Digital Solutions Reference Book
Expert Systems

digital

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Market Analysis

Overview

One of the many facets of Artificial Intelligence (AI) is expert system technology. AI encompasses computer systems that solve problems by manipulating knowledge encoded from expert sources; it is also referred to as knowledge-based system technology. AI is aimed at programming computers to behave in ways that humans recognize as intelligent behavior in each other. These include the ability to understand language, to reason, to learn, and to solve complex problems.

Many companies (Fortune 500 and others) have implemented expert system technology as a way of solving internal business problems as well as providing products and services to external customers. At least ten percent of the Fortune 500 companies currently have on-going expert system application activity.

Most estimates of the combined size of the AI market worldwide (depending on what is considered AI or an expert system) in 1990 range from $2 billion to $3 billion.

General customer needs and benefits are

Needs	Increase productivity
	Find more complete solutions to problems
	Hire and keep experienced and competent personnel
	Access and maintain the wealth of information required to solve everyday business problems in a quick and intelligent manner.
Benefits	Analyze and encode information about problem-solving situations in all functional areas
	Time to market decrease
	High standard quality
	Retain knowledge investment
	Manage complexity
	Train/leverage human resources
	Cost avoidance
	Risk analysis
	What-if modeling

Overall Market Trends

Until 1984, about 85 percent of the U.S. sales of AI and expert system products have been to

- Universities
- The military
- Aerospace companies (contractors for the military)
- Research and development departments of the largest U.S. companies

Many large U.S. companies are convinced about AI benefits and are investing in expert systems that have improved effectiveness and productivity. The decision to buy an AI solution is made at higher levels of customer management than those to which Digital normally sells. This implies that:

- AI can be successfully used as a door opener to these higher level managers.
- Successful AI sales techniques focus on *Solutions to Customer Business Problems*, rather than on specific products. Actual numbers cannot be determined since many companies do not want to talk about them, fearing the competition.

Major targets are

- Corporate AI groups
- Data processing groups
- Management information systems departments
- Line management/operational departments

The following table portrays the changing behavior in the AI market:

	Old	New
Market	R&D	Vertical industries; management information systems/data processing
Buyer	Individual researcher	All organizations
Purpose	Exploratory	Problem-solving applications
HW/SW Configuration	Standalone prototypes	Integrated systems with embedded AI modules
Focus	Tools	Applications
Platforms	Symbolic processors, PCs	Workstations (development); general purpose computers, PCs, and terminals (delivery)
Educational Focus	What is AI?	How to develop and integrate AI applications?
Skills	Highly specialized	Some/little AI expertise needed
Sales	Technical areas	Professionals with expertise in vertical industry markets

Digital's History with AI

Digital has been a pioneer in the commercialization of expert systems technology for a decade. Its involvement began in 1978 with a collaborative research project done in conjunction with Carnegie-Mellon University. The result is shown below:

- XCON (eXpert CONfigurer) and its associated manufacturing systems
  - Considered to be the most successful and largest expert system in commercial use
  - Saves Digital over $135 million per year
  - Collective knowledge base of over 17,000 rules

Collaborative research and development efforts continue with several leading universities.

Digital is recognized as the leading vendor of expert systems products and services worldwide. Business Week indicated in their May 8,1989 issue that "Everyone seems to agree that one company has climbed head and shoulders above all others: Digital Equipment Corporation. DEC is one of only a handful of companies worldwide with a foothold on the top rung of the automation ladder."

As a user, Digital has changed the way it does business due to its internal success with expert systems. Digital will continue to apply expert systems technology in an integrated, cooperating fashion to key business processes like those listed below:

- Marketing
- Sales
- Order administration
- Manufacturing
- Distribution
- Field service
- Engineering

Digital's focus is to develop expert systems and deliver them as functioning applications in a commercial environment.

Experience has taught Digital that standalone expert systems are rarely successful or appropriate. They are more likely to be part of a larger application solution and that's what prompts Digital to place heavy emphasis on the need to integrate AI technology with conventional software development in a Digital environment.

Digital Definition

Drawing on the knowledge and experience of our own experts, Digital markets a wide range of internal and third party products for developing and delivering AI applications, as well as an extensive array of consulting and educational service offerings.

Digital's primary goals in AI:

- Provide products and services that facilitate integration with conventional computing to enable customers to build commercially viable AI applications
- Preserve customers' investments in Digital hardware, software, applications, and data as well as investments in multivendor hardware and software
- Provide customers with a set of products that are interoperable and compatible
  - Distributed computing
  - Networked solutions
  - Powerful and rich operating system environments
- Multivendor integration

Typical Applications

The following table describes needs within, and benefits to, industries where expert system applications can be successfully developed using Digital's AI products and consulting.

Industry	Applications Need	Benefit
Financial Services*	Diagnosis/maintenance of computer equipment for banking/money transfer	Reduce equipment downtime
	Screen insurance applications and generate policies	Reduce errors, improve accuracy/completeness
	Satisfy loan applications	Improve consistency, increase turnover of applications, save time of customers/loan officers
	Reduction of fraud in money claims	Improve quality assurance
	Reallocate personnel to available positions according to their skills	Save time and reduce number of people needed
	Realtime analysis of datafeed information in currency trading support – awareness of currency purchased, its value, and cash position	Increased effectiveness on trading floor
	Cross-selling/products advisory (selling of bank services and products)	Increased sales, new product introduction and availability
Telecommunications*	Diagnosis/maintenance of electronic signal switching computer equipment	Reduce fault diagnosis and downtime
	Planning/operations/executive decision support in communications manufacturing	Identify shortfalls in manufacturing capability; examine "what ifs" of manufacturing operations/plans
	Reallocate personnel to available positions according to their skills	Save time and reduce number of people needed
	Analyze network failures on communications computer equipment	Reduce equipment downtime
General Services		
Travel/Transportation*	Planning/operations/executive decision support in transportation manufacturing	Identify shortfalls in transportation capability, examine "what ifs" of manufacturing operations/plans
	Reallocate personnel to available positions according to their skills	Save time and reduce number of people needed
	Freight scheduling, material dispatching, selection of optimum routes	Quicker, cost-effective schedules; advanced capacity planning
	Transport/handling of hazardous materials (chemicals, hazardous waste, explosives)	Cost effective, safety, and easier/more effective interpretation of government regulations

* See Appendix B for more detail

Internal Use Only

Discrete/Process

Industry	Applications Need	Benefit
Manufacturing*	Diagnostics/maintenance of manufacturing equipment	Reduce downtime of equipment undergoing repair
	Determine alternate uses of inventory and associated costs	Reduce time to market; provide total life cycle planning
	Planning/operations/executive decision support in manufacturing	Identify shortfalls in manufacturing capability, sales forecasts/financial management
	Reallocate personnel to available positions according to their skills	Save time and reduce number of people needed
	Analyze network failures on computer equipment	Reduce equipment downtime
	Automatically produce engineering schematics; provide a process and simulation tool for planning	Eliminate tedium; save time and money; provide higher-quality products
	Schedule order and time of hydrocarbon products through pipelines; produce pumping orders	Save time and expense impact of schedule changes on refineries' operations/downline storage capabilities
Aerospace*	Diagnosis/maintenance of computer, avionics, electromagnetic warfare hardware (airborne/ground-based) and its support equipment	Reduce aircraft downtime, improve mean time to repair and mean time between failure of spares/support equipment
	Determine alternate uses of inventory and associated costs	Reduce time to market, alternate uses/end-of-life dispersal of aircraft spares
	Planning/operations/executive decision support in manufacturing	Identify shortfalls in manufacturing capability
	Reallocate personnel to available positions according to their skills	Save time and reduce number of people needed
	Analyze network failures of computer equipment	Reduce computer equipment downtime on aircraft or ground-based support equipment (subsystems)
	Automatically produce engineering schematics; provide a process and simulation tool for planning	Eliminate tedium; save time and money; provide higher-quality products
	Signal processing, C3I, pattern recognition of enemy or allied transmissions	Quicker mission-critical threat classification and analysis; crucial advisor to operators
	Automatic source code production from electronic diagrams, "automatic programming" (Ada)	Address some of the armed services' stated "software crisis" for on-time specification, programs, maintenance, etc
	Proposal configuration for Government systems integration business	Higher quality, more complete and systematic proposals from diverse sources on the team; greater competitive edge for prime contractors

* See Appendix B for more detail

Process

Industry	Applications Need	Benefit
Oil and Gas*	Diagnosis/maintenance of petrochemical equipment	Reduce downtime of equipment undergoing repair
	Planning/operations/executive decision support in oil manufacturing	Identify shortfalls in oil manufacturing capability
	Reallocate personnel to available positions according to their skills	Save time and reduce number of people needed
	Schedule order and time of hydro-carbon products through pipeline; produce pumping orders	Save time and expense impact of schedule changes in refineries' operations/downline storage capabilities
Pharmaceuticals*	Diagnosis/maintenance of pharmaceutical manufacturing equipment	Reduce downtime of equipment manufacturing drugs, thereby increasing production
	Planning/operations/executive decision support in pharmaceutical manufacturing	Identify shortfalls in manufacturing capability
	Reallocate personnel to available positions according to their skills	Save time and reduce number of people needed
Federal, State, and Local Government		
Federal*	Fraud detection of state services	Reduce money spent on fraudulent claims
	Diagnosis/maintenance of computer, avionics, electromagnetic warfare hardware (airborne/ground-based) and its support equipment	Reduce aircraft downtime; improve mean time to repair and mean time between failures of spare and support equipment
State and Local*	Diagnosis/analysis of computer equipment used for tax forms/bills/checks; sewer/gas/electricity/phone lines	Reduce downtime of data processing equipment at critical periods (tax/pay periods/power outages)
Federal*	Determine alternative uses of material inventory and associated costs	Provide total life cycle planning and end of product life dispersal
	Planning/operations/executive decision support in manufacturing capability of vendors/contractors supporting weapon systems	Identify shortfalls in manufacturing capability, financial management, and sales forecasts
Federal, State, and Local*	Reallocate personnel to available positions according to their skills	Save time and reduce number of people needed
Federal, State, and Local*	Analyze network failures of computer equipment on weapon systems and management information systems	Reduce computer equipment downtime
Federal*	Automatically produce engineering schematics; provide a process and simulation tool for planning	Eliminate tedium; save time and money; provide higher-quality products
Federal, State, and Local*	Schedule order/time of hydrocarbon products through pipeline for use in wartime scenarios and national emergencies	Save time and expense impact of schedule changes; contribute to national defense and energy

* See Appendix B for more detail

Industry	Applications Need	Benefit
Federal, State, and Local*	Freight scheduling, material dispatching, selection of optimum routes	Quicker, cost-effective schedules, advanced capacity planning
	Fraud detection in claims for money	Improves quality assurance in claims
Local*	Bylaw interpretation/advisory required during requests for building permits – fire, zoning, gas/sewer lines	Improve service, identify planning short-falls
Local*	Mass transit scheduling/planning	Quicker, cost-effective schedules, advanced capacity/route planning

* See Appendix B for more details

Business Problems/ Needs Analysis

Typical Buyer Profile

Who Do You Sell To?

Although many Fortune 500 companies have AI development/research departments, the market trend and our experience show that more successful business is sold to people who own the business problem, not necessarily the AI research department. However, we have been successful as "*partners*" with AI researchers in large companies, and it should not be assumed that there isn't any business in the corporate research groups. The types of people in the various industries who own the business problems for which AI solutions can be developed are listed below:

Financial

Banking

WHO:

- Presidents, Vice Presidents, CEOs, and Management Information Systems managers who are interested in internal financial management activities
- Loan officers
- Financial consultants
- Financial planners
- Brokers
- Investment analysts
- Corporate finance officers
- Resource managers

Insurance

WHO:

- Presidents, Vice Presidents, CEOs, and Management Information Systems managers who are interested in internal financial management activities
- Agents
- Brokers
- Corporate underwriting managers
- Risk analysts
- Resource managers

Telecommunications

WHO:

- Vice Presidents, Management Information Systems managers, service managers
- Equipment manufacturing managers
- Telephone switching and cable maintenance managers
- Telephone operations managers
- Telephone accounts managers
- Resource managers

General

Travel and Transportation

WHO:

- Vice Presidents, Management Information Systems managers and managers of the operations listed below:
  - Ticket/travel agents
  - Air traffic management
  - Airline engineering
  - Aircraft maintenance
  - Pilots/aircrew
  - Airlines/railway safety engineering
  - Freight scheduling
  - Subway planning
  - Truckline scheduling, dispatching, and vehicle maintenance
  - All types of scheduling activities (gates, vehicles, passengers, freight)

Discrete/Process

Manufacturing

WHO:

- Vice Presidents, Management Information Systems managers and managers of the operations listed below:
  - Manufacturing maintenance
  - Manufacturing planning
  - Manufacturing scheduling
  - Resource and inventory

Discrete

Aerospace

WHO:

- Presidents, Vice Presidents, CEOs, Management Information Systems managers and managers of the operations listed below:
  - Production planning/scheduling
  - Engineering
  - Aircraft maintenance
  - Electronics/avionics diagnostics
  - Resource and inventory

Process

Oil and Gas

WHO:

- Presidents, Vice Presidents, CEOs, Management Information Systems managers and managers of the operations listed below:
  - Engineering
  - Drilling
  - Equipment maintenance
  - Diagnostics for drilling and scheduling
  - Diagnostics, design, and maintenance of oil and gas, and associated pipelines
  - Resource inventory

Pharmaceuticals

WHO:

- Presidents, Vice Presidents, CEOs, Management Information Systems managers and managers of the operations listed below:
  - Chemical engineering
  - Chemical equipment maintenance
  - Chemicals production
  - Planning, scheduling, and monitoring
  - Resource and inventory

Department of Defense Direct, Civilian Agency Direct

WHO:

- Local and state department planning commissioners and financial officers
  - Federal Reserve Board members
  - Departments of Energy, Education, Agriculture, Interior, and Environment
  - Department of Defense – Air Force, Army, Navy, Marine Corps
- Defense Logistics Agencies:
  - Artificial Intelligence Program Office Managers
  - System Program Managers (SPMs)
  - Material Management/Maintenance/Distribution Directors

What Do You Sell?

