Artificial Intelligence: Expert Systems and the Graphic Arts Industries

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Introduction

In this paper the concentration and application of artificial intelligence will fall and form on the basis of *expert systems* and the desire to better the working environments in the graphic arts industry. The graphic arts industry poses appropriate for an expert system in that the information that is available to the industry is vast and rapidly changing. This information need be captured and utilized for it to be optimized. The volatility of the industry makes it difficult to track factors influencing the success and failure of a given graphic arts business. In the present day, to compensate and push ahead as related to the success of a work environment, a company may hire consultant(s), send employees for more education, do in house research, and/or mirror other companies similar to itself which are successful. Unfortunately, these all are costly pursuits which have both time and effort restrictions. The solution to keeping pace in a successful, profitable, cost effective, efficient, controlled, manner with an obvious lack of mistakes lies in the use of expert systems.

Imagine

As a manager walks up to her office building she knows that what she wants to accomplish for the day will get done without distraction. The budget decision she must make, the production schedule she oversees, the technology purchase she must choose, all were carefully analyzed, compared, bench-marked, and scored based on given factors relating to the companies success and future expectations as related to the world around them. Her day will run smoothly and she will have the time she wants to enjoy her day, enjoy her work environment all without the stress and concern of poor quality, bad decisions, or mistakes. Her day will not get piled up with meaningless jobs that have no significance and wasted time. Efficiency, excellence, high standards, high quality, knowledge of best options, what markets will best serve the company, when and where, and customized customer tracking are all part of her day because she is utilizing an expert system.

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Paper Overview

AI consulting systems are used everyday in our banks, at our car manufacturers, at the local supermarket, and many other places one would not expect. Expert systems have emerged out needs and the desire to better the world around us. Saving costs, avoiding large life threatening or monetary mistakes, comparing data in making a purchase decision, screening a customer before getting approved for a loan, optimizing a production or manufacturing schedule, maintaining a printing presses quality and consistency while running, and seeing a management decision through as an optimal one, are some of the ways in which expert systems affect us daily. Why hire a consultant or spend hours of time hungry research when an expert system can advise us of an optimal choice or reveal multiple options to a solution which would otherwise take many minds and inaccessible time to accomplish? This paper will look at the development, basic structure of an AI system, how, why, and where it can affect the graphic arts industry, and present day applications of expert systems. Lastly, this paper will show that expert systems are a thing of the present and that graphic arts work places can benefit from expert systems.

What is Artificial Intelligence?

Definition

artificial intelligence[1], (AI), the use of computers to model the behavioral aspects of human reasoning and learning. Research in AI is concentrated in some half-dozen areas. In *problem solving,* one must proceed from a beginning (the initial state) to the end (the goal state) via a limited number of steps; AI here involves an attempt to model the reasoning process in solving a problem, such as the proof of a theorem. In *pattern recognition,* shapes, forms, or configurations of data must be identified and isolated from a larger group; the process here is similar to that used by a doctor in classifying medical problems on the basis of symptoms. *Natural language processing* is an analysis of current or colloquial language usage without the sometimes misleading effect of formal grammars; it is an attempt to model the learning process of a translator faced with the phrase "throw mama from the train a kiss." *Machine learning* occurs when a computer improves its performance of a task on the basis of its programmed application of AI principles to its past performance of that task. An outgrowth of AI research has been the **EXPERT SYSTEM**, a computer program that uses AI techniques to predict the outcome of events or solve problems.

Artificial Intelligence is a branch of computer science dealing with computer systems implementing a restricted but definite part of human intelligence. These areas include, knowledge acquisition, perception, learning, reasoning, language understanding, theorem proving, and problem solving.

Definition of An Expert System

An expert system is firmly planted at the application end of Artificial Intelligence. In application, an expert system usually specializes in the area of problem solving, learning, and linguistics. Expert systems embody large amounts of human knowledge about a specified problem and use this knowledge provide advice on what to do in a particular circumstance. Expert systems have the ability to explain to the user how a decision is reached, how its reasoning affected the information, and how it sees the problem need be solved. In the case of an expert system choosing an optimal location for a printer based on logistics, competition, markets in area, customer availability in the area, and cost/benefits of location it will look at each factor as a problem to be solved. The expert system may then use different forms of logic, reasoning, language translation, calculations, estimations, comparative reasoning, and known facts to base its advise upon. An expert system may be used to maintain the efficiency of a press schedule keeping track of customer needs, ink orders, viscosity regulations, etc.

