Area Rep Report

Artificial intelligence market has huge potential

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Conference Speaker

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I'm going to talk about the 4404 Artificial Intelligence System, also known as Pegasus. There are two stories to the system, one is what the 4404 and artificial intelligence is and the other is how the product was developed.

The product officially was started in March, 1984, when Jon Reed (Vice President, IDG) formed the Artificial Intelligence Machines Group as a special program. Before that there was a lot of preliminary product development going on in Tek Labs. And, before that there was work that went on at Xerox, Palo Alto Research Center.

In 1980, Xerox developed a programming language called Smalltalk. They wanted some other companies that were highly respected in the industry to evaluate this language. They asked Apple Computer, Digital Equipment Corporation, Hewlett-Packard and Tektronix to evaluate it.

Allen Wirfs-Brock (Tek Labs) started evaluating Smalltalk in 1980. By 1983 he had developed a version of it that was very fast and also ran on a Tek Labs developed workstation.

In March, 1983, when I was engineering manager in Unicorn, Allen and a group of engineers from Tek Labs approached me with an idea for a product. They liked the Unicorn manufacturing processes, and thought they could fit an artificial intelligence computer inside that package and have a really low cost, high performance Smalltalk product.

We started working on it and in October of that year, we presented a product proposal to Jon Reed. Jon supported us and, with the additional support of Rick LeFaivre and Kevin Considine, we were given the approval in March, 1984, to go ahead and build the product.

In the meantime we had refined the product definition a little more to focus on the emerging artificial intelligence market. The Japanese had announced their fifth generation computer effort, which was a plan to pool the resources of the total country to build a super computer, making artificial intelligence a national priority.

Every August there is a show called the Artificial Intelligence Show (AAAI). Even though we had only started in March, we were determined to display our new products at the show to take advantage of the new interest in AI.

We put together prototypes, a sales force, marketing plans, and training. We got software. And, we made it to the show. The really significant thing about this accomplishment is that it was done as a team effort between Tek Labs and IDG.

We were late making reservations for the show so we only had a small 10-foot booth. We didn't have many marketing people so we had engineers doing booth duty and explaining our product.

The first day we didn't get a lot of traffic in the booth. We thought it might be because we didn't have the price displayed anywhere. So, we had a sign made with the price ($14,950). Then we had all sorts of action.

It was probably the greatest show I have ever been to with a product. It wasn't a large show, there were only about 3000 people there, but it seemed like every one of them came through our booth.

Now I'd like to explain artificial intelligence.

There are two major areas of research in artificial intelligence. One is cognitive science that deals with how humans actually think and process information. The people doing research in this area worry about how nerve impulses get transmitted around your brain, and all the chemical processes that go into making your brain and body work.

The other side is intelligent machines. The objective is to try to get the machines, or computers, to mimic human behavior.

Picture sitting down at a terminal, and having a written (typed) discussion with it, where it responds with written answers. If you can't tell whether the answer is given by the computer or a human being, then the machine is said to be artificially intelligent.

Expert systems is the most popular application of artificial intelligence. In just about any magazine you pick up you can usually find some reference to it. The expert system is a compilation of facts and rules and methods for using the rules and facts. Another way to describe it could be like repairing your car.

Usually when you need to fix your car you have to go through a series of steps to determine what's wrong with it. The next time you have to work on it you usually have to start all over again because you forgot what you did the last time.

What an expert system does is collect all the different little rules for repairing the car, and the different methods for checking different symptoms. So, if you sit down with an expert system and say "my car chugs when it goes uphill," the system will come back with a series of questions. It might ask "does it only chug going uphill? Have you checked the fuel pump?" and go on through a series of questions to help you find the problem.

The whole idea is that knowledge is collected and organized so it isn't lost.

An important thing to understand is that artificial intelligence does not take away from human expertise. It merely organizes information and provides a very good user interface to that data. There is still a human making the final decisions. It's like having an expert advisor work with you.

One of the questions that always comes up on expert systems is "can they learn?" Right now they can't. A lot of research is being done in this area because if you come across an error, you'd like to be able to correct that error and say "well, no, you don't need to replace the fuel pump, you should get a new carburetor." So, the ultimate goal of expert systems is to allow that kind of flexibility.

