# ARTIFICIAL INTELLIGENCE: AS APPLIED TO TEXT ENTRY SYSTEMS

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Abstract: In the interest of developing more powerful and sophisticated devices for gathering, processing, and distributing data, artificial intelligence techniques are being applied to text entry systems Intelligent character recognition systems will be able to recognize multiple type sizes, different fonts, multiple columns, and split or touching characters This and other applications of artificial intelligence in the printing and publishing industry will make production more efficient and cost effective as well as less labor intensive.

## Goals

Users of text entry systems have become more sophisticated in understanding computers and their own production bottlenecks. Higher volumes of timely information will drive and develop more powerful, sophisticated, and intelligent devices for gathering, processing, and distributing data for what is known as an "information society."

The Federal Office of Technology defines artificial intelligence (AI) as "the way knowledge is built up and used in computer-based systems. how it is collected, stored, accessed, manipulated, and transferred.[1] AI research and development seeks methods of formalizing and representing knowledge in consistent and unambiguous, yet flexible, ways so that these tasks can be performed by machines."

Goals of AI as it relates to the entry of text into computers is ultimately to make this type of production more efficient, more automated, more cost effective, and less labor intensive; the goal of any new technology in the graphic arts.

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1. Artificial intelligence will be referred to as "AI" from this point on.

## Technology

AI technology began at the Massachusetts Institute of Technology (MIT) in the 1950's. All AI technology involves using computational power for solving complex "what if" problems. Instead of simply "crunching" numbers, computers running AI software tackle concepts and ideas previously the exclusive domain of the human intellect.[2] Although there are many companies today producing AI software and hardware for rapidly growing markets, Carroll Hall, manager of AI software development for Texas Instruments' Data Systems Group, says: "AI is a new technology, not a product or a market."

The technology of AI has greatly improved productivity and efficiency for data and text entry operators in today's printing and publishing industry. Because of the nature of today's Electronic Technical Publishing (ETP) systems, many bottlenecks occur during the actual data entry phase. Large technical organizations like General Motors, Boeing, and NASA are constantly updating their records, technical manuals, and parts lists. Granted, most data today can be entered by computer word processors, but there are literally millions of pages of typewritten and typeset information in books and manuals waiting to be digitized for easier manipulation and up-dating of reports within these corporations. Today's manager should understand that there will always be information that companies can use for computer databases that will be generated outside of "in-house" data entry systems. Because of this, intelligent text entry scanning systems will always have a market.

To be effective, an ETP system must be able to accept a variety of information in many forms as input, quickly and cheaply. Re-keyboarding and its high cost in time, personnel, and accuracy can sometimes reduce the potential benefit of an ETP system.[3] To overcome this problem, many users have looked into optical character recognition (OCR). Due to many limitations of OCR, such as its need for exact formats of the text and fonts that it is reading, it has had only marginal impact on the text entry problem. Promising applications for OCR have been in the reading of retail labels, test sheets, credit card vouchers,

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2. Robert Cheslow, "Prospects for Artificial Intelligence in the Graphic Arts," *Graphic Arts Monthly,* October 1985, p. S46.

3. Noel Coletti, Jr., "Intelligent Character Recognition Looms Ahead," *Graphic Arts Monthly,* February 1985, p. S16.

bank checks, and other high-volume documents that have a repeated format.

Intelligent character recognition (ICR) combines optical scanning with AI. ICR is based on AI technology which has the capability to make decisions and determine character recognition with "feature detection." Feature detection includes software which analyzes geometric and topological properties of characters and with decisions of character formation, identifies the character. AI technology provides ICR with the capability to decide where the text starts and ends, individual characters that are touching or split, the difference between numbers and letters, open and closed quotes, hyphens and dashes, multiple type sizes, varying contrast, graphics, line skew, multiple columns, background dust, and other details that consistently "halt" OCR systems. Applied to EPT, however, ICR is not limited to single column, typewritten material in specific typefaces, and does not require meticulous document preparation due to poor master quality from a photocopy. The scanning resolution of most ICR products today varies from 200-240 dots per inch. Perhaps the most brilliant aspect of AI and ICR is that an ICR system can decide when the learning process of a font is done and when actual production should begin. With this technology behind it, ICR systems "learn" to accurately recognize virtually any of the thousands of fonts in use today. This dramatically cuts machine-operator interaction which leaves the operator free to proceed with other important operations.