Why Expert Systems for the Graphic Arts?

A company in the graphic arts industry operates similarly to any production based company except that the technology and methods available to produce the desired product are increasing at a pace that makes it difficult for many companies and business to keep up. As a result of this lack of an inability to process overwhelming amounts of knowledge, quality, time, efficiency, money, and customers are lost. This is where expert systems fit in. Expert systems allow companies to keep up with the pace of new knowledge. Expert systems specialize in knowledge sorting, gathering, translating, classifying, and reasoning. With this premise in mind an expert system is similar to the ideal consultant, advisor, and information database rolled into one.

What Would An Expert System Do for My Business?

An Example

First, look at an example of a description of a consulting business specializing in expert systems. This page, found on the www describes what this company found most important to achieve and success in a business and how an expert system can help the business achieve and maintain that success:

> PROBLEM
> Businesses have a need to increase their relative and absolute performance. This need is brought about by a combination of factors both internal and external to the business. Examples of such factors are the needs to: improve customer satisfaction; improve financial performance; decrease cycle times; and adapt to growth

and recession cycles. To achieve successful management of change, businesses need to be able to monitor and improve their performance against strategic objectives. This ability needs to be supported by methods and tools which help model, analyze and improve various aspects of how a business works and how it is organized.

SOLUTION

To improve and where necessary replace existing modeling methods with a framework for integrating methods and tools which are appropriate to enterprise modeling and the management of change.

The xxxxxx project is aimed at providing a method and computer tool set which will help capture aspects of a business and analyze these to identify and compare options for meeting the business requirements.

MAIN FEATURES

The framework for integrating methods and tools will be solidly based on an ontology for enterprise modeling. It will support a generic core of practical knowledge based modeling tools and methods for business application and will be developed in accordance with existing and emerging standards in open systems and knowledge representation.[2]

As exemplified in this description, the system described uses both existing and emerging standards for its basis. Expert systems today can look at both existing and emerging possibilities and compile advice, databases, quality standards, help a machine maintain quality standards, and analyze profitability. The graphic arts industry comprises most, if not all, of the industries, products for these industries, manufacturers related to this industries directly connected to graphic communication. This includes, but is by no means limited to, publishers (substrate and electronic), package printers, book manufacturers, graphic software manufacturers, software companies, and any other industries relating to graphic communication around the globe. Expert systems affect these industries on a daily basis. The graphic arts industry is no exception to big business as it is the third largest industry in the United States. Quality, efficiency, excellence, high standards, knowledge of best options, what markets will best serve the company, are all crucial to the survival of a graphic arts establishment which will find themselves in the middle of merging and take-over wars. A company must not just get by in this present day, it must strive to survive and stay ahead. The companies which have the knowledge and can use the knowledge are those that are the most powerful and they will survive because they stay on top of information.

How would an Expert System Help a business?

Every year associations (such as the PIA and the NAPL), industries, groups, organizations (such as the EPA and OSHA), companies, researchers, and others provide knowledge, advice, standards, methods, protocol, and other facts that are both helpful and useful to the workings of a business in the graphic arts. But to compile, group, sort, and filter *all* of this knowledge in a manner that would optimize the operations of a business in an immediately applicable manner is impossible. Instead, a company enlists consultants, send employees off to school, and spends much time, research, and money on knowledge interpretation. Expert systems are designed to interpret knowledge in an efficient and given manner.

The more information becomes readily available to us in a form easily read by an AI system the more the information is merged with other information and the better off in checking on data and integrity of information, less wasted time in scheduling, production, quality control, documentation of quality, new standards and laws and keeping up with them.

What is to stop and AI system from finding all it needs to know for a company to meet the newest OSHA, EPA, standards, or international protocol? It is the quality of these systems and their design structure and integrity which will need questioning and which will require knowledge of them.

Where Did Artificial Intelligence Come From and From Whom?

Artificial intelligence as it is thought of today developed in the computer field over a span of 40 years. But AI was in place long before the nineteenth century. As one may see from the following information, attempts at creating intelligent systems have spanned the centuries.