Expert system technology has not evolved yet to a point where there are many "*off-the-shelf*" packaged applications. Thus far the major reasons seem to be that:

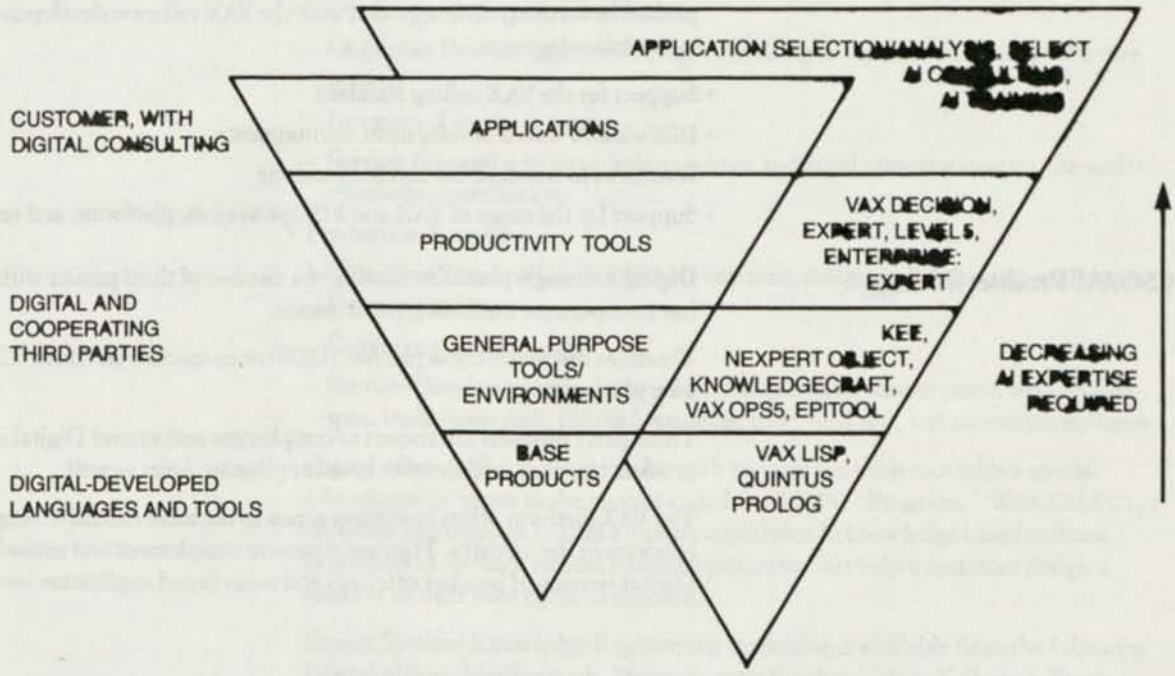
- The expertise the customer puts into each and every expert system is the proprietary information that is valued by the company (e.g., a special process for manufacturing, a secret formula, years of experience, etc).
- If this information or process were available "*off-the-shelf,*" there would be no differentiation, and therefore, no added value or competitive advantage for the customers

Digital *does* have the software, languages, tools, consulting, and training to provide solutions to address the needs of each industry we have mentioned. The following chart shows the interrelation among parts of the entire solution:

AI Product Strategy

The overall strategy is to make this technology accessible to an increased number of people. This market model indicates that the opportunities for sales of AI products lie in addressing the general software developers and programmers. *We estimate that there are approximately 10,000 people in the United States with the training and expertise to implement a commercial expert system from a base language. There are in excess of two million software developers and programmers in the United States. Tailoring AI tools for their use is clearly in the best interest of them all.*

There is also an expected correlation between ease-of-use and the broader opportunities to apply this technology. This, combined with the sheer number of existing users at higher levels, provides us with a very clear product direction. Over time, we will work to deliver more products at higher layers of this model, focusing on ease of use for traditional programmers and even nonprogrammers.



Internal Use Only

Digital's product strategy for the next several years has three main thrusts:

- Digital developed products
- Third party products
- Complementary consulting and educational services

Digital is a leading user of AI technology. This experience has taught Digital a great deal about what is required to implement successful expert system-based applications. Digital's product development effort is a reflection of its own experience and also that of the needs of its customers.

Digital's strategy is to strengthen its leadership position as an enterprise-wide solutions vendor through the integration of expert systems capabilities with Digital's range of products and solutions offerings. This will be accomplished by developing and/or acquiring:

- Base products that can be used to develop applications directly
- Platforms upon which Digital and third parties can build more specialized development tools (VAX LISP, VAX OPS5)
- Higher level productivity tools (e.g., VAX Decision Expert) that
  - Leverage Digital's internal expertise in building integrated solutions
  - Address the broader, traditional programmer/software developer audience by constraining the problem-solving methodology to a well defined area and optimizing product development around ease-of-use in that area
  - Can be used by traditional solutions developers (CMPs and large end-users) to incorporate and embed expert systems functionality to improve the capabilities of their applications (VAX Decision Expert)

All of Digital's products have the primary goal of facilitating the building of extensible, tailored solutions that integrate expert systems functionality into traditional software development environments and applications. This will be accomplished by focusing on integration with the VAX software development environment in the following ways:

- Support for the VAX calling standard
- DECwindow-based development environments
- Interfaces to standard key layered products
- Support for the range of VAX and RISC processors, platforms, and networks

CSO/AI Product Strategy

Digital's strategic portfolio consists of a number of third parties with whom Digital has a cooperative marketing participation.

We either distribute those product (DDS) or co-market/sell them (CMPs sell their own products).

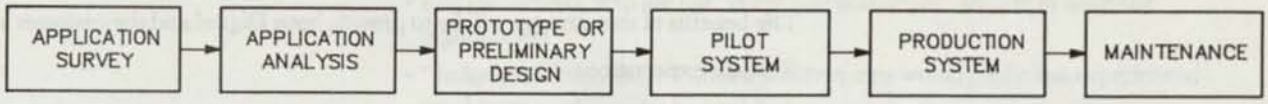
Third-party products are chosen to complement and extend Digital developed product offerings, and to cover broad application areas as well.

The VAX platform offers customers access to the most extensive range of AI products in the industry. They are chosen to complement and extend Digital-developed product offerings and cover broad application areas as well.

Consulting Strategy:

Digital Professional Software Services – Digital offers a full range of assistance, from evaluating the applicability of AI technology in solving a customer's business problem to developing a complete solution.

Given the needs within multiple levels of a company, Digital Professional Services (consulting) plays a major role in winning potential business. Both IS and line management will have problems which not only require our hardware and software, but will also require our expertise to solve the problem. The natural progression for an AI project can be outlined as follows:



Services are offered to assist the customer with each of these development stages.

- Expert System Selection Study
  - Objective: Identify high payback potential expert system applications
  - Duration: Two weeks on-site, two knowledge engineers
  - Service: Oral and written report on best candidates for expert systems, problem sizing, resources needed, recommendations
- Expert System Application Analysis
  - Objective: In-depth analysis of identified expert system application
  - Duration: Two weeks on-site, two knowledge engineers
  - Service: Oral and written report on technical feasibility of the application, costs, benefits, and risks; tentative overall design and recommendations
- Strategic AI Application Consulting
  - Objective: Provide high level design consulting to customers building their own systems
  - Duration: 2 weeks or longer
  - Service: General advisory, design reviews, technical presentations; on-site and/or telephone consultations
- Production Systems
  - Objective: Based on feasibility study outcome, design, build, and put application into production
  - Duration: 6 to 24 months
  - Service: Develop program, education, and user involvement plans, write design spec, build basic shell, fill out knowledge base, field test, and release to end users

Digital offers individual services for each piece of the project or adds a special educational program to the process called the SELECT Program. * With SELECT, a customer can share in Digital's unique experience in knowledge-based systems development through custom designed programs that help a customer design a solution to their own business problem.

Expert Systems Knowledge Engineering consulting is available from the following Digital offices: Marlborough, Massachusetts; London; Tokyo; Valbonne, France; Sydney, Australia; and the Palo Alto AI Expertise Center in Palo Alto, California.

* See Appendix A, AI SELECT/Technology Transfer for further information.

Selling consulting along with the products and services gives you the advantage of:

- Knowing the customers' management, users, experts, and Management Information Systems groups from business/strategic, organizational, and technical perspectives
- Identifying appropriate timeframes
- Relating to customers needs of
  - Solving their business problems
  - Determining how AI can make a difference
  - Validating the approach and applications

The benefits of this strategy will be to provide both Digital and the customer with

- Realistic expectations
- A shortened sales cycle
- Better qualified opportunities
- Higher probability of success at a low cost
- The ability to verify the approach to the problem
- The ability to leverage Digital experience and follow on with requirements and estimates

Selling Strategy

How Do You Win?

Qualifying

Recognizing that the need for proposing an expert system solution may be the hardest part of the selling process, the following points may help to move the process.

Consider an expert systems approach in solving a problem when:

- A few key individuals are in short supply, and they spend a substantial amount of time helping others
- Key individuals, who are the "corporate braintrust" are due to leave the organization
- "Judgment" knowledge within a problem area would profit less experienced employees
- Performance of a small task requires a large team of people because no one person knows enough
- Expertise in the area can be defined as more than the application of "book knowledge"
- Performance is degraded because a task demands a thorough analysis of a complex set of conditions, and the typical performer never seems to remember everything
- There is a large discrepancy between the best and worst performers
- Traditional computer methods have been tried and found inadequate. Rapidly changing or exponentially explosive problem characteristics make "hardcoding" impractical
- Corporate goals are compromised as a result of scarce human resources
- Competitors appear to have an advantage because they can perform the task consistently better

Additional qualifying information:

The "AI" code content is an average of 10% to 30% of applications code, the rest is traditional code. Thus, the development of our AI philosophy. AI languages are just tools to be added to the VAX tool box. If there's a business problem worth solving, chances are that at least part of the problem has already been solved using appropriate traditional language tools. AI languages and tools let you put the expertise on top of the deterministic, algorithmic parts of the problem.

Why Are We Competitive?

Because we've been writing expert systems for over 10 years.

Because the analysts and consultants say we are Number 1 (Gartner Group, New Service Associates).

All are "*deliverable*" across the enterprise.

All are capable of "*being integrated*" with conventional languages and tools, e.g., embedded expert modules.

Consulting	Tech transfer. Systems integration management consulting. Proven success with customers
VAX LISP	Designed to deliver; no runtime license fee
VAX OPS5	Designed to start small ⇒ scale up. Proven, reliable, can get the job done. No runtime license fee for V3.0.
VAX Decision Expert	Easy to use by programmers (non-AI), produces smaller scale applications quickly. Inexpensive.
NEXPERT	Available across multiple platforms: RISC/ULTRIX, VMS, MS-DOS.

Strategy

It has been Digital's experience that the majority of the customers we have called on (or currently sell to) fit into four categories:

- Corporate planning and strategy
- AI research and development (R&D) groups within large companies
- Corporate information systems/management
- Line management/operational departments that own the business problem

Their needs, the sales strategy, and the products to offer them are indicated in the following table.