### Industry Structure

Like all new emerging technologies, AI is still being researched. The groups doing most of the research are universities, computer related companies, and the government. The Defense Department and Pentagon are investigating AI applications in weaponry, defense systems, and surveillance systems. U.S. companies that have invested the most money into their own research and for product development are Texas Instruments, Symbolics, Inc., Perq/Expert Technologies, Tektronic, Inc., Lisp Machine, Data General Corp., Digital Equipment Corp., Rockwell, and Xerox. One company that has marketed its ICR products in the U.S. and overseas is Kurzweil Computer Products. The Kurzweil 4000 Intelligent Scanning System is presently in use in the United Kingdom, France, Belgium, and Spain. The universities with extensive AI programs are Stanford, Massachusetts Institute of Technology, and Carnegie-Mellon. Herb Halbrecht, an executive recruiter in Stamford, Connecticut, who specializes in technology searches, expects demand

for AI engineers to exceed supply for four or five years, at which point new graduates will enter the field.[4]

The current upsurge in the AI industry in the United States stems from Japan's decision four years ago to launch its own fifth-generation computing project for the 21st century. This project is managed by the Japanese government and funded largely by eight industrial companies in order to enhance productivity in agriculture and fisheries, office automation, service industries, and automobile design and manufacturing. Some estimates put the level of the Japanese investment at $1 billion to $1.5 billion during the next eight to ten years.[5] In order to meet the challenges of the United States and Japan, Germany, France, and the United Kingdom have agreed to set up a joint research institute to coordinate their ideas on AI as well.

### Markets

"AI is exploding," says Curt A. Monash, a technology analyst with Paine Weber, Inc. "AI is the new technology." More than 200 companies are now scrambling to develop products that imbue computers with rudimentary abilities to mimic human logic and communication. This is an increase of 40 percent over last year (1985). Sales for AI technology will top $719 million this year, up 62 percent from last year, according to DM Data Inc. a market researcher in Scottsdale, Arizona.[6] Currently the "AI software market" is growing at an annual rate of 76 percent per year, and the AI industry is forecasted to achieve one of the highest growth rates of any of the emerging markets.[7]

Current existing markets for AI based ICR systems are large or specialized printers, publishing companies, typographers, typesetting com-

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4. Fred Guterl, "Artificial Intelligence is Not Here Yet," *Dun's Business Month,* August 1985, p. 44.

5. John Couretas, "Marketers Get Smart with Artificial Intelligence," *Business Marketing,* September 1985, p. 68.

6. Emily Smith, "A High-Tech Market That's Not Feeling the Pinch," *Science and Technology,* July 1, 1985, p.78.

7. James Gay, "Artificial Intelligence Technology Applied to Printing/Publishing," *Graphic Arts Monthly,* March 1985, p. 136.

panies, Fortune 500 companies with office automation networks, public utilities, data entry companies, and suppliers of electronically distributed information. Michael Backler, vice-president of marketing for Kurzweil Computer Products, Inc. declares: "The new generation of ICR technology will open the vast in-plant publishing markets. As the prices of typesetting and front-end systems are reduced with improved technology, more and more companies will create or expand in-house publishing departments.[8] The in-plant publishing (or ETP) of timely publications must be accurate and available at the time of product introduction. Conventional printing has difficulty keeping pace in this environment. ICR along with ETP are newly growing markets that are growing to meet this problem. ICR for data entry is only the beginning of a major change in the way business' gather, store, output, and distribute information.

AI applications cover a vast range of business activities. One company has selected two vertical markets as its initial focus: computer-aided printing and publishing (CAPP) and the construction industry. The CAPP industry has discovered the advantages of electronic manipulation of text and graphics; hence the role of software has become increasingly vital to the operations of printing firms. Yet many day-to-day problems have eluded solutions using conventional tools. The need to manage information with even more advanced and sophisticated techniques is known in the printing industry. As a result, approximately 50 percent of the leading CAPP suppliers are currently investigating ways to use AI techniques in their products.[9]

In general, markets and users that hold the most promising future for AI fall into three general categories: those which perform professional or expert functions, those which perform clerical functions, and those which perform complex functions.

"Expert systems" put the knowledge and experience of established practitioners at the fingertips of their junior or less-informed colleagues. While AI cannot give junior staffers the full capabilities of the system's mentors, it will enable them to perform at a higher level than their experience would ordinarily allow. One application for this expert

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8. _____, "Artificial Intelligence Program at Core of Scanning System," *Graphic Arts Monthly*, July 1984, p. S66.

