry-university groups, is still active and has funded a number of interesting projects that are helping to drive innovation in Europe.

One interesting government-sponsored project was announced at Avignon this year. The French government provided a grant to Bull to develop an expert system to handle the security at the 1992 Olympic games. It is their hope that the system will incorporate security heuristics of a sufficiently generic nature that the system can be sold to subsequent Olympic sites and, in effect, become a growing repository of knowledge about the special problems involved in managing Olympic security problems.

### OBJECT-ORIENTED PRODUCTS

We have not focused this article on object-oriented products, although all of the hybrid tools we have mentioned have include object-oriented technology, and we did briefly mention SPOKE, an OO programming language/environment.

Another OO product that caught our eye at Avignon this year was O2, an object-oriented database. O2 is being developed by Altair, a consortium

funded by IN2Groupe Siemens, Bull SA, INRIA (the French National Institute of Research in Computers and Control), and LRI (the Computer Science Lab at the University of Paris XI, Orsay). The consortium was created in 1986 and has just begun Beta tests of O2. O2 is intended to be both a OODB and a language for developing applications and managing the database. It's a little early to tell, but on the surface, O2 looks to be on a par with the OODB products that were being shown at OOPSLA this year, which confirms our overall impression that Europe is very interested in OOP technology and is only slightly behind the U.S. in bringing OO products to market. As in the U.S., we expect that the expert systems vendors of Europe will play a major role in creating the commercial OO products that will actually be used by business and industry.

In 1991 we will make a serious effort to survey European object-oriented technology efforts and describe their best products.

### SHOWS AND CONFERENCES

In 1991, as in the past several years, the commercially-oriented conference to attend in Europe will be Avignon '91 held in Avignon, France. This year the conference will be held from May 27 to 31. All the major U.S. and European vendors will be exhibiting and there will be specialized conferences on defense, telecommunication, transportation, materials, and electrical engineering. In 1989 there were 2,800 attendees, in 1990 there were over 3,000. If we are right and the sale of mainframe tools invigorates the European market in 1991, the show should be bigger than ever, so make your reservations early if you plan to attend. For more information, contact EC2 at 269 rue de la Garenne, 92024 Nanterre Cedex, France; 331 4780 7000; Fax: 331 4780 6629. (EC2 also sponsors a major show on Neural Networks in Nimes in November and a conference on CASE and other software tools at Toulouse in December.)

### SUMMARY

The U.S. tool vendors are playing a major role in the European expert systems market, but in the

meantime, a number of European vendors are getting their act together.

There are already a number of European AI products being sold in the U.S. Bull is offering the first version of a constraint tool, Charme, that may

set a trend for U.S. vendors in the coming years (see the article on Constraints) and several of the domain-specific tools currently being sold in Europe could appear in the U.S. in the near future.

### Some Important European Vendors

We are sure our list is incomplete. The European market is so divided that it's very hard to get an overview of which vendors are important outside the major countries. This list does not include U.S. vendors who are active in Europe.

**Alcatel-ISR (SPOKE)**, 34 cours Blaise Pascal, 91025 Evry Cedex, France; (33) 1 6078 2327, Fax: (33) 1 6497 1885.

**Altair (O2)**, BP 105, 78153 Le Chesnay Cedex, France; (33) 1 3963 5417, Fax: (33) 1 3963 5890.

**Bolesian (SKE)**, Steenovenweg 19, 5708 HN Helmond, The Netherlands; (31) 04920 23455, Fax: (31) 04920 33985.

**Bull (KOOL, Charme)**, AI Commercial Contact: Armel Durand; (33) 1 3902 5832, Fax: (33) 1 3902 4795.

**Cap Gemini Innovation (Shelley)**, 118, rue de Tocqueville, 75017 Paris, France; (33) 1 4054 6626, Fax: (33) 1 4267 4139.

**Creative Logic Ltd. (Leonardo)**, Brunel Science Park, Kingston Lane, Uxbridge, Middlesex UB8 3PQ, UK; (44) 0895 74468, Fax: (44) 0895 70244.

**Elsa Software (LAP)**, La Grange Dame Rose, 6 avenue du Marechal Juin, 92366 Meudon la Foret Cedex, France; (33) 1 4630 2455, Fax: (33) 1 4630 5526.

**Epitex (Epitool)**, St. Larsgatan 12, S-582 24 Linkoping, Sweden; (46) 1311 4075.

**Expertech (Xi Plus)**, (Now owned by Inference Corp and renamed Inference Europe Ltd.), Expertech House, 163, Bestobell Road, Slough, Berkshire, SL1 4TY, UK; (44) 753 696321, Fax: (44) 753 696734.