Department	Need	Strategy	Products
Corporate Planning	Strategic Planning. Staying or moving ahead competitively. Multiple locations usually affected. Justification for spending money ($).	Sell consulting. Talk about our strategic systems and the fact that we know why they are important. When talking to a manufacturing company, recommend a visit to a plant using AI. Start strategic consulting program. Recommend Application Survey first. Opportunity usually uncovers additional shorter term sales. Talk cost/benefit if it is comfortable.	SELECT Program Consulting Management Consulting Education Services – AI for Managers
R&D	High performance development	Give them best AI power tools on a VAX platform. Workstations are price/performance competitive. Push DECwindows environment – interoperability	VAXstation 3100 DECstation VAX LISP VAX OPS5 KEE Knowledge Craft Epitool NEXPERT OBJECT Quintus Prolog DECwindows DECstation 3100 Lucid LISP IBUKI LISP Franz LISP Other party AI tools
IS/IS Management	Development environment that supports realistic, less costly delivery. Desktop integration issues. Many tools, many platforms to support and maintain.	Sell them on desktop integration ⇒ DECwindows, VMS services for PCs. Point out that our AI products will allow them to centralize the applications on a large VAX with access by many. Push the idea that VAX Decision Expert, VAX LISP, and VAX OPS5 require no runtime license. Stress ease of maintenance compared to maintenance of a PC application.	VAX 6xxx VAX 3xxx VAXstations DECwindows VMS services for PCs – Networking products VAX LISP VAX Decision Expert Epitool CASE Tools Consulting Services – SELECT/tech transfer – Application survey/analysis Educational Services – Train the Trainer

Internal Use Only

Department	Need	Strategy	Products
Line Managers* (Those who own the problem)	Quick problem solving, productivity of programmers and SW engineers. Maintenance. Development/delivery is extremely important (can't waste money migrating/converting applications).	Start by reassuring line manager that we can help solve problem in short term. Combination of training/products/ consulting which can boost productivity of existing programmers – can teach them to use tools quickly. DECwindows strategy will have appeal here because there may be other PC/workstations on desktop. Recommend our AI tools which will help avoid migration and costly maintenance, and standardize expertise and procedures, thus reducing errors and improving quality.	Application survey/analysis Consulting Product training Knowledge acquisition skills VAX 3xxx VAX 6xxx VAXstations Networking products (project team LAN) CASE tools VAX OPS5 VAX Decision Expert DECwindows (NEXPERT) VMS services
SW Development Managers	Ways to control, maintain code – add expert systems components to existing applications. Develop new expert system applications.	Tell them how Digital's expert system tools take advantage of Digital's entire case environment. We provide an environment (NAS, AIA) for the sharing of code and data. Using our repository (CDD Plus)will provide the engineering manager with proper management and productivity gains to cut down project schedules. Push case environment and integration capability; it saves the engineering manager aggravation and gives SW managers the ability to develop an architecture for case and AI.	DECdesign VAX set Third party case tools VAX Decision Expert VAX OPS5 VAX LISP DECwindows CDD Plus Applications consulting
Managers who have responsibility for large numbers of PCs	Make use of investments in PCs and continue to produce new applications which span PCs, mid-range and high end systems.	Tell them they need not throw PCs away. With DEC's PC integration software, they will be able to add an applications server or use their PCs as terminals for development on VAX systems (DECwindows application servers).	MS-DOS services DECNET DOS DECwindows MicroVAX systems Networking tools which are easily ported from PC to VAX and VAX to PC: NEXPERT, Level5, VAX Decision Expert

* Best bet for short term revenue. Diagnostic, help desk applications are very cost effective solutions which can be delivered in a reasonably short time (3 to 6 months).

Summary Comparison of AI Products

Digital Products/ Competitor Products	Type of Software	Knowledge Representation	Development Hardware	Delivery Hardware	Cost*
VAX Decision Expert	Productivity Shell	If-Then, And-Or and Decision Trees, Goal-Driven	VAXstation	Any VAX	$7,400 – $37,740 (No Runtime License Fees)
Competitors					
Software Architecture & Engineering, Inc's Knowledge Engineering System (KES) II	Mainframe-Based Tool	If-Then, Hypothesize and Test, Statistical Pattern Classification	PCs	PCs/Mainframes	$4,000 – $60,000
Carnegie Group Inc/ Texas Instrument's TestBench	Diagnostic Bench	Object-Oriented Tool	TI Explorer Workstations	PC, MS-DOS 3.1 or Better, 640 K RAM	$40,000
Texas Instrument's Personal Consultant Series	Mid-sized, Mini Workstation Tool	Rules/Frames/Procedures	PCs, At Class Explorer	PC, LISP/C, VAX C	$95 – $2,950
IBM's The Integrated Reasoning Shell (TIRS)	Embedded Application Building Tool	Rules/Frames	IBM PS/2, IBM RT PCs	IBM PS/2, IBM RT PCs, Mainframes	$10,950 – $60,000
NEXPERT OBJECT (DDS)	Expert System Shell	Objects/Rules	PCs/VAX Systems	Multiple Platforms	$5,400 – $9,200
Epitool (DDS)	VAX LISP Representation Language	Rules/Frames Objects	VAX Family	VAX Family	$15,000 – $49,000
Competitor					
IBM's Expert Systems Environment	Entry-Level Shell	Rule-Based	Mainframes	Micros/PCs	$21,240 – $57,570
VAX OPS5	Expert System Tool	Event-Driven	Standalone VAXstations/Client-server Configurations	VAXstations, VAX Terminals, Batch Mode	$6,000 – $28,500 (One-Time License Fee)
Competitor					
IBM's Knowledge Tool	Development Shell/ES Tool	Rule-Based, Event-Driven	Mainframes	Mainframes	$9,205 – $105,880
VAX LISP	General Purpose Programming Language		VAX Family	VAX Family	$6,325 (No Runtime License Fees)
Competitor					
Sun's Lucid LISP and Symbolic Programming Environment (SPE)	SPE-Automated Assistance Toolkit for Debugging Analyzing, and Developing LISP-Based Applications	Object-Oriented	IBM RT PCs, H-P RISC/ Sun/Apollo Workstations Prime 50's and VAX Family	IBM RT PCs, H-P RISC/ Sun/Apollo Workstations Prime 50's and VAX Family	$7,000 (LUCID/Franz $3,500/SPE $3,500)

* U.S. prices

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Competition (Product Detail)

Digital's VAX LISP	Sun's Lucid LISP Compiler and Symbolic Programming Environment (SPE)
Features: • First vendor-supported Common LISP implementation (compiler and development environment) • Premier language for AI prototype and application development • Powerful, DECwindows-based programming environment • Ephemeral Garbage Collector for high performance • Unique system building utility (patent filed) for efficient application delivery • Enhanced integration with VAX languages and tools Attributes: • DECwindows-based programming environment • LISP-Sensitive Editor • Symbolic debugging facilities: – Stack debugger – Stepper – Tracer – Inspector • LISP Listener • Graphics programming interfaces – DECwindows XUI toolkit access – CLX interface to X11 • Ephemeral Garbage Collector • VMS integration • Client-server mode	Features: • Lucid LISP Compiler and SPE Development Interface make-up package Attributes: • SPE: Automated Assistance Toolkit for debugging, analyzing, and developing LISP-based applications includes: – Inspector – Source Code Finder – SPE Program Analyzer – LISP Editor/Listener – Application Manager – Requires Sun Common LISP and 12 Mbyte of main memory – 30 Mbyte of swap space required for both Sun Common LISP and SPE
Approximate U.S. price: • $6,335 – No Runtime License Fees ($5,210 License, $925 Media/Doc, $200 One-Year Support)	Approximate U.S. price: • Total Package: $7,000 (Lucid/Franz – $3,500, SPE – $3,500)

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Competition (Product Detail) (Continued)

Digital's VAX OPS5	IBM's KnowledgeTool
Features: • OPS5 Architecture: – Working memory – Production memory – Inference engine • Proven implementation: – Many successful and profitable applications for MIS/DP professionals • Positioned as an Expert System tool Attributes: • DECwindows-based development environment • For mainstream programming • Development on standalone VAXstations, on VAXstations; VAX delivery on VAXstations, VAX terminals or in batch mode • Call out to languages optimized for procedural coding: – VAX Bliss • Integration with: – VMS Utilities – VAX Ada – VAX Bliss – VAX C – VAX FORTRAN – VAX Pascal – VAX DEC/MMS – VAX DEC/CMS – VAX DEC/TEST Manager • Forward/backward chaining, event-driven through asynchronous system traps, usable across full range of VAX/VMS: – VS2000 to VAX 8978 – Emphasis on integration, power, speed, flexibility, and simplicity	Features: • OPS5 Architecture: – Working memory – Production memory – Inference engine • New implementation • Positioned as a development shell and an Expert System tool Attributes: • For knowledge engineers and DP professionals • Development/delivery on mainframe • Test facility with windowing but no window-based development environment • Procedural coding: – PL/1 Implementation (Native Mode Code) • Integration with: – PL/1 – COBOL – Assembler – FORTRAN – Pascal • Forward chaining, rule based, event-driven, pattern-matching • Usable in VM/SP/CMS; MVS/XA/TSO; CICS/OS/VS; IMS /VS • Emphasis on power, speed, flexibility, and convenience Competitive knockoffs: • Lack of user friendly development environment • Nonprogrammers find it difficult to use since standard editor must be used to create a knowledge base • Lack of rapid prototyping – no interpreter; must be run as a compiled program • Lack of backward chaining • Lack of cooperative processing capability
Approximate U.S. price: • One-time license fee of $6,000 – $28,500 No Runtime Fee	Approximate U.S. price: • License $9,205 – $105,880

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Digital's VAX Decision Expert

Features:
- Written In VAX C
- Productivity shell for any problem-solving activity

Attributes:
- For any developers of ES; not necessary to know AI or ES techniques
- Complete VMS Call-In/Out facility
- Integration with other VMS languages, programs, databases and utilities
  - BASIC
  - OPS5
  - VAX C
  - Ada
  - FORTRAN
  - COBOL
- VAXstation development and delivery on any VAX system
- Represents knowledge of:
  - If-Then rules
  - And/or trees
  - Decision trees
- Automatically generates ES for the end user
- Graphical windowing interface
- Backward and forward chaining

Applications:
- Diagnosis
- Analysis
- Selection
- Help Desk Advice

Approximate U.S. price:
- Licenses $7,400 – $37,740
  No Runtime License

Software Architecture and Engineering, Inc.'s Knowledge Engineering System (KES) II

Features:
- Written in C; Procedural and Declarative Programming

Attributes:
- Three subsystems:
  - If-Then (structure rule-based)
  - Hypothesize and test (no rules)
  - Statistical pattern classification
- Usable in NOS/VE, MVS/TSO, VM/CMS
- Develop off-line knowledge bases
- 100% portable to support hardware PC version
- Interact with systems via menus, windows, and a mouse
- Can be embedded within a C program and compiled
- Provides 3 types of confidence factors
- Can be delivered on mainframes

Applications:
- Intelligent Help Systems
- Intelligent on-line documentation
- Error detection and correction utilities

Competitive knockoffs:
- Appeals more to programmers than non-programmers
- Designed for people who want to develop Expert Systems on PCs in conventional languages

Approximate U.S. price:
- PC $4000; Mainframe $10,000 – $60,000

Competition (Product Detail) (Continued)

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Approximate U.S. price:
- Licenses $7,400 – $37,740
  No Runtime License

Carnegie Group Inc's/Texas Instruments' TestBench

Features:
- Written in C
- Domain specific high-end tool for large, complex, diagnostic a pplications

Attributes:
- Delivery via PC, MS-DOS V3.1 or better, 640 K RAM
- Consists of three modules:
  - TestBuilder – Expert technician or system developer creates KB combining documentation, expert's knowledge and rules of thumb on a TI Explorer Workstation
  - TestView – Runtime solution on a PC requiring deployment at multiple stations
  - TestBridge – Translates information created with TestBuilder so it can be used by TestView
- Graphical editor, error checking/reporting and KB reporting utilities
- Tracing and breakpoint utilities developer – some computer skills and no AI experience required
- End User – no computer skills required

Applications:
- Ford Service Bay Diagnostic System
- Ford Vehicle Powertrain Diagnosis
- Ford Wave Solder Process Diagnosis
- Ford Fuel Injector Machine Diagnosis
- Ford Dynamometer New Engine Diagnosis
- Digital Equipment Corp Software Diagnosis
- TI NC Code Diagnosis
- General Tire Rubber Cutter Factory Diagnosis

Targeted Industries
- Manufacturing
- Telecommunications
- Aerospace

Approximate U.S. price
- $40,000

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Competition (Product Detail) (Continued)