9. James Gay, "Artificial Intelligence Technology Applied to Printing/Publishing," *Graphic Arts Monthly*, March 1985, p. 136.

system technology is in the field of medicine because of the great amounts of information that exist in the medical field. Dr. Andrew Freeman, an AI researcher at Stanford University in Palo Alto, CA, says that expert systems are being developed to help answer questions in medicine. With the vast amounts of information that exist in the medical field, it is impossible for one hospital or doctor to be "all knowing," especially in emergency situations. Dr. Freeman also added: "Ideally, one day doctors will be able to enter into the expert system the patient's symptoms. In return, after comparing medical concepts, effects of drugs on one another, statistics, and condition of the patient, the system will recommend steps to help cure the patient after searching its database and making an intelligent analysis of the knowledge it contains."[10]

Because of the characteristics of the printing industry, and especially ICR systems, AI markets in the industry would fall under the "the automated clerk" category. Many processes in the printing field are clerical and automatic. This is exactly why AI has found its way into ICR systems and robotics. Such systems improve the accuracy of the function they are performing, reducing costs due to errors. They also can handle some of the exceptional cases, which would ordinarily require the attention of higher-level personnel.

In the third category of artificial intelligent market applications, AI systems can perform integrated tasks that are too complex to be done cost-effectively using ordinary methods, or which require expertise in several fields. A market that is currently being pursued for this application is banking. An AI system makes information on all of the bank's products readily available to the service representative, and can suggest variations to meet the customer's needs. The ability of AI systems to perform tasks that require expertise in several fields gives banks the opportunity to offer sophisticated services at prices that middle-income customers can afford. Personal financial planning, for example requires expertise in insurance, portfolio building, tax planning, retirement planning, and other areas. In the past, this has made such services very expensive. An AI system can develop a personal financial plan cheaply for its middle-income customers, opening a new market to the bank.

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10. Dr. Andrew Freeman, Stanford University, personal discussion, November 15, 1986.

In summary, the main users of AI technology are those that: 1) are in a field that has vast amounts of information that need to be constantly compared resulting in a correct answer to a problem 2) are high in repetitive clerical and factory automated work 3) perform complex functions requiring expertise from many fields of knowledge. The major relationship between the users of AI technology and those that they serve is one of making information more readily available to society. Social analysts often classify our society as an "information society"; a society that has demanded the availability of information immediately. AI promises to comply with this demand.

## Product Form

The applications and products that are produced with AI technology are increasing every year. As early as 1976, Kurzweil Computer Products, Inc. of Cambridge, Mass. developed a unique approach to permit computer recognition of the alphabet using AI technology. Its product, the Kurzweil Reading Machine (KRM) became one of the first practical prototypes that could generate synthetic English speech for the blind from an ordinary printed page. With the support from government agencies and private foundations, the KRM was put into production.

Just recently the company announced major advances in the system, resulting in a new generation of "intelligent scanning systems." According to Michael Backler of Kurzweil Computer Products, the Kurzweil 4000 employs new hardware and enhanced AI software which enables it to go beyond conventional OCR reading systems to what is known as ICR at a price of $34,500. ICR stems from the systems ability to learn most fonts with minimal operator intervention.[11] The system can read either typeset or typewritten material and convert it to computer codes. This is made possible by "Autotrain," a feature included in AI software that makes intelligent decisions relating to character recognition, learning new fonts, and resolving ambiguities of text.

Another company that has incorporated AI in character recognition as well as symbol-to-typeset command translation is Intelligent Vision, Inc. in Artesia, CA. Its IVI-60 is designed to recognize almost all typewritten and computer print-out fonts. This scanning system is able to recognize up to 15 special symbols stamped on the original manuscript to be

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11. _____, "Artificial Intelligence Program at Core of Scanning System," *Graphic Arts Monthly,* July 1984, p. S64.

later translated into measures, leadings, superiors, and fonts. Intelligent Vision, Inc. reports that its product can read at a rate of 60 pages per hour with an automatic feeding mechanism.