**Framentec (Maintex)**, Tour Fiat, Cedex 16, 92084 Paris La Defense, France; (33) 1 4796 4600, Fax: (33) 1 4796 4601.

**GSI-ERLI (Intelligent Service II)**, Place des Marseillais, 141, rue de Paris, 94220 Charenton, France; (33) 1 4893 8121, Fax: (33) 1 4375 7979.

**ILOG (Le Lisp, KOD)**, 2, avenue Gallieni, BP 85, 94253 Gentilly Cedex, France; (33) 1 4663 6666, Fax: (33) 1 4663 1582.

**Infosys (SECSI)**, 15, rue Anatole France, 92800 Puteaux, France; (33) 1 4778 8535, Fax: (33) 1 4776 4982.

**Intelligent Applications Ltd. (Synergist)**, Kirkton Business Centre,

Livingston Village, EH54 7AY, Scotland; (44) 0506 410242.

**Intelligent Environments Ltd. (Crystal)**, Northumberland House 15-19, Petersham Road, Richmond, Surrey TW10 6TP, England; (44) 01 940 6333.

**Intellisoft (Procyon Common Lisp)**, 28, rue Georges Clemenceau, 91400 Orsay, France; (33) 1 6941 2777.

**Laboratoires de Marcoussis**, Division Informatique, Route de Nozay, 91460 Marcoussis, France; (33) 1 6449 1000, Fax: (33) 1 6449 0694.

**Logic Programming Associates Ltd. (FLEX)**, Studio 4, RVPB, Trinity Road, London, SW18 3SX, UK; (44) 01 871 2016, Fax: (44) 01 874 0449.

**Lysia Ltd. (BSR/FI/MI, SmartPlan)**, Crown House, 2 Crown Dale, London, SE 19 3NQ, UK; (44) 1670 7163, Fax: (44) 1670 4541.

**Mind Soft (Instant Expert Plus)**, 3, rue de l'Arrivee, B.P. 63 - 75749, Paris Cedex 15, France;

(33) 1 45 38 70 12, Fax: (33) 1 45 38 68 73.

**Odyss'ia (Ramses)**, 2 bis, rue Marcel Doret, 31700 Blagnac, France; (33) 6130 0609, Fax: (33) 6130 0045.

**Open University (MIKE and Knowledge Engineering)**, Human Cognition Research Lab, Milton Keynes MK7 6AA, England; (44) 0908 65 3149, Fax: (44) (0908) 65 3744.

**Sira Ltd. (Genesis)**, South Hill, Chislehurst, Kent BR7 5EH, UK; (44) 01 467 2636, Fax: (44) 01 467 6515.

**Software AG (Natural Expert, Natural)**, Uhlandstrasse 12, 6100 Darmstadt, FRG; (49) 061 51/92-1457, Fax: (49) 061 51/92-1191.

**Systemia (Ship Planner R)**, Domaine de St. Hillaire - Pichaury, 13290 Aix Les Milles, France; (33) 4224 2484, Fax: (33) 4224 3799.

**Telecomputing (TOP-ONE)**, 244 Barn's Road, Oxford, UK; (44) 8657 77755.

We expect that mainframe tools will play a major role in the European market in 1991-92 and precipitate a shakeout of some of the smaller vendors, as happened in the U.S. in 1987-89. On the other hand, the European market seems better balanced than the U.S. market. The European emphasis on

knowledge acquisition and larger systems delivered on workstations, domain specific tools and applications, as well as mainframe and PC systems, may make for a smoother transition in Europe and may position them to play a leading role in the next round of knowledge-based systems development.

## WHAT'S HAPPENING WITH NATURAL LANGUAGE

The market for natural language products began earlier than the expert systems market (AICorp's Intellect was introduced in 1981, two years before the first expert system tool was introduced) but it has yet to take off. At this year's AAAI convention in Boston, only two natural language vendors chose to demonstrate their products — AI Corp. and Synchronetics, Inc. Although a real need does exist for simplifying the use of computers by employing natural language (NL) commands for such tasks as accessing information stored in databases (in both textual and standard format), many companies still seem somewhat reluctant to fully embrace NL technology.

This is not an attempt to provide an overview on the theory and use of NL, but rather to discuss what some of the natural language companies are doing. (For a good overview on NL theory and development see *ESS* vol. 5, no. 4, April 1989.)