Digital's VAX Decision Expert	Texas Instrument's Personal Consultant Series
Features: • Written In VAX C • Productivity shell for any problem-solving activity Attributes: • For any developers of ES; not necessary to know AI or ES techniques • Complete VMS Call-In/Out facility • Integration with other VMS languages, programs, databases and utilities – BASIC – OPS5 – VAX C – Ada – FORTRAN – COBOL • VAXstation development and delivery on any VAX system • Represents knowledge of: – If-Then rules – And/or trees – Decision trees • Automatically generates ES for the end user • Graphical windowing interface • Backward and forward chaining Applications: • Diagnosis • Analysis • Selection • Help Desk Advice	Features: PC Easy – Quick prototype concept or problem solution, small to medium Kbyte Attributes: • Self contained • Interactive • Forward/backward chaining rules • PC development • Confidence factors • End user explanation • Graphic image capture/display • Interfaces to dBASE, Lotus, DOS files, .EXE/.COM program • Multiple delivery options – PC LISP and C, VAX C 512K – 640K RAM Features: PC Plus – Quick prototype concept or problem solution, broader range of development features for broader range of problems Attributes: • LISP development • Interface to C, Turbo, Pascal, DOS, dBASE Lotus • Forward chaining rules/frames/procedures • AT class/explorer development • KB Browser • Frame descriptors, meta rules, mouse support • DOS based version up to 2 Mbytes • Explorer version up to 16 Mbytes plus Virtual Memory • PC LISP and C delivery • VAX C delivery Add-ons of PC images and online-interactive dials, gauges, forms, and selection images for user input/output interfaces to data acquisition and analysis programs Applications: • Hotline helper • Risk analysis • Pilot executive • Maintenance assistant • Soup cooker diagnostic • Analog circuit design • Grain marketing advisor
Approximate U.S. price: • Licenses $7,400 – $37,740 No Runtime License	Approximate U.S. prices: • PC Easy $495 (Development) $95 – $1995 (Delivery) • PC Plus $2,950 (Development) $95 – $1995 (Delivery) – Images $495 – Online $995

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Digital's VAX Decision Expert	IBM's The Integrated Reasoning Shell (TIRS)
Features: • Written In VAX C • Productivity shell for any problem-solving activity Attributes: • For any developers of ES; not necessary to know AI or ES techniques • Complete VMS Call-In/Out facility • Integration with other VMS languages, programs, databases and utilities – BASIC – OPS5 – VAX C – Ada – FORTRAN – COBOL • VAXstation development and delivery on any VAX system • Represents knowledge of: – If-Then rules – And/or trees – Decision trees • Automatically generates ES for the end user • Graphical windowing interface • Backward and forward chaining Applications: • Diagnosis • Analysis • Selection • Help Desk Advice	Features: • Written in C; compiled in C on workstation • Development on IBM PS/2 under OS/2 and IBM RT PC under AIX with graphic interface • Delivery on above as well as IBM mainframes – runs under VM/CMS, MVS/TSO, and MVS/CICS Attributes: • High-performance, embedded application building tool for multiple platforms • Frame based • Displays rules and frames graphically • Backward/forward chaining • Opportunistic reasoning Competitive Knockoffs • No C offering on mainframe • No standard interfaces to mainframe databases such AS dBASE or SQL/DS • Discourages users who want to forgo services (training, documentation, 800-number support, follow-on)
Approximate U.S. price: • Licenses $7,400 – $37,740 No Runtime License	Approximate U.S. prices • $10,950 – $60,000 (Development and Runtime)

Competition (Product Detail) (Continued)

NEXPERT OBJECT	IBM's Expert Systems Environment (ESE)
Features: • Implemented in VAX C • Expert System Shell Attributes: • Window and icon based developer interface • Call-in mainstream applications or libraries of application code or applications can call-in ES • Multiple users share one copy of executing code • Object and rule representation • Backward/forward chaining • Event-driven • Developed on PC or VAX and ported to other platforms • Integration with conventional languages such as: – C – Ada – FORTRAN – COBOL – Assembly • Direct access to relational databases	Features: • Implemented in Pascal; updated in "C" • Entry Level Shell Attributes: • Users with few computer skills • Mainframe development and delivery on Micros and PCs • Usable in MVS/VM/XA/CMS/TSO/BATCH/IMS/CICS • Integration with: – DB2 – SQL/DS • Works with IBM's Expert System • Consultation environment/PC • Forward/backward chaining, rule based, online editors, debugging • Free help desk applications for installed IBM PC or mainframe systems • Supports non-alphabetic languages such as Japanese and Chinese Competitive knockoffs • Users want to develop on PCs and deliver on mainframes; this tool does the opposite • Shallow AI techniques • Successful implementations are rare • Memory-intensive • Poor performance • Not supported the way a "Product Program" would be
Approximate U.S. prices • $5,400 – $9,200 (Development and Runtime)	Approximate U.S. prices • One Time MVS License $42,500 • One Time VM License $21,240 – $57,570 • Additional Copies $595

Competition (Product Detail) (Continued)

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- Analysis
- Selection
- Help Desk Advice

Approximate U.S. price:
- Licenses $7,400 – $37,740
  No Runtime License

IBM's The Integrated Reasoning Shell (TIRS)

Features:
- Written in C; compiled in C on workstation
- Development on IBM PS/2 under OS/2 and IBM RT PC under AIX with graphic interface
- Delivery on above as well as IBM mainframes – runs under VM/CMS, MVS/TSO, and MVS/CICS

Attributes:
- High-performance, embedded application building tool for multiple platforms
- Frame based
- Displays rules and frames graphically
- Backward/forward chaining
- Opportunistic reasoning

Competitive Knockoffs
- No C offering on mainframe
- No standard interfaces to mainframe databases such AS dBASE or SQL/DS
- Discourages users who want to forgo services (training, documentation, 800-number support, follow-on)

Approximate U.S. prices
- $10,950 – $60,000 (Development and Runtime)

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Competition (Product Detail) (Continued)

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Arthur Anderson & Company (AA&Co):

Marketing Strategy

AA&Co's effort in AI leverages off their mainline consulting practice which crosses all industries and most business functions. A main thrust is integrating AI technology into information processing. AA&Co worked with Intellicorp to develop KEE Connection and with Aion on a high performance option of its ADS mainframe tool. AA&Co is the biggest consulting group of the Big Eight. It has grown 25 to 35% per year for the past several years and expects AI to be an integral part of continuing this growth. They believe that expert systems can be marketed as 40 to 60% of the overall solution. Bruce Johnson of AA&Co feels that the major payback from using AI is increased development productivity resulting from the testing and performance flexibility of knowledge-based systems. AI can cope with complexity due to its flexibility.

Partner	Competitor	Target Markets	AI Services
Yes	Yes	Financial	Teaching its large number of field consultants to be KEs, using the CIM design tool and a project manager assistant. Training – often relies on vendors but does supply it.

Price Waterhouse (PW)

Marketing Strategy

Consulting business of the Big Eight accounting firms is knowledge intensive and changes constantly. PW feels that AI has the leverage to respond to the problem. PW's AI strategy is an industry focus, for which their Special Practice Units are set up with a marketing perspective, to offer enhanced services to industries such as money center banks or mutual fund organizations. With the industry focus, PW can walk in and say they know about their clients' problems and competitors and understand the technology rather than "we know about AI, what's your problem?" Their second focus is reactive with no specific industry target. Integration is a key issue for PW (matching tools to specific systems development and getting AI into the business mainstream).

Partner	Competitor	Target Markets	AI Services
Not yet	Yes	All industries	Training – internal for AI and ES. Their tax/audit experts learn ES technology for 6 months to 2 years while serving as experts. Technology Center – looks at how to apply ES technology. Special Practice Units – look at how to deliver it. Provide orientation seminars to full systems development.

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Carnegie Group, Inc (CGI)

Marketing Strategy

Sixty-five percent of CGI's 1986 revenues came from developing custom applications for clients, using its own tools in the manufacturing area. Applications fall into six categories: design, planning, production, distribution, field services, and text processing. Contract programming exists with various companies such as Ford Motor Company to deliver AI expertise and knowledge based software, with Digital for knowledge-based engineering and manufacturing applications development and ES tools, and with General de Service Informatique of Paris, Boeing, and Texas Instruments. Minority stakes in CGI are owned by Digital (10%), GSI of Paris (10%), Boeing (10%), and Ford Motor Company and Texas Instruments (10%).

Partner	Competitor	Target Markets	AI Services
CMP	No (although they offer their products on a Sun platform also)	Manufacturing engineering and associated markets such as electronic design	Full range of training Courses: FAIVS, Tutorial on Common LISP, Knowledge Engineering, product training for Knowledge Craft and Language Craft.
		Design for assembly of mechanical parts, production planning, and scheduling	Applications consultants aid customers in developing systems or application software.
		Machine diagnosis	Product support includes telephone assistance, electronic mail, product and documentation updates, and a newsletter.

Texas Instruments (TI)

Marketing Strategy

Although TI has roughly 4000 employees in its Data Systems Group (the Advanced Systems Division within this group is responsible for the TI Explorer and speech/natural language products), consulting plays a small part. AI accounts for the second largest expenditure in TI's $400 million plus R&D program. TI's basic marketing strategy is to provide economical solutions to problems in the development of expert system products (e.g., TI Personal Consultant running on PCs). TI will integrate AI capabilities with all machines.

Partner	Competitor	Target Markets	AI Services
No	Yes	Researchers Developers Universities Military/ government.	Natural language (Natural-Link); speech voice recognition, record and playback, text-to-speech, and phone management (TI-Speech System); and speech synthesis (TI Speak and Spell).

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Marketing Strategy

Focus is on sale of the ESE shell for corporate mainframes. IBM believes AI is not a specialized technology but a complement to the spectrum of data processing applications. Biggest market is at mid-range. IBM has organized its AI activities with a Corporate Steering Committee set up by the president with three senior VPs representing Resources, Manufacturing, and Business Unit divisions participating. An AI project office monitors activity for the Steering Committee. Research divisions are in Paris (Prolog), Yorktown (LISP), and Palo Alto, California (ESE). Research hands prototypes to the Software Development Group to be turned into finished products. The ESE Group is under the General Products Division in Menlo Park, California. Internal applications are being developed at Endicott, San Jose, Poughkeepsie, etc. Marketing is located in Princeton, New Jersey. The ESE group is responsible for the Cambridge and Palo Alto support centers for AI custom programming and education.

Partner	Competitor	Target Markets	AI Services
No	Yes	ESE – horizontal and across industries. Workstations – scientific, engineering, and AI markets.	Seminars and workshops – LISP/VM, ESE/VM, and VM/Prolog. On-site program service or assistance.

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Appendix A
Product Detail

VAX LISP (QL-917AX-XX)

Features and Benefits

Features:

- It is a general purpose programming language for symbolic processing.
- More AI applications have been developed in LISP than in any other language.
- First commercially available, and most accurate implementation, of Common LISP.
- It is used to develop expert systems and expert system shells.
- It is useful for rapid prototyping and exploratory programming.
- With its interactive programming style, developers can incrementally compile individual LISP functions and mix compiled and interpreted code in a single program; it returns a value immediately when developers are doing exploratory programming.

Benefits:

- LISP has a reputation for significantly better programmer productivity than conventional languages.
- Developers can work in a DECwindows-based programming environment with an editor, stepper, tracer, debugger, inspector, and LISP listener.
- LISP has recursion capabilities – a way for a procedure to solve a problem is to break the problem up into simpler problems and hand these off to other identical procedures; in each copy of the procedure, the process of breakup and handoff may be repeated.
- LISP has been used for implementation of KEE, Knowledge Craft, GoldWorks, and Epitool.
- Developers can access systems services, functions, languages, and tools available in the VMS or ULTRIX operating system environment.
- The CALL-OUT and CALL-BACK interface allows VAX LISP programs to access routines and modules written in other languages and applications.
- The ALIEN STRUCTURES mechanism allows VAX LISP to access data from non-LISP data formats.
- VAX LISP's System Building Utility allows developers to customize the run-time environment by excluding those parts that are unnecessary when running a program, as well as to include their own modules in the run-time image, which can be translated into "better delivery performance" for the customer.
- Developers can produce VAX LISP applications in a single, executable image and multiple users can share a single copy of the application code.
- A run-time license fee is not required when running application programs with the program development components of VAX LISP excluded from the executable image.