The following companies are using the Kurzweil 4000 in their daily operations:

1. Chrysler Corporation - Michael Penn, manager of production for the Pentastar Publications department, says his company uses the Kurzweil 4000 for transferring hard copy engineering specifications and converting it to digitized data in a fraction of the time needed for manual keyboarding. After a document is scanned and placed on the database, it can then be formatted for photocomposition or transferred to disk and given to the user. Penn claims that the company saves about 12 minutes per page using ICR technology instead of entering the information through manual keyboarding.[12]

2. Department of Commerce - Thomas Beacon, printing officer and chief of the Composition Department, reports that his department use the Kurzweil 4000 to enter information and text onto the database in-house. The Department wants to have all of its documents on a database, from one to two-page memos to press releases to transcripts that can run as many as 600 pages. To type all of the information by hand is beyond their personnel capabilities, claims Beacon.[13]

3. AiResearch Manufacturing Company - This company is a division of the Garrett Corporation of Torrance, CA. The company recently converted from an 11-year old word processing system to a Xerox 860 and a Kurzweil 4000. With both of these, they can now develop their goal for a totally electronic publishing system. The Kurzweil 4000 allowed them to scan their technical documents electronically and have them entered onto the Xerox 860 database quickly and accurately. Even their best typists could only enter six pages per hour. The Kurzweil 4000 scanning

12. Noel Coletti, Jr., "Intelligent Character Recognition Looms Ahead," *Graphic Arts Monthly*, February 1985, p. S18.

13. Ibid.

capabilities can enter at least 18 pages in the same time period. Besides the speed and accuracy of this technology as applied to the graphics field, the Kurzweil 4000 can read any typeface from 6 point to 24 points and multiple fonts per page, which vastly expands the number of documents and style of documents that can be scanned.[14]

Many of the advanced capabilities originally developed to aid AI programmers are now making their way into the graphics marketplace. In the field of publishing, for example, AI has already made substantial inroads through the incorporation of many of its key elements in a new generation of computer-based electronic publishing systems.[15] These systems merge the diverse technologies of data and word processing conversion formats, page composition, computer controlled typesetting, sophisticated grammar checking, translation of foreign language materials, automatic management of the printing process itself.

Consider, for example, the development of an AI system designed to assist a layout designer for a newspaper or magazine. The system would require an understanding of typography, graphic design and photography, as well as specific format requirements for the publication involved. A system such as this derives its experience by consulting a "knowledge base" composed of lists of facts, rules-of-thumb, and observations gleamed from questioning experts such as professional layout artists. The system manipulates this knowledge with its "inference engine"; a program containing the strategies for solving a particular class of problems. However, the development of a sense of "design aesthetics" in computer technology is far beyond the abilities of AI at this point. It requires access to certain unconscious aspects of the mind that have baffled scientists for decades. But AI can provide powerful assistance to human experts, freeing them to tap the full potential of their own creativity.[16]

At Yale, scientists have programmed a computer to interpret newspaper articles that it reads with a scanning device. Eventually, researchers

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14. Ibid.

15. Robert Cheslow, "Prospects for Artificial Intelligence in the Graphic Arts," *Graphic Arts Monthly,* October 1985, p. S54.

16. Ibid.

hope that computers will become voracious readers, constantly updating their reservoirs of knowledge in order to help people solve problems.

Since AI has many future possibilities, other industries besides the printing and publishing industry have already implemented the use of this new technology for their own applications:

- Stanford researchers have developed a program called "Eurisko" that enables a computer to develop its own theories and ideas once it is given the principles of a discipline.[17]

- "Production Planner" tells manufacturers what materials and machinery is needed to produce a new product at a given volume.

- DEC's "Xcon" takes customer computer orders and configures a system, including parts, accessories, and an assembly plan.

- In the U.K., a product called "The Last One" generates a program coded in BASIC after the user specifies flowcharts in the English-language format and responds to different questions on such things as file size and error routine options.[18]

- AI is under study for use in battlefield management systems, unattended tanks and submarines, and expert assistants for F-16 pilots.[19]

- Risk analysis for financial auditing, equipment maintenance and operation in telecommunication, measurement collection and analysis in utility plants, natural language communication for computers, speech understanding, handwriting recognition, geological exploration, medical diagnosis, robotic vision systems, credit evaluation, stock analysis and trading, cash trading, loan review, tax planning, and design of computer chips.

17. Dr. Edward Alex Tomeski, "How Artificial Intelligence has Developed," *Journal of Systems Management,* May 1986, p. 8.

18. Ibid.

19. John Couretas, "Marketers Get Smart with Artificial Intelligence," *Business Marketing,* September 1985, p. 68.

## Personnel

The interaction that will be required between work force personnel and the AI technology that is rapidly growing in all industries should be watched very closely. Some AI watchers are predicting the technology will produce nothing less than a radical transformation of the way business is done. If this is true, upper level managers should prepare their companies for it. As the technology grows, not only will it speed the automation of many manufacturing functions, but its ability to duplicate human decision-making expertise will spell the end of some middle-management jobs.