1956 Conference on AI

The Inspirational origins of modern AI are credited to the work of the British mathematician Alan Turing who wrote a paper entitled " Computing machinery and intelligence" in 1950.[3] *Artificial Intelligence* was a phrase coined around 1956 when a man named John McCarthy wanted to have machines complete tasks that were considered intelligent by humans. He proposed a conference of similar minded persons. The results of the conference were sadly not as expected. The conference provided numerous studies on automation and less studies on Artificial Intelligence than expected. Pursuing his desire to successfully create intelligent machines McCarthy again held a conference in 1956 with the phrase *artificial intelligence* included in the description. The purpose of the conference was made known as it was to discuss 'the possibility of constructing genuinely intelligent machines'.[4] Attending the 1956 conference were a few of the trailblazers in early AI. These pioneers included Marvin Minsky who went on to establish the AI school presently at MIT, Simon and

Newell, who established the school today known as Carnegie-Melon, Claude Shannon, and A.L. Samuel. The result of this pivotal conference on Intelligent machines was the notion of utilizing a "high-level language to construct symbolic models of various intelligent activity"[5]. It is important to note that at this conference Simon and Newell were the only attendees with a working AI program. At this time, two areas which took top attention of AI research were that of theorem proving in mathematical logic and that of game playing such as chess. The commonalty these areas shared as playing a key role in developing intelligent systems was that the mathematical solution or game move was matched to a correct solution or calculated move. It remained a dream to have an AI system gather and recreate knowledge from written or spoken word, use this data and create as optimal or improved situation.

Every aspect of learning or any other feature of intelligence can in principle be so precisely described that a machine cab be made to simulate it.

—Organizers of the 1956 conference[6]

Before 1956

That approach to machines was long in place before that important conference. AI had been in place, but in many different forms long before the phrase was ever coined. Back as far as before 1000 BC astrologers were exploring an arbitrary system of planetary relationships with three orthogonal dimensions: planet sign and house and trying to map them onto human experiences. Also, The I-Ching, much later in time, offered the 64 permutations of a six-bit binary system, as well as the eight three-bit half-words they contained.[7] Lastly, the Kabalah and Tarot (43k, 1 gif) offered simpler systems around 1000 AD, tied more directly to particular human meanings like virtue and vice.

Orthogonality

Orthogonality is a critical concept in *software design*. The name implies a set of dimensions that are at 'right angles' to each other, so that any 'point' can be defined in terms of one-value-for-each-dimension. A vivid example of this arrived with the 1984 debut of MacPaint, where one could easily vary the following orthogonal dimensions for each graphic 'object': shape, size, position, fill-pattern, border-thickness, and border-pattern.

```
y
|  z
|  /   * P = (x, y, z)
| /
|/
|/_________x
```

The beauty of orthogonality in software design is that it allows an extremely broad range of objects to be defined with a minimal set of parameters. Consequently, one need only remember these few commands to master all the objects so created. [8]

LISP and early 1960s

LISP was the first AI language given credit as a high level programming language. It is still used today and preference over COBOL and Fortran in relation to integration of programming environments.[9] Emerging out of the roots of the first conference in 1956 grew branches of AI quickly and furiously through the 1960s. In 1963 the first conference on computational linguistics occurred and in 1965 the first international conference on computational linguistics occurred.

Late 1960s and Early1970s

The first international conference devoted to the general and very broad field of AI was held in 1969 as the International Joint Conference on Artificial Intelligence (IJCAI). As the 1960s recognized and developed the importance of the solution search, the 1970s concentrated substantially on the importance of the representation of knowledge. In the systems designed in the late 1960s it was very difficult to transfer the knowledge from the mind of a person to the knowledge base of a program. Setting parameters around the heuristic, illogical human rules of linguistics proved difficult.[10] In the late 1960s and early 1970s researchers concluded that knowledge was the key to solving *problem solving power* and thus actively sought ways to enable their computers to use large amounts of knowledge. Their search led the researchers into an IF . . .THEN format, and involved new ways of filtering large amounts of data. The result of these discoveries were the first expert systems. In addition, knowledge engineering was formed.

