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Artificial Intelligence: New Jobs From Old

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Abstract: The age of artificial intelligence (AI) is upon us, and its effect upon society in the coming years will be noteworthy. Artificial intelligence is a field that encompasses such applications as robotics, expert systems, natural language understanding, speech recognition, and computer vision. The effect of these AI systems upon existing and future job occupations will be important. This paper takes a look at artificial intelligence in terms of the creation of new job categories. Also, the introduction of AI into the organization to better familiarize the employees about AI will be discussed.

Keywords: Artificial intelligence; Expert systems; Job employment; Implementation; Management

Introduction

Artificial intelligence (AI) has two major thrusts: first, to develop intelligent computer power to supplement human brain power, and second, to understand the nature of intelligence. AI applications are being developed and used worldwide, and figures indicate that the AI marketplace will continue to grow rapidly into the 1990s. Walker et al.[1] indicate AI market estimates from most of the research firms following the AI marketplace[2] (Table 1).

Even though there is a wide range of estimates, it appears that AI applications will have an increasing impact and market share in the years ahead. Instead of AI being a technology-driven market, as it was several years ago, it is now a market-driven technology.[2]

With more AI applications entering the marketplace, what effect will this have on the creation of new jobs? The next section addresses this area.

Table 1. Hardware and software (in millions of dollars)

Market Research Firm	Total 1987	Total 1990
DM Data	1555	4200
Frost and Sullivan	939	1267*
IDC	638	1306
Input	350	885
Macintosh International	495	966
Ovum	424	1162

* This estimate is for 1989 rather than 1990.

Creation and Expansion of Jobs

With the advancement, development, and implication of AI applications, several expanding job categories will become available. These include:

Knowledge engineer

AI user training specialist

Robotics maintenance engineer

Industrial robotics supervisor/manager

AI venture capitalist

Expert system shell vendor

AI project managers

AI hardware architecture specialist

Knowledge acquisition specialist

AI "headhunter"

AI computer lawyer

Each of these occupations will be discussed in turn.

The *knowledge engineer* is the individual usually responsible for developing the expert system from the stage of problem selection, knowledge acquisition, knowledge representation, and knowledge encoding, through to knowledge testing and evaluation stages. Since expert systems are the most practical applications of AI today and should continue to be so in the future, there exists a need for more knowledge engineers (especially trained, experienced ones) for building these expert systems. A current bottleneck in expert systems development is the shortage of knowledge engineering talent, so there will be an expanding job role of the computer science/information systems professor for training future knowledge engineers. There will also be a greater need for AI programmers who will be knowledgeable in the AI languages, like LISP, PROLOG and OPSS, as well as the conventional languages like C, Ada and Fortran.

The AI user training specialist's job will expand and new jobs for this position will be created in the near future. If the number of AI applications increase, then there will be a need for these individuals for both developing these applications and training the users on how to work, maintain and update these systems. Thus, *AI user training specialists* will be needed to get users accustomed to working

these new systems, and to show how they can be integrated into the users' current working environment. The most spectacular AI applications could be developed, but if users are not adequately trained on how to use, maintain and update these systems, they will not be effectively implemented and used.

Another job the importance of which will increase is the *robotics maintenance engineer*. With the increasing number of industrial robots being implemented on assembly lines worldwide, there exists a need for preventive and corrective maintenance on these robots. The robotics maintenance engineer would be in charge of correcting faults in the robot, as well as maintaining the robot in good, accurate working condition. The job of the engineer could be more complex if there are groups of robots performing interrelated actions on an assembly line, for example. The engineer might need to consult an operations researcher, whose job could be expanded to include queuing of robots on an assembly line, as well as looking at other AI applications like handling uncertainty in expert systems or developing structured testing methodologies for expert systems.

With robots mixing with workers in the industrial plants, this creates a job for an *industrial robotics supervisor/manager*. This manager would be in charge of making sure that the workers and the robots worked smoothly in an integrated style. This individual would also manage the operations of the robots and report if problems occurred in their operation. This suggests the need for another person who would act as a quality control individual, to make sure that the products being produced are uniform and meet product standards.

With the proliferation of AI applications occurring over the next decade, there will be new AI start-up companies and other companies might want to become involved in AI. This suggests the role of an *AI venture capitalist* who would be responsible for raising money for the creation of new start-up AI companies, and for raising capital for getting other existing companies involved in AI work. A company who wants to become involved in AI can do so by various strategies. First, the company might merge or acquire a company that is performing AI work. A second strategy is to own stock (perhaps a majority) in an AI company. A third strategy is to become affiliated with an AI company or university involved in AI. A fourth strategy is to build an in-house capability within the firm.