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VAX OPS5 (Official Production System) (QL-VD4AX-XX, QL-502AX-XX, QL-913AX-XX)

Features:

- DECwindows programming environment
- Used for building expert systems
- Rule-based language where knowledge is encoded in "if-then" rules called "productions"
- OPS5 rules can be grouped in any order because execution is controlled by pattern-matching; rules can be updated whereas conventional programs update the entire program across all dependencies
- Has a built-in inference engine driven by a powerful pattern-matching algorithm – the Rete algorithm which creates a highly efficient representation of the interdependencies of rules; as matches occur, the system collects these matches using one of two built-in conflict resolution strategies to determine which rule should be executed or "fired"
- Is normally forward chaining (the current situation is described and the system deduces a solution); backward chaining can be accomplished by writing a few control structures (describe a solution and have the system describe the conditions under which this solution is satisfied)

Benefits:

- Currently used most frequently in problems such as configuration, scheduling, diagnostic support, process monitoring and control, and advisory systems
- Is compiled rather than interpreted, contains its own debugger, and uses an integrated performance measurement and evaluation tool to determine possible program inefficiencies
- Integration with VAX Ada, VAX BASIC, VAX BLISS-32, VAX C, VAX FORTRAN, VAX Pascal, VAX DEC/MMS, VAX CMS, and VAX DEC Test Manager; expert systems can be started outside of OPS5 and called in as an external subroutine
- VAXstation window-based programming development environment
- Maintenance of code at the rule level
- Integrated edit, compile, link, run, debug, and trace activities done inside the environment with no need to exit to do them
- True real-time support through a port to VAXELN

VAX Decision Expert (QA-VI2AX-XX)

Features:

- Implemented in VAX C, easy-to-use, menu-driven, graphical shell for developing diagnostic problem-solving expert systems
- Requires no knowledge of AI programming
- Three ways of entering information:
  - If-then rule tables allowing developers to build "rule-based" expert systems in a spreadsheet format
  - And/or trees enabling developers to build expert systems through a collection of nodes connected in parent-child relationships
  - Decision trees which are graphical trees representing a question to be answered or a procedure to follow
- Provides a built-in end-user interface allowing for goal (inferencing is done forward first and then backwards) and forward chaining
- Priority factors allow assigning a value for the percentage that the fact is true and a cost value placed on finding out the truth of that fact; weighting factors are used to combine value and cost, and to rank candidate goals
- Support for VMS Version 5.0
- Use of DECwindows in the development environment
- Ability to call-in and call-out of the VAX Decision Expert environment
- An integrated editor, a help facility, and a terminal based end-user environment

Benefits:

- First product on the market that is robust enough for commercial applications development, yet easy enough to use for traditional applications developers and computer-literate experts
- Development times remain short
- Since developers with no AI knowledge can use the shell, capturing and spreading expertise throughout a company is easier
- Companies using Decision Expert as the end users become more productive through faster, more accurate, and more reliable decisions

CSO/AI Products

The CSO is a joint product marketing and selling arrangement. Marketing relationships exist with third party vendors. The third party products listed below run on a VAX platform.

Digital remarkets, sells, and supports the following products:

- Neuron Data's NEXPERT OBJECT
- Quintus Computer Systems' Quintus Prolog
- EPITEC AB's Epitool
- Carnegie Group for Knowledge Craft, Graphpak, and Simpak products
- Cullinet for Enterprise:Expert
- Information Builders for LEVEL5
- IntelliCorp for KEE

Listed below are the names and descriptions of some of the products:

- Knowledge Craft – (CMP)
  - A product of the Carnegie Group
  - Based on VAX LISP and is a toolkit approach for building expert systems
  - Offers a mixed graphics and screen-oriented developer interface
  - Designed for experienced knowledge engineers
  - Represents knowledge in frames, objects, and rules allowing mixed chaining; LISP, Prolog, and OPS5 work on a common knowledge base for support
  - Positioned as the high-end tool
  - Included are Graphpak (graphics package) and Simpak (simulation package) tied to expert systems built with Knowledge Craft

    Digital's relationship with Carnegie Group goes back to before it was incorporated

    Digital uses these products in a variety of manufacturing-oriented applications

    Digital worked with Carnegie to jointly produce Graphpak and Simpak

- Enterprise:Expert – (CMP)
  - Product of Cullinet Software, Inc.
  - English syntax rule-based expert system development tool
  - Applications created with this tool can be applied to input, process, and output phases of applications processing
  - Written in COBOL, Macro, C
  - Runs on all VAX-based CPUs; supports DECnet
  - ExpertEdit (intelligent rule editor, syntax checker, split screen maintenance)
  - Integrated and complementary with Enterprise:Builder and Enterprise: Generator for automatic generation of calls to and from knowledge bases written in COBOL, FORTRAN, C, and BASIC
  - Access to IBM mainframe applications, DBMS, and application file structures
  - Full portability of applications written on VAX platform to IBM mainframe platform for execution and vice versa
  - Preferred development tool for development of voice applications used on DECvoice hardware
  - Integrated with VMS mail facility to generate intelligent documents to report processing results and document decisions; integrated with voice messaging systems

- LEVEL5 – (CMP)
  - Specifically for customers with FOCUS databases
  - Product of Information Builders, Inc.
  - English syntax Production Rule Language for building knowledge bases
  - Can activate COBOL, FORTRAN, and ASSEMBLER programs
  - Easily understood if-then-else statements used to describe problem-solving logic
  - Backward/forward/goal chaining
  - Supports scientific and engineering applications with logarithmic and trigonometric functions, financial functions, floating-point arithmetic, and parenthetical nesting to 100 levels
  - Portable and runs interchangeably on IBM PC/XT/AT/PS/2, all IBM machines supporting VM/CMS or MVS/TSO, any Macintosh II, SE, or Plus, and any VAX/VMS configuration from MicroVAX to VAX 8900
  - Applications include decision management, diagnostic/troubleshooting, maintenance/scheduling, design/configuration, process monitoring/control, and intelligent text/documentation
- KEE (Knowledge Engineering Environment) – (CMP)
  - Robust, high-end LISP - based expert system development environment
  - Licensed directly to Digital customers by its manufacturer, IntelliCorp
  - Knowledge representation is in frames, supports forward and backward chaining of rules, and allows developers to ask "what-if" type questions
  - Best used for complex expert system applications by competent LISP programmers interested in an excellent user-interface and preferring a workstation-based tool
  - Currently running on VAX LISP Version 2.2
  - Digital is exploring system building utility optimization to reduce application system requirements and make it easier for customers to deliver KEE-based applications
- NEXPERT OBJECT (QB-OCFAX-XX, QT-OCFAX-XX, Q6ZFS-XX) – (Digital Distributed)
  - Implemented in VAX C, which supports the VMS calling standard and a common interface to VAX/RDB databases
  - Can call in mainstream applications or libraries of application code or these applications can call in the expert system
  - Multiple users can share one copy of the executing code
  - Window and icon based developer interface provides developers with easy-to-use features for

    Representing knowledge
    Building rules
    Controlling the inference process
    Browsing through an existing knowledge base
  - Can represent knowledge in frame or if-then like rules and reason about it through the controlled firing of rules, to provide a point (backward chaining) or for exploratory purposes (forward chaining)
  - Future releases will be based on DECwindows, will support ULTRIX, and will call for a runtime system
  - Developed on a VAX system and can be ported to other platforms

- Quintus Prolog (QL-VCYAX-XX) – (Digital Distributed)
  - Leading language for Logic Programming based on constructs of mathematical logic
  - Based on the Edinburg syntax which is the de facto standard for Prolog implementations
  - Uses backward chaining inference employing a tree-like data structure and efficient pattern-matching across this data structure
  - Provides for automatic backtracking to seek alternate paths to satisfy the stated goal
  - Application areas
    Advisory
    Diagnostic and scheduling
    Database design and query
    Natural language user interfaces
  - Supports both the VMS and ULTRIX operating systems on the VAX
  - Provides an incremental compiler
  - Interfaces to C, FORTRAN, Pascal, BASIC, COBOL, and PL1
  - Offers ProWINDOWS which provides an object-oriented windowing interface programming capability
  - Version 2.4 is currently available
- Epitool (QB-YFMAX-XX) – (Digital Distributed)
  - Powerful representation language based on VAX LISP
  - Graphics and text based interfaces
  - Pascal-like representation language
  - Rules, frames, concepts (objects), rule sets
  - Forward/backward chaining, multiple inheritance
  - Descriptions: sets of concepts
  - Flexible, fast tool for software engineers, LISP experience not a requirement
  - Allows use of VAX LISP System Building Utility for efficient applications delivery
  - Applications span many industries including aerospace, defense, utilities, pharmaceutical, and finance
  - Used by Volvo, Alfa Laval, Asea Brown Boveri, Saab Aerospace, Modo Chemetics, and Swedish Defense

Other third party products for development on VAX

- VAX/VMS
  - AI Flavors from AI Ware, Inc.
  - ART from Inference Corp. (full function LISP-based shell)
  - CLIPS from NASA
  - CommonLOOPS from Xerox Corp
  - Copernicus from Teknowledge, Inc. (C-based extended ES facilities)
  - DataTalker from Natural Language Products (natural language for RDB, Oracle, Ingres)
  - EXSYS from EXSYS, Inc.
  - I-CAT Electronic Equipment Fault Diagnosis from Automated Reasoning Corp
  - InterLISP from University of California, San Diego (DECsystem 10/20 to VAX)
  - KES II from Software Architecture and Engineering

- Lockheed Expert System (LES - PLI based) from Lockheed Research and Development Division
- Lucid LISP from Lucid, Inc.
- Mercury Knowledge Base Environment from Artificial Intelligence Technologies, Inc (VAX LISP-based full function shell)
- POPLOG from Integral Solutions Ltd (UK)
- RS series expert system shell from BBN Software Products Corp.
- RuleMaster2/PC from Radian Corp.
- S.1 from Teknowledge, Inc. (C-based ES structured shell)
- TIMM (The Intelligent Machine Model) from General Research Corp.

▪ ULTRIX/RISC

- DataTalker from Natural Language Products (natural language, March 1989)
- Franz Allegro Common LISP from Franz, Inc. (expected June 1989)
- IBUKI Common Lisp from IBUKI (Now available)
- Knowledge Craft from CGI (early 1990)
- Lucid LISP from Lucid, Inc. (expected late 1989)
- Mercury Knowledge Base Environment from Artificial Intelligence Technologies, Inc. (2nd half 1989)
- NEXPERT OBJECT from Neuron Data (Now available)
- Smalltalk-80 from ParcPlace Systems (April-June 1989)

SELECT Consulting Program

SELECT is Digital's AI technology transfer program. Goals include assisting customers in applying AI to their business in practical ways, providing comprehensive services to transfer Digital's AI know-how, and assessing the core business needs and selecting the appropriate technology to increase competitive position. Digital can train AI developers in the customer's organization or supply some of Digital's own developers.

With the exception of Introduction to AI in Business, and Choosing, Building, and Managing Knowledge-Based Systems seminars, the following training is available only for participants of the SELECT Program. This training is offered by the AI Training and Education Group at Digital's AI Training Center in Marlborough, Massachusetts. It is intended for carefully selected individuals who are, or will be, responsible for providing technical and/or managerial leadership in applying AI techniques to meet business goals. The training is grouped into the following categories:

- Technical Curriculum
  - Knowledge Engineering is an 8 to 10 week program provides theoretical and practical information on design, development, and implementation of knowledge-based systems in a business environment. The courses include:
    a. Introduction to AI (overview of AI/expert systems technology)
    b. Introduction to Symbolic Programming in LISP
    c. Introduction to OPS5
    d. Behavioral Skills for Knowledge Engineers
    e. Choosing, Building and Managing Knowledge-Based Systems (understanding and skill practice for organizational and interpersonal issues)
    f. Knowledge Acquisition
    g. Knowledge-Based System Prototyping
  - Advanced courses include
    a. Advanced OPS5
    b. Advanced Course on Knowledge Representation and Reasoning
    c. Object Oriented Technology and Its Role in Database Systems
- Management Curriculum
  - Introduction to AI in Business (4 days)
  - Introduction to AI in Business and Managing Knowledge-Based Systems (focuses on management implications of strategic, justification, technical, human resource, and organizational decisions in developing and implementing knowledge-based systems technology (two 4-day modules)
  - Choosing, Building and Managing Knowledge-Based Systems Seminar (2 days)
    a. Program Management of expert systems
    b. Comprehensive overview, structured methodology, and tools critical to choosing, scoping, planning, managing, and implementing knowledged-based systems
    c. Faculty is composed of knowledge engineers and technology transfer consultants who have successfully implemented Digital's knowledge-based systems
    d. Includes lectures, prerecorded video case study, group exercises, and demonstration of working knowledge-based systems
- Technology Implementation
  - Customized consulting services
  - Focuses on managing the program with perspectives of business/strategic, technical and human resource/organization
  - Organizational Assessment

a. Encompasses consulting services to determine knowledge-based system impact on people in the organization and plan for its successful integration with a customer's business plans

b. Includes work sessions with customer's management to understand how this integration requires effective management of expectations, communications, and change

c. Determine extent to which training and changes to work design, organizational structure, and reward systems are necessary for successful program implementation

d. Two-day training seminars on how to manage development of a complex knowledge-based system

e. nindividual courses in AI

- Management and Technical Seminars
  - Custom-designed based on customer's specific objectives and needs
  - Introduce senior and middle management to AI concepts and implementation techniques
  - Technical seminars for in-depth reviews of technical topics such as
    a. Design
    b. Knowledge representation
    c. Maintenance
- Conversion Assistance
  - Consulting program to assist customers to port existing prototypes and applications from the Symbolics environment to VAX
  - Provided by Software Services and using an internal toolkit known as VAXtv to ease porting of the windowing portion
  - Managed out of the Washington, D.C. Software Services Group, it has been proven with the government

Contact Don Weymouth, Manager, Business Development, SELECT, at DTN 291-8362 for further information about SELECT.