Additionally, this switch from studying qualitative data to the control and manipulation of knowledge marked a pivotal point in the development of expert systems. Starting in the early 1970s computers had hundreds of thousands of words of memory in them but the software required to develop applications for these resources were complex due to the fact that the field was still in its younger years. A gentleman named Edward Feigenbaum is credited with the development of the first expert system known as DENDRAL. DENDRAL allowed the user to map the structure of a molecule which, previously was not an exact science where educational guesses were close but not correct. DENDREL exemplified the fact that a computer could drastically reduce the work required to find an answer by doing extensive numerical work.

After scientists became dissatisfied with the stiff nature in which DENDRAL operated they searched for a more modular knowledge based system. The result was MYCIN, a system which is similar to today's expert systems in the most basic sense. MYCIN used control logic or backward chaining to prove that a knowledge based system was real. The system depend on a given set of rules using IF, THEN, OR, and AND statements to link, classify, and deduce information. The use of OR today enables a production system to capture the parallelism that occurs in human thought.

Following developments in computing, computer users and inventors saw the potential of substituting numbers for symbols representing concepts far more abstract than the usual straightforward data. If the computer could manipulate these symbols as specified in its programs, perhaps it could "think". Thus was born the controversial concept *cognition as computation.* Questions were raised such as "Could one represent all things under the sun through a set of symbols?, Could thought result from manipulation of these symbols according to a predefined set of rules?, and What should these rules and symbols be?" that echoed the early efforts of AI and which formed the focus of the late 1970s in AI research.

Late 1970s and Early1980s

The eighties recognized fully the development of linguistic translation within a computer. The concentration of effort had been on the different meanings a sentence can have as well as the grammatical structure. What was found was that the grammar was not as relevant as expected for the accurate translation of sentences into conceptual representations.

In the late 1970 Marvin Minsky developed a paper which stated that "when one encounters a new situation . . . one selects from memory a substantial structure called a frame. This is a remembered frame work to be adapted to fit reality by changing details as necessary." The concept of the frame both physically and in abstract has allowed systems to relate knowledge on a new basis. For example, a business may have a hierarchical frame or a child may have a cognitive learning frame. In robotics frames are used also in a physical nature as the surround. At the end of the early 1980s it was recognized and feasible that real world applications for expert systems could assist and actively do and exceed the jobs of experts such as profitability consultants, engineers, database designers and the like.

Interesting Facts on Early Computer Devices

Additionally, the first truly programmable device had nothing to do with numbers. It was invented in 1805 to drive looms: removable punch cards let the same machine weave different patterns. Credit for this machine goes to Frenchman Joseph-Marie Jacquard.

Forty years later Charles Babbage used punched cards to feed instructions to his "analytical engine" which, had it survived, would of contained all the elements of a modern computer including a memory and processing unit. Babbage later teamed with Augusta Ada daughter of Lord Byron the poet. Together they attempted to produce machines that performed given tasks, but the lack of accuracy in nineteenth century mechanics disallowed this. They did however invent a chess playing machine, a tic-tac-toe playing machine, and a system for wining at the race track which on two separate occasions caused the countess Augusta to pawn her jewels!

In 1890, the American Herman Hollerith invented for the US government a tabualting machine that processed census data. Hollerith's Tabulating machine Company eventually merged into a conglomerate called IBM.

The electronic computer in America, which contained no moving parts, appeared during the second World War, contained 18,000 tubes, weighed 30 tons, used as much power as a locomotive and would of filled a ballroom. It performed as much as 20,000 multipulcations per minute.

What is Important to Know About Artificial Intelligence?

The two principle structural components for every intelligence system are a knowledge base and a solution search method.

Knowledge Gathering

Artificial Intelligence encompasses many perspectives which each have many facets. What remains true throughout the numerous perspectives is that AI *systems attempt, achieve, and can supersede intelligent tasks performed by human beings.* Expert systems, for example, not only save millions of dollars as seen later, but can perform the job of 10,000 minds in a specific area. But in order to more thoroughly understand AI it is important to look at some of these views.