As expert system applications become more widespread and popular, more tools will be created to help build these applications. The *expert system shell vendor*, whose main responsibility will be to develop, market and maintain the shell, and train users on how to work the expert system shell, will play an increasing role in the years ahead. More shells will be developed for an increasing variety of hardware and applications, and these shells will become more powerful in their features (and at lower cost due to competition) in the years ahead. For example, a shell that is geared toward "blackboard" applications or a shell for classification applications are examples of shells yet to come on a widely commercial basis. With the number of expert system shell vendors increasing, competition will tend to eliminate the weaker competitors.

If there are to be more AI projects developed, then there will be a growing need to have *AI project managers* to oversee their developments. The AI project manager will make sure that the AI product or application is produced to specifications, on time, and within cost. He/she will be responsible for putting the

AI team together and managing the team's progress. Of course, in the near future, there will be a shortage of AI project managers because many people do not and will not (in the near term) have the experience to manage an AI project.

New AI applications will also bring about new kinds of specialists like *AI hardware architecture specialists* and *knowledge acquisition specialists*. As parallel processing and neural networks gain popularity, there will be a greater need for having someone who is proficient in programming on various AI machines and in knowing what hardware is needed to solve various AI problems. This will be the role of the AI hardware specialist. The knowledge acquisition specialist will be a new position whose skills might include being an expert in interviewing and who might have proficiency in developing and using automated knowledge acquisition tools for expert systems development. The knowledge acquisition specialist would then assist the knowledge engineer during the knowledge acquisition phase of the expert systems development. Since knowledge acquisition is a major bottleneck in today's expert systems development, the knowledge acquisition specialist will have an important and expanding role in AI applications in the years to come.

In order to fill the growing number of positions in the AI field, there will be more *AI headhunters* who would serve in matching AI positions with qualified individuals. The positions would range from top executives to managers to entry level AI positions. There are already various AI recruitment firms, like Halbrecht Associates, Wallach Associates, and Management Recruiters, which exist today, but many other AI personnel recruitment firms are likely to follow.

The last major AI position which will be newly created is the *AI compter lawyer*. The computer software lawyer will expand his/her litigation to include AI applications. Such questions as the malfunctioning of a robot or the inaccurate advice of an expert system or the negligence in failing to use an available expert system will be grounds for litigation.[3,4] As AI applications develop, so too will the chance for law suits increase. The AI computer lawyer's role will hence be created.

The expanding role of AI technology and applications will not only have a positive effect on society in terms of new and expanding jobs, but also it will have some negative effect on displacing some workers or altering a worker's current duties and postion. Because of AI technology, some workers may need to be retrained for other positions and some workers' roles and duties may be different. Those jobs most affected by AI technology are:

assembly line worker

secretary

mail sorter

some telecommunications fault isolation/diagnosis analysts

some operators, e.g. satellite control center operators

some quality control/assurance personnel, e.g. those who identify faulty or poor quality

satellite image data

some claims processors, e.g. group health insurance claims processors

some data entry people, e.g. medical data entry individuals who obtain medical information from a patient

some medical, tax and legal consultants for simple kinds of questions

In order to educate an organization's personnel about the effects of AI technology on their role in the organization, it is very important to keep the employees informed and properly introduce AI into the organization. The following sections take a look at ways of familiarizing employees about AI and strategies for introducing AI into the organization.

Familiarization of AI Technology and Applications

Familiarization of a new technology and introduction of its use into an organization are sometimes difficult tasks. With AI technology the first step for a company to decide whether or not to make AI a part of its corporate strategy is to understand the technology. Once the technology is understood in terms of its capabilities and limitations, the next step is to consider if it is economically, technically and operationally feasible to make AI a part of the corporate goals and objectives. Once that is determined, the next major step is to decide which implementation strategies should be used to introduce AI into the organization.

Many companies today are incorporating AI technology as part of their corporate missions. Other companies are not making such a strong statement, but rather are using AI as one of the available tools to explore and consider for a particular problem. By attending short courses and conferences on AI, tinkering with expert system shells on the microcomputers, enrolling in university courses on AI and reading various AI journals, books and magazines, managers and staff are able to better familiarize themselves with AI technology. Once AI technology is better understood by management and staff, management must decide whether to participate actively in AI technology and must choose the best vehicle for implementing AI technology into the organization.