The use of NL front-ends for databases is "The" application area that has received the most attention from the NL vendors. AI Corp. has been marketing its product, Intellect, since 1981, and to date, claims to have on the order of 600 installed sites worldwide. Intellect is an English-to-SQL database front-end for IBM mainframe environments operating under MVS/XA, MVS, and VM. It provides English language query capabilities for such database management systems (DBMS) as DB2, SQL/DS, Focus, Adabas, VSAM, IMS, IDMS, DBC/1012 (Teradata), KDB (AICorp), and Sequential.

Intellect, like most English-to-SQL DB interfaces, accesses DBMS data by generating the proper data manipulation language from a user's typed-in English request. In the case of relational DBs, Intellect can serve as automatic SQL gener-

ator, creating optimized SQL statements from the user's English requests. For non-relational DBMS, it generates direct database calls.

The Intellect package includes an application development tool called the Automatic Data Definition (ADD) feature. This feature is intended to speed system development by creating an initial Intellect dictionary by reading the DBMS catalog, schema, or dictionary, and adding the DBMS information to Intellect's basic dictionary of English words and grammatical rules. Information incorporated from the DBMS catalog or schema includes: DBMS file names, field names, and any aliases supported by the DBMS; data type and indexing information; and DBMS-specific parameters for files and fields. In addition, the ADD feature is also used to update existing Intellect dictionaries as new fields or files are added to the database. The system is optimized to utilize the performance advantages of the DBMS. For example, large volume record passing is handled by the DBMS, whenever possible, to enhance efficiency.

The Mutual Benefit Life Insurance Company of Newark, New Jersey, U.S., has made extensive use of Intellect. The company has fielded nearly 20 different applications, allowing a total of 150 employees across all departments to access multiple MVS files using Intellect's NL capabilities via 3270 terminals or PCs connected to an IBM 3090 mainframe. The largest, known as the Adjustable Life Insurance application, was established in 1986. It contains a history file of all adjustable life insurance policies ever issued by company agents. The system is used by the underwriting, policy service, actuarial, and sales areas to access information

for analyzing policy popularity by geographic region and buyer demographics. This information is then used for targeting projected markets. In addition, the system is also used to speed the policy underwriting process. English language query capabilities allow users to spend much less time retrieving relevant information, such as medical requirements for policy issuance, etc., from company DBs.

Intellect can be purchased as an end-user system, but since AI Corp. introduced its KBMS expert systems tool, (which bundles Intellect together with KBMS), the Intellect/KBMS package has accounted for the majority of Intellect sales.

Intellect is written in C. A single copy for VM and MVS environments starts at \$65,000.

For more information, contact: AICorp., Inc., 138 Technology Drive, Waltham, MA 02154, U.S.; (617) 890-8400.

Natural Language, Inc. (NLI) is also marketing an English-to-SQL database front-end. The company has just released the latest version of its flagship product, Natural Language (version 4.0), a tool to allow users to access and analyze data residing in relational database systems (RDBMS) using English commands. The system has a knowledge base of over 11,000 English language concepts and root words which allow it to "intelligently" resolve the ambiguities found in English sentence structures.

The latest version has several new features, including a new window-based development tool (ICon) that helps decrease development time, an application programming interface for integrating Natural Language with other interface tools, and report writing capabilities.

Natural Language operates on DEC workstations running VMS and Ultrix, Unix workstations, and 386-class machines running Xenix. It works with all the major RDBMS, including Oracle, Sybase, Ingres, Rdb, Informix, and Sharebase.

Intelligent Connector (ICon) is the window-based graphical development tool for building and

debugging Natural Language applications. ICon helps IS managers and database administrators map the semantics and structure of a specific DB. It helps automate the customization process by guiding the developer through a series of windows and menus using inherent knowledge about a particular DB application; ICon automatically reads in and incorporates the database schema in Natural Language. It then uses four main windows to guide the user to describe relations, attributes, mapping, and other information about the database. Paul Ricci, VP of marketing at NLI, said that, "initial customer feedback has shown that ICon helps improve development time by over 50% percent." ICon runs in an X Windows environment and is compatible with Motif, Open Look, and DECwindows.

Natural Language first became commercially available in 1988 and is currently installed in over 100 sites. Cypress Semiconductor of San Jose, CA, is using Natural Language to support its management and sales force in analyzing manufacturing and shipping information maintained in the company's database. Cypress's database resides on Sun workstations and may have up to 150 users at any one time seeking to access information. Previously, managers relied on MIS reports, which often took up to two months to generate. Few of the users were proficient in SQL nor had the time to learn it. Now, sales managers and executives can retrieve information regarding sales and inventory, etc., almost immediately.