"A.I. views hierarchies as networks of 'nodes' connected by 'isA links.' In computer memory, any clump of data can be a node, and any pointer to such a clump can be a link. 'IsA' is the particular relationship between a more-specialized and a less-specialized form of the same thing: "hunger isA motive" translates as: "Motive is a general class that includes hunger as one specialized form." (Another common sort of link is 'partOf'.)"[1]

This view, the perspective that in AI things are able to get linked, gathered, and "clumped" allows clumps and links to be assigned numbers or symbols. Then, as if taking turns, in a structured way like a game or calculation the symbols carry out instructions leaving them manipulated into new formations and new knowledge. In the early years of AI, from 1956-1963 the scientists felt as if they had hit up against impenetrable walls with trying to teach the systems to see the world in their own way to make sense of new situations and understand new knowledge.

What Do You Do with the Knowledge Once it is Captured?

Once knowledge is captured it is reasoned. In AI reasoning can mean the inferring, common sense relations, or other methods to manipulate the data. In expert systems knowledge is goal orientated. Inference is defined as a process of extending an incomplete relational structure so that it is less complete. In AI inference is defined as a process where new facts are derived from known facts. The actual process of inferences broken down into three steps. One, identification of the pieces of knowledge relevant to a problem or classification occurs. Two, a conflict is resolved. Lastly, control and interpretation of the results occurs. In an expert system this occurs with the use of an inference mechanism which is a computer program that can select, understand, interpret and draw conclusions or generate new knowledge from existing knowledge.

Relationships in the Knowledge Base

We achieve more than we know
We know more than we understand
We understand more than we can explain

—Claude Bernard (French scientific Philosopher)[11]

As knowledge is viewed as a collection of facts about the world, the *knowledge base* of an AI system is formed by these facts. This is quite similar to a database used in some software. Facts are fragments of knowledge defining something about objects in the world that need be represented in the computer. These facts state relationships such as *the grass is red* or the *horse is purple* between them. Since all objects have different facts linked to them they produce different *logic inferences*. The most elementary form of *inference* is *modes ponens*; p and p-q then q can be inferred. Inference rules are used to draw conclusions about facts and relationships. Each rule is applied such that a conclusion follows logically from the information represented.

Once a conclusion formed it is transformed into a normal form so that it is in the same form as the rest of the information. The conclusion can then be tested to see if any or all is redundant and whether or not it should be discarded. In the case of a contradiction, as would occur within searches based on new technology and markets etc., the reasoning applied would have to be *non-montonic* reasoning.[12] Non-montonic reasoning can be revised if some values change during a session. It is used in dealing with problems that involve rapid changes in short periods of time.

There are numerous techniques available for representation of knowledge. The techniques in the representation of knowledge in a given system are directly reflective of the type of application. For example, in a linguistics application, the words and grammar are represented in such a way to emulate a human sentence (<noun><modifier>etc). In a medical advising system, the information may be represented as symptoms and solutions in an IF. . .THEN form. As of this date there are still difficulties encountered in the accurate translation and interpretation of sentences by a computer. Usually, the less the structure is based on common sense and the more the structure is based on logic the easier it is for the system to interpret, conclude, sort, and link the information provided.

AI is the science of making machines do things that would require intelligence if done by men

Marvin Minsky[13]

"I believe that in about 50 years' time it will be possible to programme computers . . . to make them play the imitation game so well that the average interrogator will not have more than 70 per cent chance of making the right identification after five minutes of questioning

—Alan Turing, 1950[14]

Knowledge Manipulation

In a modern expert system there are literally thousands upon thousands of rules. For the computer to be sure it is processing the rules in the correct order pertinent to the information rule chaining occurs. Rule chaining allows the program to infer conclusions from conclusions by entering its rules in an order different from the order they appear in the reasoning.[15]

Furthermore, since problem solving does not follow a single set of rules in a straight line formation, several alternatives are always given using different paths within a program. When new rules are required, they are either added or as the system concludes information it may form its own rules based on gathered information. If a system sees the need to change or remove a rule the rest of the system is not necessarily affected. This is especially true in systems using non monatomic reasoning. In expert systems, knowledge is considered declarative whereas in a conventional program such as an algorithm, the knowledge is procedural. When knowledge is manipulated it is done so in a form that is customized to the end result or and expected and desired result and/or solution to a problem.