AI really plays a part in that quasi learning process. The software tools that are available for AI allow programmers to write programs that will allow that manipulation very easily. If you write in a conventional language, such as Fortran or Basic, it's very difficult to have that kind of flexibility.

The second big area for application of AI is in natural language interfaces.

There's a lot of work being done on user interfaces. The idea is that you don't have to learn all this complex computer jargon. That's the thing that keeps me from making effective use of a computer. At Wilsonville we're logged on to three or four different systems and I get electronic mail on each system. I can never remember what to type to get onto each system. I just want to sit down and ask a simple question like "did I make my budget last month?" Right now that can't be done. That's the kind of application area where people are heading with natural languages.

Another application area is intelligent robotics. There are some problems though. Some of them are: object avoidance, motion planning, error recovery and route planning. There's a lot of military money being spent in this field for building robots, mobile vehicles, mobile planes, and mobile boats to run around without pilots in them.

The other area of intelligent robotics has to do with assembly type robots. For example robots that can tell the difference between a philips screw and a flathead screw.

Along with robotics, you need vision. The remote land vehicle that Martin-Marietta recently demonstrated has an image processor inside it that actually scans and looks for objects to avoid.

Another area of AI research involves working with symbolic mathematics. In other words, doing things in algebra instead of numbers, working with symbols. A + B = C instead of 2 + 3 = 5.

The last area of AI research is in automatic programming. This is intended to facilitate the human interface to large amounts of computer data on powerful computers. If I come up with a problem where I want to do something the computer is not programmed to do, I would like to be able to describe what I want the computer to do in some natural language fashion such as "I really don't like your graph or the way you did my budget. I want you to shrink the scale down so it doesn't look so bad," and the computer will follow those instructions.

When we started the 4404 program we said we were going after the artificial intelligence market. But, we didn't exactly know what that was. So, we said "Okay, we know there is something there, we've got a product, let's get into the market and find out what's going on. Let's keep the group small and responsive so if we make any mistakes, we can make corrections and move ahead."

We had some market surveys that showed there was a huge market potential for artificial intelligence type products. We also said that this technology was going to be useful in other product lines at Tektronix. We had visions of using it in scopes, workstation products, computer aided engineering, and for expert systems to help division managers do financial planning.

Our objective was to lay some foundations so that we could use this technology throughout Tektronix as well as marketing it.

Our strategy was to develop the 4404 so we could sell it profitably for $15,000. In terms of AI research, that's a very low price. Users normally were paying $50,000 to $150,000 for a system that's only two to four times the performance of the 4404. So, we have less than half the price with twice the performance.

The 4404 looks very much like the Tektronix Unicorn because it uses the same package and the same keyboard. The mass storage device looks very much like the 4926 because it uses the same package.

Some of the features of the 4404 are the AI languages. The Smalltalk 80 that I mentioned before is a proprietary implementation that Allen developed. Xerox sells Smalltalk on a product called the Dolphin that costs about $30,000 and runs at about half the speed of the 4404. So, we're half the price and about twice the performance. That's where you'd like to be when competing in these markets.

LISP is a list programming language and Prolog stands for programming in logic. It's a way of expressing things in logical sequences.

All three of these languages are used for artifical intelligence because they are very good at manipulating symbols and developing relations between symbols. For

Glossary of Terms, Artificial Intelligence Machines

Alvey—The UK program for developing and installing smart applications on personal computers. They expect that expert systems will be of most use to personal computer users in the areas of problem solving, question answering and education.

DEC VAX—Computer which is technically a minicomputer but is more powerful than some mainframes. The name stands for "Vertical Address Extension".

ESPRIT—The Europe Economic Community program equivalent to the "Japanese 5th Generation Computer Project". The consortium is located in Paris, France and consists of members from industry, government and education.

Ethernet—The connection between several computers or computer devices (terminals) by dedicated wires.

IBM 4300—High speed computer manufactured by IBM.

LISP—A high-level programming language designed primarily to run on large systems and widely used in artificial intelligence work.

The name comes from "list processing", because LISP is basically oriented toward handling data in the form of lists.