AI technology in an ICR system is such that the machines that use AI as a "brain" are structured to operate themselves with little interaction with the operator. Undoubtedly, this will have a great impact on the work force, especially the manual workers such as typists. Once an intelligent reading system is "trained" by its operator, the system will be able to correct itself, compare fonts, formats, and guidelines pre-programmed into it, and then analyze the procedure it is required to do. At this point, the operator's job title will literally change to "supervisor" of these intelligent systems, and will advance to other areas in their company that require less physical labor and offer more intellectual growth.

Some advocates of AI and computer technology say that "intellectual man" is slowly developing "intellectual systems" and computers in order to free the mind from daily repetitive and mundane operations; something that these machines can do much more efficiently than operators. In turn, over a period of generations perhaps, computers and AI technology will provide us more time and opportunities to expand our own intelligence, creativity, and limits in ways that are now not possible.

## Outlook for the Future

Since its birth in the 1950's, AI technology was slow to advance because society still needed to be introduced to the basic concept of computers; let alone AI. In addition to this, society was afraid of AI creating "artificial human beings." In 1972, when research was growing in the AI field worldwide, there were still scientists opposing AI's further development. Sir James Lighthill, a respected mathematician in the U.K. who

undertook an investigation of AI for the Science Research Council (SRC), produced a report that virtually eliminated AI and robotic research in that country.[20] Although all of the major countries in the world are researching AI to great extents (including the U.K.), only minimal advances have been made toward emulating genuine human thinking.

To get an idea of the degree of interest that U.S. companies are putting into the future of AI technology, Rockwell International Corp. has established an AI laboratory in Palo Alto, CA to gain access to the community which includes Stanford University, Stanford Research Institute, and companies such as Teknowledge and Xerox. Currently, there are two employees working in the lab, but in one to three years, 15 to 20 workers will be doing research there. Rockwell wants to have their work unclassified and as open as possible in order to stimulate ideas from outside sources. Future plans call for the building of demonstration systems to display the usefulness of AI technology. It is reported that 75 percent of the work done in the Palo Alto lab will be geared toward applications in robotics and telecommunication. Company officials said three-fourths of Rockwell's products now contain computer software, from space station proposals to printing presses. As a result, the number of people that apply AI in their work at Rockwell is expected to triple in the next year.[21]

The future for AI is quite promising even though the number of researchers in the field is hindering the growth. Reports claim that we have only been exposed to a small part of what is to come in AI and its applications to the graphics and other industries. According to a study in 1981 by the Defense Service Board, AI is one of the top technologies for the 1980's and its importance is likely to continue into the 1990's.

It is clear that ICR will evolve from a technology with value in the graphic arts field which comes primarily in its ability to convert volumes of historical data to electronic form quickly and easily. The office copier of the

20. Dr. Edward Alex Tomeski, "How Artificial Intelligence has Developed," *Journal of Systems Management*, May 1986, p. 6.

21. _____, "Rockwell Establishes Laboratory to Investigate AI Technology," *Aviation Week and Space Technology*, March 10, 1986, p. 261.

future will be much more than that. It will include a scanner wired to a non-impact printer, microprocessor, ICR, and communications, serving a range of needs from facsimile communication to ETP and database applications.[22]

Computers emerged decades ago to mechanize the process of converting raw data into information that humans could comprehend and use in decision-making. Today, an era is beginning where AI and computers will convert information into knowledge. Perhaps a day will come when computers will begin converting knowledge into wisdom; a day when computers advise us as to what purposes are truly worth accomplishing.[23] However, like anything that is powerful, abuses may come with this technology. Perhaps, the government could use AI technology in monitoring personal phone calls. Could this "big brother" alert the authorities to "undesirable" conversation or behavior coming from within a citizen's home?

Experts agree that "thinking" computers almost certainly will replace people in millions of jobs in many industries and offices. According to an estimate by Carnegie-Mellon University, 25 million to 28 million people are employed in manufacturing, and it is expected that this number will decline to less than 3 million by the year 2010.[24] Is it possible that no one understands what is happening or grasps the extent of what is coming?

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22. Noel Coletti, Jr., "Intelligent Character Recognition Looms Ahead," *Graphic Arts Monthly,* February 1985, p. S26.

23. Dr. Edward Alex Tomeski, "How Artificial Intelligence has Developed," *Journal of Systems Management,* May 1986, p. 10.

24. Ibid.

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