Representing the Knowledge

In an expert system the knowledge is represented symbolically. Ideas, notions, and conclusions. As mentioned before in expert systems knowledge is considered as declarative knowledge. *Declarative representation* of knowledge relies upon the emphasis of facts and assertions and how the knowledge is to be guided or used. The most common representations of knowledge in declarative form are semantic nets, frames, and scripts. Nets rely on what is called graph theory and use links for the description of objects and the interrelationships between them. Frames and scripts rely on structural knowledge representation which enables more complex data structures to be placed into classifications or *nodes.*

A program called TEIRESIAS was created by Bruce Buchanan which pivoted the step towards information mining/engineering. The program operated partially on information it called meta-knowledge. Meta-knowledge: is the knowledge that we know about our knowledge.[16] The knowledge that we have about the limits or reliability or our understanding of a subject and the knowledge that we have about the strengths and weaknesses of human cognition both are examples of meta-knowledge.

You can never step in the same stream twice

—Anaximinder[17]

Because of the vast amounts of knowledge and links that may be generated in an AI system, the possibilities of a correct and ideal situation answer are many. The links and gathered information are tied and inter-related. Related in a way that is similar to the way of thinking in psychology that humans at some level cannot be disconnected from others. For example, a down quilt is shared because the down feathers from one goose, the material, the stitching, the person making the quilt and all other factors going into the quilt link it and the user to numerous facets and objects. Because of this there are vast probabilities for links resulting in vast solutions; *uncertainty due to complexity*[18] in AI computing. To overcome this an AI systems sometimes use fuzzy logic.

fuzzy logic, a multi-valued (as opposed to binary) LOGIC. Classical logic holds that everything can be expressed in binary terms: 0 or 1, black or white, yes or no; in terms of BOOLEAN ALGEBRA, everything is in one set or another but not in both. Fuzzy logic allows for values between 0 and 1, shades of gray, and maybe; it allows partial membership in a set. When the approximate reasoning of fuzzy logic is used with an EXPERT SYSTEM, logical inferences can be drawn from imprecise relationships. It is used, for example, to optimize automatically the wash cycle of a washing machine by sensing the load size, fabric mix, and quantity of detergent. Fuzzy logic is used to control passenger elevators, household appliances, cameras, and automobile subsystems.[19]

As knowledge availability increases the need for expert systems to more readily accept different forms of knowledge increase. The logic and reasoning behind an expert's system ability to come up with an ideal answer relies on the specifics of the problem posed. There are many other different approaches and forms of reasoning that were not able to be discussed in this summation. The other forms of knowledge gathering and processing and outputting become specific to the filed in which they affect. But it remains true that the systems that can use the most knowledge for the most reasons are the systems that will carry power and breadth of quality, efficiency, and benefits to those utilizing them.

Why should we know these in the Graphic Arts?

The user need be empowered in a correct ethical and moral way in using an AI system, an AI system is configurable, customizable to the users needs, it can metamorphosis and learn from those using it, many can use one system at the same time as compared to hiring a consultant if there was an ideal one but that does not exist.

An expert system today can assist in many forms. If one were to set up an ideal business or improve their existing business and an expert system was available to them they may do many things. An example is that the expert system could advise on location based on data and information collected from numerous sources. These numerous sources could include two of which are always free, the Internet and libraries. With information becoming more readily available in digital form it is not difficult to link an existing expert system to a powerful search engine which can search and documentation in a format read by the system. This may include, summaries of articles, statistical data, population data, market data, descriptions of new technology, costs of new technology, manufacturing indexes, EPA standards, OSHA standards, International Protocol on shipping, and much more in digital form. An expert system could maintain ones quality.

Proof that Expert Systems can Work[21]

1995 - IBM Corporation

System
PCE (Product Cost Estimator)

Function of System
A system that advises the true manufacturing costs of IBM products. The system is used by product planners to evaluate alternatives when planning new product launches, setting warranty periods, etc. The product features end-user tools for capturing knowledge used in costing and "What if" analysis.

Benefits
The system has reduced cost estimation times from months to days, while improving the accuracy and thoroughness of product cost estimates. The result is markedly improved time-to-market for new products.

Software/Hardware
OS/2 on PCs with access to DB2

1995 - Canon, USA

System
SAMS (Strategic Account Management System)

Function of System
A laptop-based strategic sales automation tool for sales representatives and dealers of Canon copiers. Application proactively coaches sales reps in structuring their approach to major accounts according to Canon's sales methodology. The system offers interactive brain-storming and competitive analysis capabilities as well as tools for sharing and retrieving knowledge across the company.