Some examples of typical user queries include: "What were our sales, broken down by product, for FY 1989?" and "How many dollars of backlogged orders did I have on July 15, 1989?" The initial application took four months to develop. This included integrating Natural Language within Cypress's database, which contains on the order of 50,000 records. Representatives at NLI say that Cypress has plans to deploy Natural Language at their other domestic and international operations as well.

NLI has targeted the government sector and companies involved in the financial services, telecommunications, manufacturing, and pharmaceutical/medical research areas. The company's primary

marketing strategy has been to sell the product directly to customers as a standalone system. NLI has, however, entered into significant marketing agreements with the major RDBMS companies, including Oracle, Sybase, Ingres, Informix, and Sharebase. NLI products are also being jointly marketed by Sun Microsystems, IBM, DEC, HP, and Sequent Computer. Intergraph Corp. has bundled the Natural Language interface with their Unix-based CLIPPER engineering workstation. In addition, NLI has just announced that Microsoft Corp. has invested \$1 million in the company, bringing its total ownership to over 10%. Both companies say they are working on integrating NL technology into future versions of Microsoft's products.

Natural Language 4.0 is written in C. It is priced from \$5,000 to \$93,000, depending on platform and CPU size. For more information, contact: Natural Language, Inc., 2910 Seventh St., Berkeley, CA 94710, U.S.; (415) 841-3628.

Synchronetics, Inc. has taken another approach to developing and marketing its NL products. While AI Corp. and Natural Language Inc. are primarily focusing on developing and marketing English to SQL database interfaces, Synchronetics is concentrating on selling a development environment which is aimed at AI developers. The company's main product, NL builder, was introduced last July at AAAI in Boston. It is primarily intended for the rapid prototyping of embeddable NL applications without the need to write extensive programs.

Synchronetics specializes in NL text processing and NL interfaces, particularly used in conjunction with voice input systems. Company representatives define NL Builder as an NL processing shell (NLP), that is intended to allow users to construct NLP applications for human/computer interfaces, text processing and translation, message understanding, and higher education laboratory work. It is written in C and is fully embeddable in other DP environments.

The system features modules for tokenization, morphological analysis, dictionary construction and maintenance, integrated syntactic processing and

semantic interpretation, domain world model rule base, English-to-SQL mapping, and the ability to interface with advanced algorithms written in HOL by the user. It operates on Sun workstations, DecVAX, Apollo, Macintosh, and IBM PC computers. A version for the Next machine is currently being developed.

Edwin Addison, from Synchronetics, said that the use of NL Builder in developing NL applications "saves developers [from writing] somewhere on the order of 40,000 lines of code, and in addition, adds a high-level language to provide a support environment."

Synchronetics currently has about 18 - 20 sites using NL Builder, including the following:

- ◆ Prospective Computer Analysts, a Virginia-based company, has used NL Builder to develop a knowledge acquisition system for NASA. The system allows users to acquire rules for expert systems by NL query. NL Builder is being used as a component of that demonstration system for NASA.
- ◆ University of Maryland, Baltimore county, is using NL Builder as one component of a series of modules in a system that does automatic linear-to-hypertext conversion.
- ◆ A major corporation has combined NL Builder with a voice input system to allow users to enter spreadsheet information orally. The application was developed by integrating NL Builder and a speech board.
- ◆ John Hopkins University is using NL Builder for graduate course work in the university's NL processing lab.

In addition, Synchronetics has demonstrated the use of NL Builder as an English-to-SQL database front-end in an application developed under contract with the U.S. Air Force. Synchronetics is also developing a NL text processing system for document retrieval, known as Text SR. Text SR differs from conventional document retrieval systems in that the user can make a search request completely in

English. This is an end-user product intended for embedding in other data processing environments (for text retrieval and document processing). Mr. Addison said that another benefit of the system, in addition to the NL query capability, is that it "indexes into text based on the concepts or the word senses, rather than the words themselves, thus achieving higher precision and recall." He adds that the system "is also very portable across applications and platforms."

Mr. Addison explained that the reason Synchronetics decided to enter the NL text retrieval market, instead of the NL DB interface area, is that they believe there is a bigger demand and need to access textual information and also because text retrieval is more possible. "What many universities have tried to do with full text retrieval," he said, "is full parsing of sentences and free-running text, which really isn't possible. What Synchronetics is doing is parsing into phrase units and using statistical techniques. The coupling of the statistics to clarify the sense of words in the phrase parsing provides higher precision of recall."

Text SR is still in development and is entering the testing phase. The company is currently seeking additional beta test sites.