Mega—A prefix indicating one million.

Megabyte—1024 kilobytes; 1,048,576 bytes (byte—eight bits, the amount of information required to define one character).

Microprocessor—The actual computing power of a computer squeezed onto a tiny chip.

Mouse—A device used for moving the cursor on the screen of some systems.

Mycyn—A medical diagnosis system for diagnosing meningitis and blood infections.

Prolog—AI language used for logic programming. This language uses the resolution principle. Problems are solved by means of a series of logical inferences.

RS-232—An industry-standard serial interface set up by the EIA, a trade association of electronics manufacturers. RS stands for "recommended standard".

Smalltalk—A menu-driven, high-level programming language developed at Xerox Palo Alto Research Center in the 1970's and often used in conjunction with a mouse.

"5th Generation" Computer Project—In October 1981 the Japanese announced their plans to become the world's leading supplier of computers by the early 1990's. They will accomplish this, contend Japanese business people, by producing new types of machines. They claim these machines, called fifth-generation computers (actually AI machines) will change all aspects of human life for the better.

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example, they are good at working with statements such as "if an animal has feathers, it's a bird."

Traditional kinds of programming languages such as Fortran, are very good at saying 2 + 2 =4. So, that's really the difference between AI and standard programming language.

The kinds of problems that heavy duty AI researchers go after are translating Russian to English, or building a chess player that will beat anybody in the world. Those problems are just not solvable. But, in the process of trying to solve those problems, they develop some really good tools that some of us mortals can use. LISP and prolog are two of those tools.

A little bit about the hardware on the 4404. It's a 32-bit, 68010 microprocessor running 10 megahertz with no wait states. That means that it's very fast.

It's a very monolithic design. There are only two main circuit boards in the product. There's a processor board and a display board. So, it's a very, very simple product. It goes together exactly like a Unicorn terminal and that really helps keep the costs down.

Because of our short development schedule we didn't have time to reinvent any wheels or set up much of an organization. So, we just kind of went through the company and grabbed things where we needed them.

Most of the engineering was done by Chip Schnarel's group in Tek Labs. The original manufacturing was split between three divisions at Wilsonville. Graphic Desktop Products did the base unit; Graphics Peripheral Products did the mass storage device; and Graphics Software and Communications Products did the software. We just tried to manage it all.

Doing this enabled us to move very quickly and go from the start of the program to first customer shipment in about ten months.

By using parts from other groups, I estimated that we saved about $3 million in capital investment in terms of setting up the manufacturing line, designing packaging and doing all the things it takes to develop a new product.

AIM will have its own manufacturing line this fiscal year. It's a very innovative group that's done some interesting things with Just-In-Time processes.

Something else unique about our product line is our stock room. Rather than having stock handlers, our two assembly people are responsible for their own stock. They go to the stock room and get what they need, and they are responsible for keeping track of all of the inventory as well as all of the MAS II transactions.

Another advantage of having a small group is very tight communications. You don't have to go through lines of management, you can just go person to person and get things done quickly.

We have flip charts all around the area that describe processes and list problems and set agendas for meetings and things like that. We are very careful about documenting every procedure so everyone knows exactly what they need to do.

Everyday the manufacturing group has a group meeting to discuss what's going on for the day. What the problems are, what can we do to fix them, what do we need to do tomorrow, how did we do today, what's the order rate like, etc. We have very tight communications about what's going on every minute. We try to build to order so we need to keep very closely coupled to what's going on in the market.

We believe that AI technology is going to develop along the same lines as graphics did in the 1970's. As the technology moves from the research to the development stage, more and more applications will become available.

There will be expert systems for financial planning, business planning, materials requirement planning and things like that.

Artificial intelligence technology will become so buried in the application you won't even know it's there. Just like you take graphics for granted in a lot of products, AI will just be there. All you'll know is that it will be a lot easier to use a computer. When you sit down and ask it a question, you don't have to remember a lot of exotic terminology, you can just ask it a question.

That's the way it is going to develop and one of the charters of our group is to promote that transition within Tektronix.