Benefits
The system provides a focused sales process and provides structure and discipline to sales activities. It adds consistency to all sales. The calls help reps recognize and prioritize sales opportunities. It reinforces Canon sales training programs, fosters a better team atmosphere and reduces the cost of rep turnover.

Software/Hardware
Microsoft Windows on Laptop PCs

1993 - Ford Motor Co.

System
CAPE (Computer Aided Parts Estimation)

Function of System
Generates design and evaluates the cost of automotive part manufacturing plans.

Benefits
Increased speed of estimating and analysis time by 50%. Improved quality of less experienced estimators by 30%.

Software/Hardware
Windows

1993 - Celite Corporation and Andersen Consulting

System
ASF (Application Software Factory)

Function of System
Increase development productivity and improve software quality through reengineering of the software development process. Developed using Total Quality Management concepts.

Benefits
Significantly reduced module development time. Elimination of bugs. Reduced training. Drastic reduction in development time. Output document used strictly for documentation.

Software/Hardware
PC-DOS and VAX/VMS FOUNDATION (Andersen CASE tool set) IBM AS/400

1993 - IBM Corporation

System
DEPICT (Digitized Expert PICTures)

Function of System
Designed for non-programmers develop and maintain applications with little training.

Benefits
Resolves manufacturing to semi-conductor Work in Progress (WIP) problems significantly with estimated savings to several million per year.

Software/Hardware
IBM MVS

1993 - IBM Corporation

System
DYCE (Diagnostic Yield Characterization Expert)

Function of System
Automated data interpretation in semiconductor manufacturing. DYCE assists manufacturing and development personnel to diagnose problems.

Benefits
Diagnosis time has been IBM MVS reduced from several hours to minutes. DYCE is performing the equivalent work of dozens of engineers. Annual savings approach several million dollars

1993 - Kraft Pulp Mills

System
PITCH: A Problem-Solving System for Kraft Pulp Mills

Function of System
PITCH makes scientific expertise available to mill engineers which augments their problem-solving capability while relieving the human expert of much of the burden of routine problem-solving.

Benefits
Savings are reported at $28 million Canadian per year. This is the largest deployed KB system in the pulp and paper industry.

Software/Hardware
Sun Workstations

1993 - IBM Industrial Sector Consulting Services

System
QRES (Quality and Reliability Expert System)

Function of System
QRES identifies problem areas in manufacturing production lines. Recommends how to make improvements with high quality and least cost levels. Predicts production for new components and assemblies during design and development

Benefits
Reduced cycle time in performing quality and reliability predictions. Two months of engineering time. Improved link between design and manufacturing. Fewer engineers needed.

Software/Hardware
PC-DOS OS/2

1992 - XEROX Corp.

System
DMCM (Design Manufacturability and Cost Modelswide System)

Function of System
Assists cost engineers with a range of cost estimation problems for piece part manufacturing.

Benefits
A 50% time-savings for cost engineers, while providing more efficient designs. Higher quality products and shorter development cycles. Estimated $20 million annual savings.

Software/Hardware
Sun workstation connected to TCP-IP, SNA and XNS to central database servers.

1991 - Nippon Steel Company

System
Quality Design Expert System

Function of System
Hybrid system using case-based reasoning (CBR) - augmented by hypothetical reasoning, fuzzy logic, and neural network components - to model the reasoning process used by an expert steel design engineer when designing specially shaped steel products.

Benefits
Savings and earnings estimated at $200,000 per year.

Software/Hardware
Sun Workstations

1990 - Ford Motor Company

System
TIES (Technical Information Engineering System)

Function of System
Product quality and design cycle time management tool that aids team development based on quality function deployment.

Benefits
Better documentation and distribution of design choices. Better consistency and coordination of vehicle development. Reduced development time. Faster training of new engineers.

Software/Hardware
Sun Workstations

1990 - Ford Motor Co.

System
ESCAPE (Expert System for Claims Authorization and Processing)

Function of System
Checks for validity of incoming warranty claims.

Benefits
Easier maintenance of warranty validation process code, allowed Ford to use warranty policy as a competitive tool.