Educational Services

These services include the following seminars and training courses

- Seminars in choosing, building, and managing knowledge-based systems and project management are provided with emphasis on non-technical aspects of AI project management and implementation
- Videotapes
- Computer-based instruction courses covering all aspects of AI
- AI product specific curriculum includes:
  - VAX LISP
  - VAX OPS5
  - VAX Decision Expert
  - Epitool
  - NEXPERT OBJECT
  - Quintus Prolog

Contact the Education Services office in Bedford, MA at (617) 276-4380 or DTN: 249-4380 for further information about the Intelligent Systems courses listed below.

Part Number	Course Title	Course Length
EY-6778E	Symbolic Programming in VAX LISP	10 days
EY-A9198E	Building and Prototyping Expert Systems	5 days
EY-8340E	Programming in NEXPERT OBJECT	5 days
EY-A919E	Programming in VAX OPS5	5 days
EY-A957E	Programming in VAX Decision Expert	5 days

Appendix B
Industry Examples

What Do They Need?

The following information summarizes the need for expert systems help solve business problems that key industries face. These problems can be solved by using Digital's experience in expert system technology. Digital offers consulting services, training, hardware, and software. See Market Analysis, Typical Applications for further information.

EXPERT SYSTEMS CAN SOLVE PROBLEMS IN THE FOLLOWING SITUATIONS

Finance

Banking

Detecting fraud that may be occurring in the processing of stock, insurance, or money transfer claims by monitoring the behavior of brokers at locations throughout the United States. (*Developed for Digital Customer – Fraud Detection System*)

Lending personnel and customers need to satisfy applications for loans while analyzing credit limits. There is a need to have a consistent approach to money lending while training new personnel. (*Digital Internal Application – Loan Advisor*)

There is a need for failure analysis when computer systems used mainly for banking and money transfer transactions have gone down. These computer systems are critical to customers in the United States and at overseas locations. (*Digital Internal Application – Computer Failures Analyzer*)

Banks must design a variety of loan portfolios depending upon the risks involved. There is a need to maintain a bank's financial stability and manage its assets and liabilities. (*Developed for Digital Customer – Loan Mix Advisor*)

Bank presidents and CEOs need to manage their financial institutions while examining the "what ifs" of banking reserves. This includes reviewing the variables and providing alternatives for revenue forecasts. (*Developed for Digital Customer – Reserve Planner*)

Bank managers need to examine the "what ifs" of banking operations, providing alternatives for financial management. (*Digital Internal Application – Banking Operations Consultant*)

Financial institutions need to match personnel with appropriate skills to available positions during business reorganizations and mass layoffs. (*Digital Internal Application – Personnel Advisor*)

Insurance

There is a need to screen insurance applications and generate policies improving insurance claim accuracy. The burden and impact of changing laws and regulations such as AIDS testing implications need to be lessened as well. (*Developed for Digital Customer – Underwriting Advisor*)

There is a need for failure analysis when computer systems used mainly for insurance activities critical to everyday operations have gone down. (*Digital Internal Application – Computer Failures Analyzer*)

There is a need to provide a uniform, consistent means for generating, selecting, and editing insurance policy boilerplates while taking into consideration necessary regulations and requirements affecting parties being insured. (*Developed for Digital Customer – Policy Assembler*)

There is a need to identify the level of risk associated with specific policies by reviewing risk tables and computing insurance risks and premiums. (*developed for Digital Customer – Actuarial Assistant*)

Insurance institutions need to match personnel with appropriate skills to available positions during business reorganizations and mass layoffs. (*Digital Internal Application – Personnel Advisor*)

Telecommunications

There is a need to relieve congestion of computer networks providing overall systems management, while acting as a router for networks of communications equipment. (*Digital Internal Application – Intelligent Switching Assistant*)

There is a need to pinpoint the cause of network failures occurring on computer equipment at phone companies. (*Developed for Digital Customer – Fault Detection System*)

There is a need to provide overall security inspection of computer nodes for compromised operating systems while detecting password level security infractions. (*Digital Internal Application – Network Security Validation System*)

Network failures on electronic signal switching computer equipment are occurring and there is a need to reduce downtime of communications lines and equipment. (*Digital Internal Application – Switch Failure System*)

Total life cycle focus planning and management are needed for communications signal switching. This includes management of inventory storage, specific parts available, and cost of transporting or holding them. (*Digital Internal Application – Switch Planner*)

A resource forecast is needed so that shipment plans can be written to specify which products should be built and delivered while identifying shortfalls in communications equipment manufacturing capability. (*Digital Internal Application – Manufacturing Operations Advisor*)

There is a need to provide executive decision support capability with an overall view of telecommunications operations. This includes examining the "what ifs" of communications manufacturing or any other operations, manipulating the variables, and providing alternatives for financial management and sales forecasts. (*Digital Internal Application – Telecommunications Operations Consultant*)

Telecommunications companies need to match personnel with appropriate skills to available positions during mass layoffs or business reorganizations. (*Digital Internal Application – Personnel Advisor*)

General

Travel and Transportation

Optimization of distribution operations is necessary for scheduling, dispatching material, and selecting routes. (*Digital Internal Application – Transportation Operations Advisor*)

There is a need to analyze failures and provide corrective action for aircraft, trucks, buses, rail lines, and subway lines undergoing maintenance. (*Digital Internal Application – Diagnostics Advisor*)

Total routing visibility is needed while coping with increasing volumes of transportation business. This includes ensuring total capacity planning and management of vehicles: keeping track of vehicles in transit, routes they are taking, cargo they are carrying, and deadlines they are trying to meet, while ensuring that terms and conditions of carriers' contract are also met. (*Digital Internal Application – Dispatching Advisor*)

A resource forecast can be created so that plans can be written to specify scheduled deliveries and which vehicles will be used to deliver, while also identifying shortfalls in transportation capability. (*Digital Internal Application – Transportation Operations Advisor*)

Executive decision support in transportation is needed while providing total transportation planning and management. (*Digital Internal Application – Transportation Operations Advisor*)

There is a need to match personnel with the appropriate transportation skills to available positions during mass layoffs and business reorganizations. (*Digital Internal Application – Personnel Advisor*)

Discrete/Process

Manufacturing

There is a need to relieve congestion of manufacturing computer equipment networks providing overall systems management based on intelligent calculations. In additional, it is necessary to act as a router for these networks of nodes. (*Digital Internal Application – Computer Networks Advisor*)

There is a need to reduce the downtime of manufacturing equipment and enhance time to market of manufactured products while providing sensor data and problem corrections in real time. (*Digital Internal Application – Manufacturing Process Control System*)

Total capacity planning and management are needed to provide schedules, dispatch material, and select routes for material output and production distribution. This includes providing total routing visibility while coping with increasing material output and product distribution. (*Digital Internal Application – Dispatching Advisor*)

Failure analysis on manufacturing equipment or computers is required to provide corrective action reducing downtime while undergoing repair. (*Digital Internal Application – Diagnostics Advisor*)

Sequencing of all detailed manufacturing tasks is required so as not to require retooling. (*Digital Internal Application – Master Scheduler*)

Manufacturing configuration abilities are required for any type of systems management by configuring computer and manufacturing equipment layouts on plant floors. (*Digital Internal Application – Xcon System*).

There is a need to create a forecast so that human resources will be properly balanced for the associated task. This includes taking into consideration time and people while identifying shortfalls in manufacturing capability. (*Digital Internal Application – Manufacturing Resource Process Loader*)

Executive decision support and modeling are required to provide product life cycle focus planning and management by simulating where inventory is sitting, specific parts available, and the cost of inventory and transporting it. (*Digital Internal Application – Inventory Advisor*)

Manufacturing operations need to match personnel with appropriate skills to available positions during business redeployments or reorganizations (*Digital Internal Application – Personnel Advisor*)

Discrete

Aerospace

There is a need to relieve congestion of aerospace computer equipment networks while providing overall systems management based on intelligent calculations. (*Digital Internal Application – Computer Networks Advisor*)

Overall life cycle focus planning and management need enhancement during production of engineering schematics. Additionally, there is a need for a process and simulation tool for planning (*Digital Internal Application – Engineering Design Assistant*)

Total routing visibility is needed while coping with increasing material output and inventory distribution. This includes total capacity planning and management, providing schedules, selecting routes for material, and dispatching material. (*Digital Internal Application – Dispatching Advisor*)

Reduction of downtime of aircraft and computers undergoing maintenance is required by analyzing failures and providing corrective action for avionics/electronics as well as computer equipment. (*Digital Internal Application – Diagnostics Advisor*)

There is a need to provide total life cycle focus and planning for aerospace engineering projects and overall aircraft inventory management. This includes simulating where inventory is sitting, specific parts available, and cost of transporting or holding. (*Digital Internal Application – Project Manager*)

Aerospace manufacturing with configuration capabilities is required for computer and manufacturing equipment layout on plant floors and other areas. (*Digital Internal Application – Xcon*)

There is a necessity to speed up engineering product design processes while increasing planning time. (*Digital Internal Application – Intelligent Draftsman*)

A forecast can be created so that shipment plans can be written to specify which products should be built and delivered. This includes examining the "what ifs" of engineering operations, manipulating variables, and providing alternatives for financial management and sales forecasts. Enhancement of executive decision support involved in engineering, procurement, and production is required. (*Digital Internal Application – Master Designer*)

There is a need to match personnel with appropriate skills to available positions during mass layoffs or business reorganizations. (*Digital Internal Application – Personnel Advisor*)

Process

Oil and Gas

There is a need to relieve congestion of oil and gas computer equipment networks while providing overall systems management. Additionally, it is necessary to act as a router for these networks of nodes. (*Digital Internal Application – Computer Networks Advisor*)

Failure analysis is required on oil and gas equipment and computers to provide corrective action reducing downtime of such equipment undergoing repair. (*Digital Internal Application – Diagnostics Advisor*)

It is necessary to schedule the order and time of hydrocarbon products through pipelines, including consideration of storage tanks, barges, and other pipelines, while producing pumping orders that include information on how long to run and at what capacity. (*Developed for Digital Customer – Hydrocarbon Advisor*)

A forecast is needed so that plans can be written to specify sequence of the hydrocarbon product refining process while identifying shortfalls in oil and gas production. (*Digital Internal Application – Operations Advisor*)

Shortfalls in the oil manufacturing process capability must be identified. This includes examining the "what ifs" of manufacturing operations and manipulating variables of volume, timing, and product mix. (*Digital Internal Application – Manufacturing Operations Advisor*)

Oil and gas producers need to match personnel with appropriate skills to available positions during mass layoffs or business reorganizations. (*Digital Internal Application – Personnel Advisor*)

Pharmaceuticals

There is a need to relieve congestion of pharmaceutical computer equipment networks while providing overall systems management based on intelligent calculations. This includes acting as a router for these networks of nodes. (*Digital Internal Application – Computer Networks Advisor*)

There is a need to reduce downtime of pharmaceutical manufacturing equipment while enhancing time to market of pharmaceutical products by providing sensor data and problem corrections in real time. (*Digital Internal Application – Manufacturing Process Control System*)

There is a need to create a resource forecast so that ship plans can be written to specify which products should be manufactured and delivered, while optimizing pharmaceutical manufacturing operations. (*Digital Internal Application – Manufacturing Operations Advisor*)

Failure analysis is required on equipment undergoing repair that manufactures drugs thereby increasing their production. The same is needed for pharmaceutical computer equipment undergoing repair. (*Digital Internal Application – Computer Failures Analyzer*)

Sequencing of all detailed tasks necessary in pharmaceutical production is needed so as not to require retooling (*Digital Internal Application – Master Scheduler*)

Pharmaceutical manufacturing and computer equipment configuration abilities are required. This includes configuring layouts on plant floors as well as any other tasks to be accomplished. (*Digital Internal Application – XCON System*)

A forecast can be created so that human resources will be properly balanced for the associated task. This takes into consideration time and people while identifying shortfalls in manufacturing capability. (*Digital Internal Application – Manufacturing Operations Advisor*)