With the advancement and commercialization of AI technology, there are many avenues that allow a manager to enrich him/herself about AI technology. One vehicle for fam-larization of AI technology is to attend conferences. With the proliferation of AI conferences being organized and held over the past few years, there are many conferences that could show managers the available vendor products being marketed and the basic AI applied research taking place. The major AI conferences, in the United States and abroad, that would be of interest to managers are:

AAAI (American Association for Artificial Intelligence) Conference – held annually in the USA

IJCAI (International Joint Conference on Artificial Intelligence) – held every two years

AI East and AI West Conferences – held annually in the USA

Expert Systems in Business Conference – held annually in the USA

AI Conference at Avignon – held annually in Avignon, France

The International Expert Systems Conference – held annually in London, UK

IEEE Conference on AI application – held annually in the USA
Each of these conferences presents not only current AI research but also many AI products

Besides attending conferences, managers may attend various short courses offered by vendors and companies and may also attend some university courses on AI. Some of the companies and universities offering such courses are:

Short Courses

Continuing Engineering Program at George Washington University, USA
Integrated Computer Systems Inc.
Continuing Education Institutes, Los Angeles, USA
Technology Transfer Society
Smart Systems Technology
Harvey Mudd College, Institute for AI, Los Angeles, USA
Polytechnic of the South-Bank, London, UK
UCLA Extension
Artificial Intelligence Ltd, UK
US Professional Development Institute

Universities (sample)

Stanford University, USA
MIT, USA
Carnegie-Mellon, USA
Rutgers University, USA
University of Texas at Austin, USA
University of Maryland, USA
Yale University, USA
George Washington University, USA
Ohio State University, USA
University of Pennsylvania, USA
Edinburgh University, UK
Open University, UK
Sussex University, UK
Imperial College, UK
Most major universities throughout the world are offering courses on AI. Many companies, like Digital Equipment Corporation, are offering in-house courses on AI, and various vendors, like Intellicorp, Inference Corp., Teknowledge, and The Carnegie Group, offer knowledge engineering consulting and training courses on how to work their expert system shells.

Besides these courses and conferences there are many shells available that run on the microcomputer so that individuals can easily experiment with expert systems technology. Some of these expert system shells are:
Exsys
Nexpert Object

Personal Consultant
Advisor-2
Guru
Goldworks
VP-Expert
M.1
Insight 2+
KnowledgePro
1st Class
Auto-Intelligence
Expert Edge
KDS
Xsys
KES

If experimenting with these shells and attending courses and conferences is still not enough to become familiar with AI technology, then there are always numerous books, journals and magazines available for reading. Some of these sources are:

Books

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Silverman, B.G. (ed.) (1987). *Expert Systems for Business*. Addison-Wesley, Reading, MA.

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DeSalvo, D.A. and J. Liebowitz (eds) (In press). *Managing AI and Expert Systems*. Prentice-Hall, Englewood Cliffs, NJ.

Journals and Magazines

Expert Systems Journal
Artificial Intelligence

The AI Magazine
AI Week
Applied Artificial Intelligence Journal
Telematics and Informatics
SIGART Newsletter
IEEE Expert
AI Expert
Knowledge-Based Systems Journal
Knowledge Engineering Review
Artificial Intelligence Review
AI & Society

After reviewing much of this information from books, journals, conferences, expert systems shells and courses, managers will start to become very familiar with different components of AI technology. After reviewing these sources and seeing the competition, managers can then make more informed decisions in determining whether to pursue AI technology in their organizations. If a manager convinces top management to make a commitment to AI then there are various implementation strategies that could be used to introduce AI into the organization. The next section takes a look at these strategies.