Software/Hardware
COBOL MVS, IBM3090

What are Some Applications of Artificial Intelligence Today?

Who is Using AI Systems?

At this time very large corporations, military, government, and educational facilities utilize expert systems. It is necessary for smaller companies to have access to these systems. If not, it is foreseeable that they will not have the opportunity to compete with the larger companies as they allow the division between highly efficient, proficient, profitable time saving, investment, market, and location savvy businesses to increase.

What do the Expert Systems Do Today?

With the speed and brevity of computing increasing an unpredictable rates AI systems are developed and utilized at increasing rates. The costs are high for an expert system, but if a system holds up to its integrity and performance level as programmed the cost savings can be quite immense. Companies save money by having expert systems answer their phones, troubleshoot problems over an online service instead of hiring employees. Expert systems aid in the design of accurately engineered parts that replaces a group of engineers. Expert systems research markets and marketability of products for large stores or catalogue based manufacturers. Expert systems maintain quality.

Proof that Expert Systems can Work for the Graphic Arts

On the previous pages are examples of expert systems in use today.[20]

Conclusion

This paper provided a very brief overview of the broad section of computer science known as Artificial Intelligence. It concentrated on the application, reasoning, and historical portion of expert systems to more clearly exemplify the usefulness of expert systems in the graphic arts industry. This is by no means a comprehensive overview of expert systems as such it only discussed expert systems and AI as it relates to a better understanding of how AI systems can improve graphic arts. If the paper offered comprehensive and more specific data relating to the graphic arts it would be in the nature of 20+ pages in length and require extensive study which is out of the breadth of the course. It is possible however, to research how an expert system would indeed exactly affect the graphic arts industry. This would take more in the nature of a whole course. The conclusions from this paper should be such that expert systems are a part of today's world, they are feasible and should be looked at as a positive monetary benefit to the graphic arts work environment.

References

[1] Artificial Intelligence Definition *Microsoft Bookshelf Dictionary*(1995)

[2] *Expert Systems for Your Business* A. Macintosh "http://www.expertelligence.com/"

[3] R. Smith *The Facts on File Dictionary of Artificial Intelligence* (Facts on File New York 1989) p.14

[4] D. Crevier *AI The Tumultuous History of the Search for Artificial Intelligence* (Basic Books New York 1993) p.p. 10-149

[5] *Ibid.*

[6] R. Smith *The Facts on File Dictionary of Artificial Intelligence* (Facts on File New York 1989) p.p. 4-60

[7] Artificial Intelligence: *A Modern Approach* Russell "http://www.cs.berkeley.edu/~russell/aima.html"

[8] *Ibid.*

[9] R. Smith *The Facts on File Dictionary of Artificial Intelligence* (Facts on File New York 1989) p.11

[10] D. Popovic and V. P. Bhatkar *Methods and Tools for Applied Artificial Intelligence* (Marcel Dekker New York 1994)p 19

[11] R. Bellman *An Introduction to Artificial Intelligence: Can Computer Think?* (Boyd & Frasier 1978)

[12] D. Popovic and V. P. Bhatkar *Methods and Tools for Applied Artificial Intelligence* (Marcel Dekker New York 1994)

[13] Artificial Intelligence "http://mnemosyne.itc.it:1024/ai.html"

[14] R. Bellman *An Introduction to Artificial Intelligence: Can Computer Think?* (Boyd & Frasier 1978)

[15] D. Popovic and V. P. Bhatkar *Methods and Tools for Applied Artificial Intelligence* (Marcel Dekker New York 1994)

[16] J. M. Rosenberg *Dictionary of Artificial Intelligence* (John Wiley & Sons Inc. New York 1986)

[17] R. Bellman *An Introduction to Artificial Intelligence: Can Computer Think?* (Boyd & Frasier 1978)

[18] Astrom and B. Wittenmark, *Computer Controlled Systems-Theory and Practice* (Prentice Hall NJ 1990)

[19] fuzzy logic Definition *Microsoft Bookshelf Dictionary*(1995)

[20] Overview of the Enterprise Project
http://www.aiai.ed.ac.uk/~entprise/enterprise/flier.html

[21] Table: Brightware.com solutions http://www.brightware.com/solutions/index.html