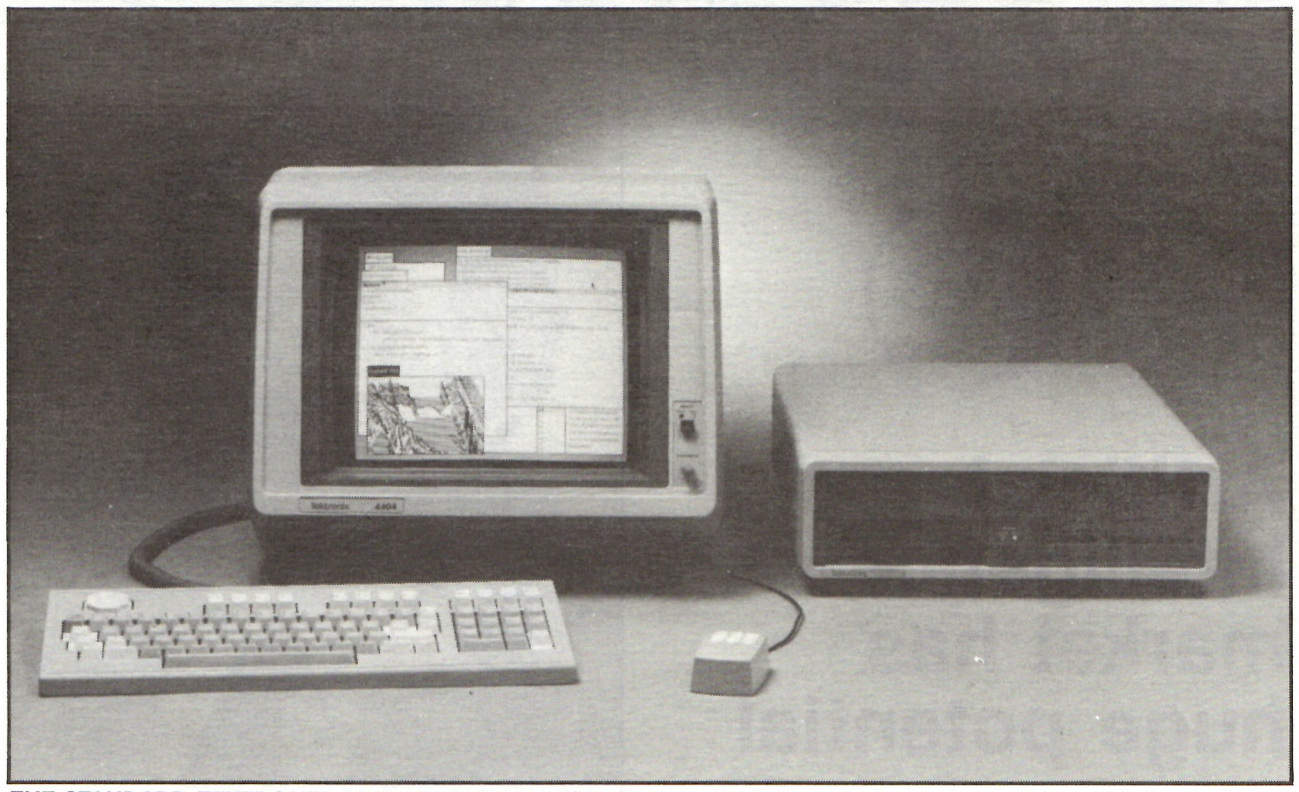
Perhaps one of the key features of the 4404 is the name Tektronix on the front panel. We sometimes lose sight of what our reputation is worth. We had a lot of people come up to us at the AAAI show and say "boy, we're sure glad to see somebody like Tektronix in this market because right now it's just a bunch of start-ups."

Tektronix has a reputation in that world that you wouldn't believe. Until you get out there and really talk to some customers, and look at some of the other equipment, you can't really understand how good our products are.

I'm very proud of the people who worked on this program and what they accomplished with very little time, very little money, and a lot of hard work. I'm also very proud to be a part of a company where so many diverse groups can pull together so effectively to reach a tough objective.

We expect the performance of the product to get higher as the price goes down. One of the things we realize is that we can't rest on our laurels. We said we were going to go out in the market with a product, find out what the market wanted, make changes, build a family if we need to, and be very responsive. That's what we're going to do.