Executive decision support and modeling are required to provide product life cycle focus planning and management. This includes simulating inventory storage, specific portions available, and the cost of the inventory and its transporting. (*Digital Internal Application – Manufacturing Operations Advisor*)

There is a need to review positions and match personnel with appropriate skills to available positions during mass layoffs or business reorganizations. (*Digital Internal Application – Personnel Advisor*)

Federal, State, and Local Government

Department of Defense Direct, Civilian Agency Direct

There is a need to relieve congestion of computer equipment networks located at state and local levels as well as large management information systems located within the Air Force, Army, and Navy. A router for networks of nodes would assist in overall systems management based on intelligent calculations. (*Digital Internal Application – Computer Networks Advisor*)

Overall aircraft life cycle focus planning and management need enhancement for the Air Force as well as state and local government planning commissions during production of engineering schematics. A need also exists for process and simulation tools in planning. (*Digital Internal Application – Engineering Design Assistant*)

There is a need to schedule aircraft/truck deliveries, dispatch spare parts, and select routes for the Air Force, Army, and Navy distribution operations. State and local governments need to dispatch street/road maintenance crews and identify state vehicle inspection stations for automobiles. (*Digital Internal Application – Dispatching Advisor*)

Failure analysis is required to reduce downtime for aircraft undergoing repair for the Air Force and Navy as well as vehicles/equipment used by the Army. The same is necessary for any computer equipment used by the federal, as well as state and local governments. (*Digital Internal Application – Diagnostics Advisor*)

There is a need to provide total planning for overall aircraft inventory management for the Air Force, Army, and Navy. This includes simulating where inventory is stored, specific parts available, and cost of transportation or storage. (*Digital Internal Application – Inventory Manager*)

Configuration capabilities are required for computer layouts for all levels of government. The same is needed for maintenance shop layouts for aircraft and equipment repair in all military services. (Digital Internal Application – XCON System)

A forecast can be created so that human resources will be properly balanced for the associated task taking into consideration time and people. It is necessary to identify shortfalls in planning capability for state and local planning commissions as well as planning for maintenance resources on aircraft, ships, vehicles, or computer equipment in day to day operations in the federal government. (*Digital Internal Application – Operations Advisor*)

Executive decision support and modeling are required to provide aircraft life cycle focus planning and management by simulating all aspects of support and repair. This can be used by the Air Force and Navy as well as for state and local planning issues for water, sewer, streets/roads, and subways. (*Digital Internal Application – Operations Advisor*)

All levels of government need to match personnel with appropriate skills to available positions during reductions in force (RIFs) or reorganizations. (*Digital Internal Application – Personnel Advisor*)

Appendix C
Resource Locator

Who and What Are Your Resources?

The information is this section is accurate as of its publication date. Contact Jeanne Douglass, DTN 291-8053, for any changes or information.

Liaison Field Readiness Team

Program Team			
Jeanne Douglass	AITG::DOUGLASS	291-8053	Program Manager
Bob Iwicki	AITG::IWICKI	291-8544	Field Readiness
Third Party Products			
Dino Lachiusa	AITG::LACHIUSA	291-8045	Knowledge Craft, KEE, DECwindows, Workstations, VAX Systems
Themis Papageorge	AITG::PAPAGEORGE	291-8529	VAX LISP, Epitool, VAX Decision Expert, VAX OPS5, NEXPERT OBJECT
Corporate CMP Account Managers			
Ralph Donohue	@PTO	422-7869	Knowledge Craft
Kayne Thrift	JULIET::THRIFT_KA	521-4484	Knowledge Engineering Environment
Linda Reding	SPGOPS::REDING	223-5843	NEXPERT OBJECT
Consulting Team			
John Walters	PAAIEC::WALTERS	(415)688-6840	Manager, West Coast AI Expertise Center
Steve Gutz	ISTG::GUTZ	291-8355	Manager, SELECT Program
Don Weymouth	ISTG::WEYMOUTH	291-8362	Manager, Business Development, SELECT
Ed Killeen	BUFFER::KILLEEN	276-8376	Program Manager, New Ventures
Paul McManus	BUFFER::MCMANUS	276-8755	New Ventures Program, Professional Software Services
Terry Potter	BUFFER::POTTER	276-8389	Manager, New Ventures
Peter Jordan	BUFFER::JORDAN	276-8748	New Ventures Program, Professional Software Services
U.S. Sales Support			
Sue Chittenden	OFFPLS::CHITTENDEN or @MKO	264-5315	U.S. Sales Support Programs/AI
AI Training Team			
Jeff Clanon	CDR::CLANON	291-8610	Manager, AI Training & Education
Jim Nuzzo	ESIS::NUZZO	291-8821	Education Services Training Manager

Northeast		
Jim Pompano	CTOAVX::POMPANO	255-5360
Daniel Suppin	@FMT	383-4535
Mid-Atlantic		
Sue Cofer	@DCO	341-2308
Joe Despautz	@PHC	376-2503
Edward Leary	GUCCI:: or TEASE::LEARY or @MEL	339-5111
Brendan McShane	@DCO	341-2362
Larry Ross	GRANPA::LROSS	337-4250
Lawrence Saunders	PRIMES::SAUNDERS	341-2429
New York/New Jersey		
Lauren Farese	KYOA::FARESE or @KYO	323-4069
Michael Heffler	@KYO	342-1958
Mark Hirmes	@KYO	352-2905
Sheela Patel	SICVAX::PATEL	352-2151
Robert Roche	PARVAX::ROCHE	465-7221
Anne Silberberg	SUBWAY::SILBERBERG or @NYO6	352-2130
Southern		
John Hennessy	SAHQ::HENNESSY	351-2476
Rick Stetson	AUNTB::STETSON	367-7038
East Central		
Jeffrey Hadley	@CLO	431-2915
Michael Kier	MTAIRY::KIER	432-7715
Richard Perlman	@PTO	422-7274
Central		
Janet Johnson	@STO	445-6573
Joe Modelevsky	POBOX::MODELEVSKY	474-5491
Western		
Kent Meagher	AITOLA::MEAGHER	521-4084
Steven Page	DV780::PAGEST	(801)268-3392
South Central		
Art Beane	HSOMAI::BEANE or @HSO	441-3764
Steve Becker	@AQO	554-7200
W. C. Blasingame	CUJO::BLASINGAME or @DVO	553-3463
Dennis Dickerson	@DCO	486-6450
Steve Donovan	@DCO	486-6448
Miriam Heller	HSOMAI::HELLER or @HSO	441-3705
Southwest		
Daryll Shatz	IVOGUS::SHATZ	(714)261-4168

Palo Alto AI Expertise Center

John Walters, Manager	PAAIEC::WALTERS	(415)688-6840	
Jeffrey Harvey	PAAIEC::HARVEY	(415)688-6842	
Paul Hebert	PAAIEC::HEBERT	(415)688-6860	
Eric Lipanovich	PAAIEC::LIPANOVICH	(415)688-6841	
Ulf Lundqvist	ULF::LUNDQVIST or STKHLM::ULUNDQVIST	(415)688-6843	
Saroja Subramanian	SAROJA::SAROJA	(415)688-6863	

GIA

Roger Camire	AKOV12::CAMIRE	246-6796	

Canada

Gordon Graham	TRCA01::GGRAHAM	637-3181	

Japan

Yasuhiko Yamamoto	TKCV58::YAMAMOTO	592-7175	

France

Andrew Buchanan	@VBO	858-5805	SWAS
Pascal Coutier	@VBO	858-5801	Marketing
Jim Kane	@VBO	858-5299	SWAS
Pat Roach	@VBO	858-5784	SWAS
Daniel Serain	@VBO	858-5154	SWAS
Mark Turner	@BST	768-5121	SWAS

United Kingdom

Mark Bosley	@RKA	830-4081	Ed Services
Eric Coates	@RDL	899-5424	Marketing
Fraser Dingwall	@BST	768-5121	SWAS
Malcolm Exton	@BST	768-5133	SWAS
Steve Hodge	@BST	768-5364	SWAS
Laurie McDonald	@BST	768-3423	SWAS
Bob Muller	@BST	768-5359	SWAS
Elise Payne	@BST	768-5121	SWAS
Brian Pogson	@BST	768-5402	SWAS
David Probert	@RDL	899-5232	Marketing
Dave Robbins	@BST	768-5372	SWAS
Richard Stow	@BST	768-5369	SWAS

Germany

Derek Bade	@UFC	773-3283	SWAS
Hanns Balzer	@CEN	770-7830	SWAS
Karl-Ludwig Barth	@COO	860-6439	SWAS
Alexandra Boeck	@UNT	786-1412	SWAS
Mariana Bozesan	@RTO	865-4432	Marketing
Peter Brittain	@UFH	773-2069	Ed Services
Klaus Grupe	@UFC	773-0111	SWAS
Andrian Hammerstein	@UFC	773-3285	SWAS
Andreas Hemberger	@FRA	877-8147	SWAS
Hubert Hers	@UFC	773-3168	SWAS
Heinz-Dieter Hufnagel	@FRS	861-3011	SWAS
Bernd Jung	@COO	860-6465	SWAS
Karl Kramer	@SUS	772-4193	SWAS
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Israel			
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Product, Literature, Presentation, Demos, Ed Services Courses, Success Stories

Product	Cross-Ref(Q #'s)	Literature	Presentations	Demos (AITG::AI-DEMOS)	Ed Services Courses	Success Stories
VAX Decision Expert (VDE)	QA-VI2AX-XX	ED 32962 74 Easy-To-Use Productivity Shell for Diagnostic-Related Problems	AIM77 35mm Linda Sears EXIT26::SEARS, DTN 249-1606	Stereo Diagnosis Application Using VDE HMO Claims Advisor Manufacturing Diagnostic	EY-A957E-LO VAX Decision Expert Non-AI Programmers and Engineers Who Want a Productivity Tool to Develop Expert Diagnostics Analysis/ Maintenance Applications (Overview) – 5 Days	ED 32443 74 Care – Requisition Engineering Expertise Put Online w/VDE ED 32445 74 Class – Making Commercial Lending Decision with VDE ED 32444 74 Jet-X – Jet Engine Performance Analyzed and Interpreted by VDE ED 32446 74 Machine Adjuster's Helper – Assembly-line Maintenance Advisor Built with VDE
VAX LISP	QL-917AX-XX	EC F0150 74 A Complete LISP from Digital	N/A	Lotsizex – MRP Schedule Revision ES Intelligent Integrated Solution – Automotive Dealership Config Asst Underwriting Asst – Insurance Underwriting ES VAX/VMS LISP Rolling Product Feature VAX/ULTRIX LISP Rolling Product Feature	EY-6778E-LO Symbolic Programming in VAX LISP (Focused/In Depth) – 10 Days EY-A954E-LO Aspects of VAX Common LISP Integral to Building Real Applications (In Depth) – 5 Days	ED 32426 74 MOC – Manufacturing Operations Consultant Tool for Proactive Response in Planning
VAX OPS5	QL-VD4AX-XX QL-502AX-XX QL-913AX-XX	ED 32432 74 An Integrated Environment for ES Development	N/A	Technical Analysis – Trader's Analytic Asst Job Scheduler Printing Press Job Scheduling Expert System VAX/VMS OPS5 Rolling Product Feature	EY-A919E-5 Programming in VAX OPS5 Fundamental (Focused/ In Depth) – 8 Days EY-A968E-E0 Advanced VAX OPS5 – 6 Months Experience Including Large Project (In Depth/SELECT Customers) – 5 Days	ED 32430 74 APES – Automatically Produced Engineering Schematics – A Logic Synthesis Tool ED 32428 74 Canbuild ES – An Investment in Tomorrow – A Payback for Today ED 32429 74 Performance Analyzer Expert System into Management/Analysis Tool ED 32425 74 X-CON – Expert Configuration System – Customized Configuration for Customer Satisfaction

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Product, Literature, Presentation, Demos, Ed Services Courses, Success Stories (Continued)