Synchronetics markets its products almost entirely through OEMs and value-added resellers.

For more information, contact: Synchronetics, Inc., 3700 Koppers St., Suite 131, Baltimore, MD 21227, U.S.; (301) 644-2400.

The NL market will probably continue to develop at a steady, although somewhat slow pace. Like the expert systems companies, success for NL vendors will depend on their ability to package or offer their products for embedding within other DP systems, not on their ability to sell stand-alone products. Obviously this process has begun: All the companies mentioned are either packaging their products with other systems they are offering, or they are licensing their technology to other hardware and software vendors for embedding within their own products.

In the future, we may begin to see some limited NL capabilities embedded within PC software. This will largely be in the form of transparent interfaces that will be so subtle the user won't even know they are being used. Good bets include augmentation of hypertext systems and friendly interfaces for entering data in to spreadsheets. The NL market may not have taken off yet, but the technology is definitely improving and the vendors are looking around for ways to package the technology. As more powerful PCs and workstations become the norm in the 90s, this segment of the AI market will undoubtedly begin to receive more attention.

## TRENDS AND NEWS BRIEFS

### Computer Aided Engineering Tool Integrated with Object-Oriented Database Management System

Wisdom Systems, Inc. introduced its latest version of The Concept Modeller, integrated with the Itasca OODBMS, at the November AutoFact trade show in Detroit, Michigan, U.S. The Concept Modeller is a multi-user, Unix-based Computer Aided Engineering (CAE) tool. It is intended to automate the design building process by allowing engineers to incorporate design rules into the system itself. In addition, the system promotes concurrent engineering by allowing several engineers to work on designs-

in-progress simultaneously. Itasca is a distributed, multi-server OODBMS being marketed by Itasca Systems, Inc. It is based on the Orion prototype OODBMS developed at MCC laboratories and features the ability to use persistent objects — reusable modules of data code.

The new system is being touted as an engineering design tool particularly well suited for design applications in the automotive, aerospace, process, and mechanical engineering areas. Company

representatives say that integration of the two systems will provide users working on networked work stations with the ability to access and manipulate data stored as objects.

Wisdom Systems is the first value-added reseller to license Itasca's OODB technology. For more information, contact: Itasca Systems, Inc., 19 Queens Terrace, Holliston, MA 01746, U.S.; (508) 429-3862.

## John McCarthy Wins Presidential Science Medal

Each year the President of the U.S. awards medals for outstanding contributions to science and technology. This year Professor John McCarthy of Stanford University (a past-president of AAAI and a member of the Board of Directors of Inference Corp.) was among the winners. Dr. McCarthy was

awarded his medal for, among other things: creating Lisp, developing multi-tasking computing environments, advancing the state-of-the-art in common sense reasoning, and dreaming up the name "artificial intelligence."

## CALENDAR

The following announcements have been received since we mailed our last events calendar.

### EXPERT SYSTEMS

#### INTERNATIONAL 1991

May 31-June 2. **PEG '91, Knowledge Based Environments for Teaching & Learning**, Rapallo (Genova), Italy. Agenda will include presentations on: Intelligent Tutoring, Hypermedia, Learning and Cognition, among others. Contact: PEG 91, Organizing Secretariat, c/o Consorzio Genova Ricerche Badia Sant'Andrea, Via dell'Acciaio 139, 16152 Genova, Italy; (39) 10 6514000; Fax: (39) 10 603801.

June 11-13. **Software Tools '91**, Wembley Exhibition Center, London. Exhibits/presentations will include "From 4 GLs to Expert Systems" and PC Software Development Tools. Sponsors include: *Exe* magazine, *Software Management* magazine, and the AI Applications Institute. Contact: Blenheim Online Ltd., Blenheim House, Ash Hill Drive, Pinner, Middlesex HA5 2AE, UK; (44) 081 868-4466; Fax: (44) 081 868-9933.

July 2-4. **Applications of AI in Engineering (AIENG '91)**, University of Oxford, UK. Organized by the Computational Mechanics Inst., Wessex Inst. of Technology, Southampton, UK. Contact: Jean Croucher, Conference Secretariat, Comp. Mech. Inst. of Tech., Wessex Inst. Tech., Ashurst Lodge, Ashurst Southampton, SO4 2AA, UK.; (44) 703 293223; Fax: (44) 703 292853.

#### OOPS 1991

#### NORTH AMERICA

July 29-Aug 1. **Tools U.S. '91**, Santa Barbara, CA, U.S. Contact: Tools Conferences; (805)685-6869; Fax: (805)685-1006.

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