There's another show this August called IJCAI. You can bet we will be there.



THE STANDARD TEKTRONIX 4404 ARTIFICIAL INTELLIGENCE SYSTEM, listed at $14,950 (U.S. only), features a monochrome bit-mapped display, keyboard, mouse, 32-bit micro-processor with virtual memory management, hardware floating point, 1 MByte RAM, and a 40-MByte hard disk with a single 5¼" floppy disk. The system comes with the Smalltalk-80* language, an interactive, graphics-oriented exploratory programming language. *Smalltalk-80 is a trademark of Xerox Corporation.

Questions from the floor for Dave Squire

Is Sony/Tek manufacturing 4404's?
No.

Will there be an intelligent computer by 1990 that can discuss a wide range of topics?
There has been a program for several years called ELISA that runs on a lot of our computers here that will discuss any topic with you. By 1990 you will be able to go into a computer, ask questions and get answers although it may not be a discussion like you would have with a human being.

Does a programmer have to be retrained in order to program these new symbolic languages?
Yes he will have to learn some new ways of programming. So far it hasn't seemed to be that difficult. Once you get into it, it seems to be easier to use.

Does AI help in developing computers that can understand spoken speech?
Yes, in handling speech one of the things you need to do is compare and match symbols. If you get some sound, however you may characterize it, that is a symbolic representation of that sound. You would need to search through a lot of different data to find a match. AI type languages are really good at that. Their power is being able to search through symbols and find matches.

Topic Questions

As far as we know, how far have the Japanese gotten with their work in AI?
The Japanese attracted a lot of attention when they announced their "5th Generation" computer project. A big part of the project involved adding AI to computers. They appear to be devoting their efforts to fundamental research, whereas in the U.S. we're moving more quickly to commercialize existing AI technology.

Are the Japanese heavily involved in AIM's?
Yes, see above. Sony-Tek is heavily involved with Tektronix and AIM.

KATHY REINHART
Conference Chairperson

Who are the world's leaders in AI? By country? By company?
I believe the U.S. is probably the leader in the commercialization of AI technology, but almost all countries have major AI programs started. The Japanese have the 5th Generation project, Europe has ESPRIT, the U.K. has ALVEY, and the U.S. has MCC. The whole area is so new and dynamic that picking a leader is really tough. Tek, Symbolics and Xerox are leading U.S. companies.

With the addition of AI, will computers be able to replace man's decision-making process?
This is a philosophical question that will be the subject of debate forever. I can only give you my personal opinion:

AI technology is a tool that man will use to organize data, develop relationships, and process the vast amounts of new knowledge that we are accumulating at ever increasing rates.

These AI tools will be used to aid man in his decision-making process by helping clear away all of the noise and irrelevant data and letting man focus on the key decisions.

In other words, I believe AI technology will enhance man's decision-making abilities, not replace them.

What is an "Expert" System? How does it relate to AI?

Can a computer with AI "learn" from its mistakes or experiences?
An Expert System is a software program that functions as an advisor to a human operator. It asks questions (Did you do a visual inspection of the bad circuit board?) and suggests possible solutions (The diode bridge has failed).

To build an Expert System a "knowledge engineer" interviews a number of human experts to learn what rules and processes they use to solve a particular problem. The knowledge engineer then inputs the rules and processes into the software program that builds the Expert System. AI technology is used to organize the rules and processes so that they connect logically and so that searches through the rules proceed in the most efficient manner.

A major feature of a true Expert System is the ability to correct mistakes and add new rules as the system is used. You could call this "learning." I haven't seen any commercial systems that do this very well yet.

Who are or will be the first users of AI? What will they use it for?
The primary application of AI technology is in expert systems (see the answer above). These systems have been in use for several years. Examples are: Mycyn, a medical diagnosis system; Prospector, a mineral exploration system; XCON, an expert system used by DEC to configure VAX's. The list goes on and on and it's growing every day.

For an organization that has a good application for an intelligent system but lacks the personnel resources to shepherd such a program, can qualified professionals be made available over an extended period of time to help in the development of such a system?
There is a limited amount of consulting that is available inside Tektronix in AIM and Tek Labs. Probably the best we can do is point you to some outside sources of information.