Product	Cross-Ref(Q #'s)	Literature	Presentations	Demos (AITG::AI-DEMOS)	Ed Services Courses	Success Stories
Quintus Prolog (DDS)	QL-VCYAX-XX	N/A	N/A	N/A	N/A	N/A
NEXPERT OBJECT (DDS)	QB-OCFAX-XX QT-OCFAX-XX Q6ZFS-XX	EA 31958 74 ES Development for the VMS Operating System Environment From CAIM Only NEXPERT OBJECT on Digital VAX Cooperative Literature Reprint	N/A	Network Diagnostic Advisor – Network Problem Diagnosis ES In Process – ULTRIX Version of Network Diagnostic Advisor	EY-8340E-LO How to Use NEXPERT OBJECT to Build Applications (Focused/In Depth) – 5 Days EY-A956E-LO Advanced Programming in NEXPERT OBJECT (In Depth) – 5 Days	N/A
Knowledge Craft (CMP)	Available from Carnegie Group	N/A	N/A	Available from Carnegie Group	N/A	ED 32426 74 MOC Manufacturing Operations Consultant Tool for Proactive Response in Planning ED 32427 74 National Dispatch Router AI Distribution System
Knowledge Engineering Tool (KEE) (CMP)	Available from Intellicorp; Discounts for Multiple Purchases; Academic Pricing, and Maintenance and Support Available	N/A	N/A	Available from Intellicorp	N/A	N/A
Enterprise: Expert (CMP)	Available from Cullinet Software, Inc.	N/A	N/A	Available from Cullinet	N/A	N/A
LEVELS (CMP)	Available from Information Builders, Inc.	N/A	N/A	Available from Information Builders, Inc.	N/A	N/A
Epitool (DDS)	Available from Digital					

Product, Literature, Presentation, Demos, Ed Services Courses, Success Stories (Continued)

Product	Cross-Ref(Q #'s)	Literature	Presentations	Demos (AITG::AI-DEMOS)	Ed Services Courses	Success Stories
Overview	N/A	Available from CAIM AI, Behind the Scenes at Digital: Commitment to AI by Michael Stock, Digital News, May 2, 1988 EA 32453 73 AI Leadership: Give Your Organization the Competitive Advantage	AIM81.002-.004 AIM81.007-.008 AIM81.013-.016 AIM81.018,.022, .027,.029,.038 AIM84.004,.008, .010,.013 AIM61.001,.002, .004,.007 AIM62.006 AIM63.004,.005 AMM09.040 The Mill Presentation (Entire AIM85) 35mm Slides Linda Sears EXIT26::Sears DTN 249-1606 DW205; AI in Telecommunications: Meeting the Challenge Today Linda Sears EXIT26::Sears DTN 249-1606 Slide Set #773 Corp Photo Library in PKO Digital and AI: The Competitive Advantage EXIT 26::PHOTO Or ALL-IN-1 – Photo @ PKO, DTN 249-1606	N/A	EY-8334E-EO Intro to AI in Business – Overview of AI Technology and Knowledge Based Systems, Potential Applications, Realistic Expectations; Implementing the Technology in a Business Setting (Overview) – 4 Days EY-A9583-LO Management Orientation to Expert Systems for the Insurance Industry, Problem Ident, Selecting an Expert, Knowledge Eng, Prototype Dev, Tech Transfer (Overview) – 3 Days EY-A969E-EO Above Two Courses Offered Together (Overview/Select Customers) – 7 Days EY-A955E-LO Technical Orientation to Expert Systems for the Insurance Industry, ES Tools and Use, Problem Classification and Tool Selection; Intro, Use, Design, and Application of NEXPERT OBJECT, Shell Selection for Insurance Applics – 5 Days EY-A918E-LO Building and Prototyping ESs ES Construction (Focused, in Depth) – 5 Days EY-A971E-EO Object-Oriented Technology and Its Role in Database Systems – Experience in Large Scale System Building Efforts (In Depth/Select Customers) – 5 Days	N/A

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Appendix D Glossary of Key AI Terms

Algorithm

A step-by-step procedure that guarantees a correct outcome. To develop a conventional computer program, the programmer specifies the algorithm that the program will follow using explicit instructions. By definition, however, this approach assumes that the path in which a problem is solved can be determined in advance.

Artificial Intelligence

A subfield of computer science, it contains 137 different facets concerned with the concepts and methods of symbolic inference by a computer and the symbolic representation of the knowledge to be used in making inferences. A field aimed at pursuing the possibility that a computer can be programmed to behave in ways that humans recognize as intelligent behavior in each other. These include the abilities to understand language, to reason, to learn, and to solve complex problems.

Backward Chaining

A type of system activity that attempts to solve a problem by stating a goal and looking into the database for the conditions that would cause that goal to come about, then reiterating this process, using those conditions as the goals and searching for their preconditions, etc. For example, in an expert system that uses backward chaining, it is possible to solve problems such as "How can I end the fiscal year at 10% under budget?" In this case, the program begins with a goal-being 10% under budget-and works backward to a set of antecedent conditions which would bring that goal about. Backward chaining also provides the foundation for the explanation facility that is used in many expert systems to retrace a solution by recalling the rules that were used in the reasoning process. Because it is used to build a strategy for reaching a known goal, an expert system that employs backward chaining techniques is commonly called a goal-driven system.

Certainty

The degree of confidence one has in a fact or relationship. As used in AI, this contrasts with probability, which is the likelihood that an event will occur. There are two types of certainty: the certainty that the expert has in a relationship expressed in a particular rule or relationship, and the certainty that the user has when he or she provides information during a consultation.

Certainty Factor (Confidence Factor)

A numerical weight given to a fact or relationship to indicate the confidence one has in the fact or relationship.

Domain

A subject matter area or problem-solving task. Finance and factory automation are very broad domains. Existing systems only provide good advice when they are used to assist users in solving problems that lie within very narrowly defined domains. Analyzing auto loans or diagnosing what could be wrong with a particular type of robotic device are examples of narrow domains or tasks.

Domain Expert

A person who, through years of experience, has become proficient at solving problems in a particular domain.

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Expert System

A computer system that embodies the specialized knowledge of one or more human experts and uses that knowledge to solve problems. By capturing in software the best knowledge and judgment available, it is possible to distribute expertise on a wider scale. An expert system consists of a knowledge base and an inference engine, both of which are continually modified and evaluated. It may also include a natural language interface that facilitates user communication with the system, an explanation facility, and a knowledge acquisition subsystem that is used to enhance the knowledge base. A major strength of an expert system is that it can take the best insights of several human experts and apply them to the same problem simultaneously.

Forward Chaining

A type of system activity that applies operators to a current state in order to produce a new state, and so on, until the solution is reached. A forward chaining rule detects certain facts in the database and takes an action because of them. For example, in a system that uses forward chaining, it is possible to solve problems such as "What will be the cost of new office furniture if I hire three more people?" The program synthesizes an answer from pieces of knowledge. An expert system that employs forward-chaining techniques is also called a data-driven system.

Frame

A knowledge representation technique based on the idea of a frame of reference. A frame carries with it a set of slots which can represent objects that are normally associated with the subject of the frame. The slots can then point to other slots or frames, a feature that gives frame-based systems the ability to allow one object to inherit characteristics from another, and to support inferences.

Goal

A condition or set of conditions to which a valid solution must conform.

Heuristic

A rule-of-thumb or other device or simplification that allows its user to draw conclusions without being certain. Because the success of a heuristic is not guaranteed, a problem that can be solved by one algorithm frequently requires many heuristics. The primary effect is to eliminate the need to examine every possible approach.

Icon

A symbol to which a computer user can point an interface device in order to select a function, such as "move window."

If-Then Rule

A rule establishes a relationship among a set of facts in an if clause and one or more facts in a then clause. Rules may be definitional, e.g., If female and married, then wife; or heuristic, e.g., If cloudy, then take an umbrella.

Inference

The process by which new facts are derived from established facts.

Inference Engine

The portion of an expert system that contains the inference and control strategies that select and execute rules. It also includes various knowledge acquisition, explanation, and user interface subsystems. When an inference engine is separated from a knowledge base, it is, in effect, an expert system building tool. The conclusion that the inference engine draws from a given set of facts is not known in advance.

Knowledge Base

The portion of an expert system that consists of the facts and heuristics about a domain. AI systems using such a base are called knowledge-based systems. In an expert system, the knowledge base generally contains a model of the problem, knowledge about the behavior and interactions of objects in the problem domain, and a level of general-purpose knowledge.

Knowledge Engineer

A knowledge engineer interviews experts to obtain the raw knowledge from which to structure the knowledge base and formulate the rule base, and programs raw knowledge into a form that the computer can understand. A systems analyst.

Knowledge Representation

A structure in which knowledge can be encoded and stored in a way that allows the system to understand the relationships among pieces of knowledge and to manipulate those relationships.

Maintenance of an Expert System

Unlike conventional computer software that is only infrequently updated, expert systems are very easy to modify. Unlike conventional systems that are "completed," most expert systems currently in use are constantly being improved by the addition of new rules. In most applications, the user organization will want to establish a regular routine to capture and incorporate new knowledge into the system. An application processing advisor system would be maintained by the senior application processing clerk. That clerk would be responsible for entering new rules whenever data or procedures change or whenever questions arose that the current system could not answer.

Monotonic Reasoning

A reasoning system based on the assumption that once a fact is determined it cannot be altered during the course of the reasoning process.

Natural Language

A person's native tongue. Natural language systems attempt to make computers capable of processing language the way people normally speak it instead of in specialized programming languages, making it easier and more efficient for both inexperienced and sophisticated users to work with computers. Natural language systems are well suited for environments that include many non-technical users or users who do not spend much time working with computers, for database inquiry systems, and for computer-assisted instruction systems. Most natural language systems are implemented in English.

Productivity Shell

A tool for software developers and applications programmers to build expert systems modules. Its focus is predominantly toward problem solving methods. It includes development and delivery packages allowing users to build expert systems by making selections from windows and menus. Its ability of integration makes it capable of calling in and out to other languages and tools, suitable for embedding AI in conventional software, and capable of enhancing existing applications.

Robotics

The branch of AI research that is concerned with enabling computers to "see" and "manipulate" objects in their surrounding environment. AI is concerned with developing the techniques necessary to develop robots that can use heuristics to function in a highly flexible manner while interacting with a constantly changing environment.

Technology Transfer

Process by which knowledge engineers turn over an expert system to a user group. Since expert systems need to be continually updated, the knowledge engineers need to train the users to maintain a system before it arrives in the user environment. Some users must learn how to do some knowledge engineering.

Windows

Conventional computer terminals use the entire screen to present information drawn from one database. Computer terminals that can utilize window software can divide the screen into several different sections or windows. Information drawn from different databases can be displayed in different windows. For example, a Macintosh computer can have a word processing program going in one window and a graphics program going on simultaneously in a second window. Most expert systems research is being conducted on computers that allow the user to display difference views of the system activity simultaneously. Windows are an example of a technique originally developed by AI researchers that has now become a part of conventional programming technology.

Appendix E
General Guidelines

Financial Justification of Knowledge-Based Systems

In preparing the financial justification for Knowledge-Based Systems, there are several factors/issues to consider. The following is a list of several key factors/issues:

- Identifying the Benefits and Costs
- Impact on Efficiency
  - Fewer people
  - Reduced inventory
  - Reduced capital assets
  - Reduced space requirements
  - Improved throughput
- Impact on Effectiveness
  - Quality improvements
  - Increased responsiveness to customer needs
  - Accuracy improved by reducing errors
  - Increased time available for solving complex problems
  - Improved market share
  - Greater flexibility
- New Opportunities
  - New services
  - New products or increased features
  - More flexible product designs
  - Coordination or integration of processes
- Initial Costs and Implementation Costs
  - Hardware
  - Software
  - Number of knowledge engineers
  - Training (for knowledge engineers and users)
  - Expert time required
  - Management time required
  - Other incremental costs (space, travel, etc.)
  - Productivity impact during implementation
- Ongoing Operating Costs
  - Hardware upgrades
  - Hardware maintenance
  - Knowledge-Based System maintenance/upgrades
- Quality of Work Life
  - Will the number of repetitive tasks or problems handled by individuals be decreased?
  - Will the job be more interesting?
  - What will be the impact on employee morale?
- Quantifying Benefits and Costs

  There are several methods available to quantify the benefits and costs.
  - Net present value
  - Internal rate of return

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- Return on investment (ROI)
- Payback

Additional approaches to justification require management judgment to place values on such strategic concerns as:

- Technical innovation
- Competitive advantage
- Research and Development
- Meeting business objectives

• Common Obstacles to Change, Pitfalls and Other Issues

- Short-term financially oriented standards
- Emphasis on short-term productivity rather than strategic goals
- Over/underestimating the benefits to be derived from use of the system
- Over/underestimating the time needed to achieve completion of the system
- Omission of direct/indirect savings automatically gives these savings a value of zero
- Selecting an inappropriate interest rate/discount rate in the quantification process
- Not including the impact of inflation
- What is the alternative to investing in the Knowledge-Based System
- Recognizing front-end costs as investments
- Recognizing the difficulty of quantifying benefits
- Corporate performance and rewards are based on performance against annual budgets/forecasts
- Capital budgeting traditionally emphasizes ROI
- Management may be unreceptive to major innovations
- Aversion to risk, especially regarding "core" business problems
- Not choosing the higher-payoff problem to solve
- Solving a problem that is going away

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