Implementation Strategies

After management decides to make a commitment to introduce and use AI technology in the organization, there are several approaches that could be made in its implementation. The strategies are[5]:

1. Develop one central in-house AI capability

2. Affiliate with an AI firm or university specializing in AI

3. Merge, acquire or become a major stockholder in a company already involved in AI

4. Build and distribute the AI talent within different parts of the company

5. Develop an initial in-house AI capability and rely on subcontracting the work out

The first strategy of developing a central in-house AI capability can be a very good tactic because the company would not have to rely on anyone once it was developed. However, to build this capability within the organization will require a great commitment on time and resources needed for recruitment and training of appropriate AI personnel. This approach has been used by the Internal Revenue Service (IRS) in the United States. Thus far, one group of agents has been sent for two years to be educated in AI in graduate work at leading universities specializing in AI. This group has finished its studies and now comprises the Knowledge-Based Systems Group in the IRS. A second group of agents is in the middle of AI studies at these leading universities. The commitment on the part of the IRS in developing this in-house capability was to send numerous agents for two years to be educated in AI. The IRS did not want to rely on contractors and

consultants for their AI development. This in-house AI group is the nucleus for developing AI applications in the IRS and, through their education, they are an informed group that could technically and managerially adeptly develop AI projects. Besides the IRS there have been companies that have used a similar strategy for introducing AI into the organization. American Management Systems, Inc. has developed a centralized in-house AI capability, after combining several divisions of AI talent from different parts of the firm. Even though some agreement for outside consulting has been made with Teknowledge, Inc., a company specializing in AI, most of the development and management of AI applications can be accomplished by this in-house group at AMS.

Another strategy that companies use for introducing AI into their organization is to affiliate with an AI firm or a university specializing in AI. By doing so the company does not have to invest many resources in training their own employees. Also, the AI firm or university acts almost as a consultant to quickly bring the employees up to speed in AI technology. One drawback of this strategy is that the company becomes reliant upon the AI firm or university and sometimes it is difficult to cut those ties. Additionally, the company becomes dependent upon the thinking of the AI firm or university and the company might find it hard to deviate from their thinking and practices. Digital Equipment Corporation (DEC) uses this strategy and has a close alliance with Carnegie-Mellon University. Many of DEC's AI applications are developed at the University and then are deployed, implemented and maintained by DEC AI personnel.

A third strategy is to merge with, acquire or become a major stockholder in an AI firm. This approach ensures that the AI talent is already present and thus the lengthy time required to build such a group is minimized. A vast amount of capital, on the other hand, is usually needed to proceed with this approch. General Motors has a major interest in Teknowledge, Inc. and, as a result, Teknowledge has contributed their talent to developing AI applications for them, such as a car engine diagnosis expert system. Also, Teknowledge can provide technology transfer to General Motors and help train some of the GM employees on how to develop, implement and maintain AI applications.

A fourth strategy used is to build and distribute the AI talent within different parts of the company. After educating and training a select group of employees on AI technology, the company could then place them throughout different divisions of the company so that AI technology could be widely dispersed throughout the company. This strategy allows for a greater technology transfer than just building a centralized AI group. The major drawback with this approach, however, is that the company might be spreading its resources too thin. In other words, instead of having a concentration of AI personnel, each AI individual sent to different parts of the company will have to train other people in his/her respective department about AI. Thus, it might take longer to develop AI applications in a distributed mode, as opposed to having a centralized approach to AI development.

The last main strategy for introducing AI into the organization is to have a few individuals become familiar with AI technology, at least with some initial understanding of the technology, and then rely on subcontracting out the AI work if, for example, a company does not have the resources to build a solid in-

house AI group. The major problem then is that the company becomes dependent on the subcontractor. The major problem with this approach is that the company becomes dependent on the subcontractor. However, it would allow for some transitioning to occur whereby the company learns about AI technology through the subcontractor.

Conclusions

After gaining some familiarization with AI technology,[6] the company must evaluate if AI technology fits in with their organizational goals and objectives. If there seems to be a fit, then the company should evaluate its resources in terms of capital, person-power, hardware, software, and facilities to determine what would be needed to develop an AI capability. Certainly, market conditions and AI competition should be evaluated to determine AI's role within the company. The company should determine if it is only going to be a user of AI technology, or is it going to develop new AI products and/or services, or will the company just concentrate on basic AI research issues, or will the company only develop applications with existing AI products. Once these decisions are made, the company can then decide on the best strategy for introducing and implementing AI technology within the firm.

As with any technology, its impact upon society must always be anticipated and measured. With AI technology becoming more prevalent, one of its impacts will be in creating and displacing jobs. Most AI applications today and in the near future will be geared for supplementing the decision maker, as opposed to replacing him/her. However, with the introduction of this new technology, some job functions will be altered to integrate AI, as appropriate, into the work environment. The overall effect of AI technology will have a positive impact, rather than a detrimental one. We are just at the beginning of this age of commercialized AI, and its rewards look promising in the years ahead.

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