Is Pegasus designed to be a home-type computer? If so, do Tek employees get a discount on it?
The 4404 (Pegasus) is a stand-alone system; however, the price ($15,000) puts it out of the personal computer category. There are no special employee discounts on the 4404; however, the standard Tek Employee Purchasing Program would apply. (Some customers have bought them for personal home use.)

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How did you choose the name "Pegasus"?

The 4404 uses a lot of the Unicorn technology such as mechanical package, keyboard, and manufacturing processes. The people in Tek Labs who designed the 4404 thought the name Pegasus was a nice tie to the Unicorn—a Unicorn with wings, if you will.

Is Pegasus used in conjunction with other Tek systems?

The 4404 can use a 4695 color copier as an output device and it will attach to the 6000 Series workstations via RS-232 or Ethernet.

What is the difference between Pegasus and Unicorn?

On the outside the 4404 (Pegasus) looks just like a 4107 (Unicorn). They share the same mechanical package and keyboard. Inside they are quite different. The 4404 has a monochrome display. The 4107 has a color display. The 4404 is a complete stand-alone computer system based on a 68010 microprocessor and it has a floppy disk and a 40 Mbyte hard disk. The 4107 is based on an 80186 microprocessor and is designed as a smart terminal that has to be attached to a host computer such as a DEC VAX or IBM 4300.

What is a Unicorn computer and what type of market are we looking at?

The Unicorn, 4107, is a smart terminal, not a computer. The Unicorn must be attached to a host computer such as a DEC VAX or IBM 4300.

Unicorn customers are people who use such computers and want a high resolution color display.

Who are our competitors in the field of artificial intelligence?

The main competitors (in order of sales) for the 4404 are Xerox, Texas Instruments, Symbolics, LISP Machines, Inc. and Sun Workstations.

What kind and which customers are we targeting?

We are targeting two types of customers. First, we are looking at customers who are doing research in AI and need cost-effective AI workstations. Our own Tek Labs is typical of this type of customer.

Secondly, we are looking for customers who have developed AI applications and need a low-cost product to use for delivering the application to their end users. An example might be someone who has developed an Expert System for manufacturing planning and now they want a low-cost workstation that they can put on each manufacturing manager's desk.

Almost all of the Fortune 500 companies and dozens of smaller companies are either in the AI marketplace or have internal projects under development.

Is there a large market, and what piece of it are we planning on having by the end of the year?

The market for AI hardware and software is projected to be between $2–$8 billion by 1990. I can't give you the numbers on what we think our market share is; however, since our introduction last August we went from nowhere to at least being on everyone's list of major AI competitors.

Will AIM interface with CAE?

One of the charters of the AIM group is to help other businesses in the application of AI technology to their products. Applying AI to CAE is a high priority.

How will artificial intelligence be used by other divisions of Tek?

We know that it can be used for user interfaces and in building Expert Systems for computer-aided engineering. It could be used to develop smart instrumentation controllers or for computer-aided software engineering, or in ways we haven't even imagined. As I mentioned before, part of the AIM charter is to help other groups in the application of this technology.

How is artificial intelligence defined? What is an artificial intelligence machine?

There are all kinds of definitions for Artificial Intelligence. I think every company makes up a definition that makes their product look best. I like the following definition:

A computer is artificially intelligent when its response to queries is indistinguishable from the response a human might give.

There are also some facetious definitions such as "AI is the study of unsolvable problems" or "if a computer can do it now, it's not AI."

An AI Machine is a computer that is designed specifically to run AI languages such as LISP, Prolog or Smalltalk.

What will the next generation of artificial intelligence consist of?

I think we'll see more AI technology becoming available on PC's. There will be many more applications products that claim to be artificially intelligent. There will be specialized processors and coprocessors that will bring down the cost of high performance systems (by 1990 you'll be able to get the same performance for under $10,000 that now costs more than $100,000). Voice input and output will become commercially viable.

Finally, I think the average computer user won't know or care about AI. All they'll know is that the computer they're using is more powerful, friendlier, and easier to use.