Patents and Artificial Intelligence:

Thinking Computers

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By

Michael J. Dochniak

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FOREWORD

In Stanley Kubrick's 2001: A Space Odyssey, (1968) movie-goers were introduced to the HAL 9000 computer that served to monitor and adjust all onboard functions of a spaceship bound for Jupiter. The crisis of the story involved HAL's presumed flawless control over mission data and functions. When Dr. David Bowen challenged HAL's prediction of a faulty electronic device, the inevitable clash between machines and humans erupted and the stage was set for an epic battle between human intelligence and artificial intelligence. In the movie, Dave Bowen elected to remove some electronic "intelligence" from HAL's memory array and in that final human-vs-machine scene, observers saw a computer devolve into rote program execution as it sung the words of the song, *Daisy Bell*. Human intelligence had challenged artificial intelligence and the day was saved for yet another confrontation or collaboration. Such was my introduction to Artificial Intelligence. AI has remained an intriguing proposition over the years since I first saw the Kubrick film in 1969.

Fast forward to the years 1984-1988 during my medical school training. The dogma regarding medical intelligence and diagnostics was simple: double check all information related to lab results and machine-generated data. Errors could not be tolerated. Physicians needed to think and derive their diagnostic and therapeutic plans from information gathered from medical histories and physical examinations; lab tests, radiographic studies and other data were primarily used to confirm information already known—the ancillary studies helped to refine medical intelligence and were not meant to replace it. Now in 2018, human intelligence in all disciplines is once again, or so it seems to me, at the juncture of having to contemplate yielding control and function to our machine AI counterparts. Only this time, the issues are greater than mechanical control; they are pressing in the realm of intelligent decision making, raising the possibility of using artificial intelligence to determine functional steps and endpoints—thinking outcomes if you will. And the intrigue over such a "thinking" machine is as intriguing as were the operations of the HAL 9000.

Ever since Alan Turing invented his "thinking" machine, one of the key questions of human efficiency and control has been how we can use

machine language and computing language to supplement our own speed at repetitive tasks. But our language of computing and task ordering has changed; we no longer think simply in terms of computing speed, but focus increasingly on computational complexity—on ways to bolster our ability to use data in a predictive and more "human" fashion. Consider the driverless automobile or farm tractor, surgical robotic devices or even our home "smart" devices—alarms, thermostats, light bulbs etc. Do they merely do things faster or more accurately? The answer is clear. We humans have demanded that our electronic control devices do more, and speed is not always the criteria for success. We now live in a world in which electronic smart devices push well beyond control mechanics and are now capable of interacting with our human mind through, at least at this stage, an internet of things and smart devices. And it seems our progression is all but certain; we shall continue moving in the direction of implemented AI, first perhaps in the more data-centric endeavors like response control or automated devices (drones and military applications as well as vehicle control) and then perhaps into realms we have yet to explore that may evoke more human emotion and interaction (might we consider companionship bots that engage us in a deeper state of thought or experience—maybe interactive play or care giving or even sex?). The possibilities seem endless, and to that point, Michael Dochniak has given us a well-researched book that serves to catalogue how AI has intersected with our society as evidenced by objective statements that inventors and innovators have made in patent applications.

Frankly, when I first read Michael's rendering of this topic in a legal framework, I wondered if his approach might be too restricted by the legal context, but it occurred to me on several readings that exactly the opposite is true. His approach is precisely the literary form that is needed to cut to the core of what is happening without the hype of a more fictional approach. It is precisely this unique approach that gives us the exact language of inventors and early adopters who have described their developments for the patent courts. Their statements allow us to see AI as they see it. And that gives us fertile ground from which to consider where we are going. Michael's approach records exactly what is real, right now, not merely in the minds of AI protagonists, but in their working models and products. Some of the patent filings reveal predictable developments, especially with precision control devices. Others push the boundaries of our comfort zones in the ways they exert control in medical diagnostics and healthcare related technologies, but these are my personal biases. AI might, in fact, allow us huge inroads into the difficult world of autism or perhaps PTSD. Smart AI learning devices could augment our ability to

effect outcomes in which we have struggled so long to gain so little ground. Could AI implanted devices monitor and evaluate our diets, our diseases and our needs for medication? The possibilities are as expansive as our minds. Michael Dochniak's detailed research and writing gives us a head start on those possibilities. And I have been both fascinated and educated by all that he has laid out here. When you read this book, read it with a pen and make lots of notes: you just might use them to develop the next AI breakthrough.

- Jon R. Kerstetter (Col. MC. FS., Iowa Army National Guard - Retired) practiced emergency medicine and military medicine, serving as a combat physician and flight surgeon for the US Army and completing three combat tours in Iraq. He has also taught disaster relief and practiced emergency medicine in Kosovo, Bosnia, Rwanda, and Honduras.

PREFACE

A pioneering patent can for a short period of time affect many lives. I've witnessed this growing up in the State of Minnesota, USA wherein a Company patented and sold Post-it® notes. A Post-it® is a small piece of paper with a strip of glue that can be used to temporarily attach notes to documents and other surfaces. It was an immensely popular product that allowed consumers to easily process small bits of information. Today, there's an infinite amount of information for us to process and artificial intelligence (AI) is there to help. As men and women continue to create and perfect AI, actively monitoring its evolution through patents can be both enlightening and unnerving.

This book was created to showcase the immense utility of AI and its "superhuman" characteristics. Without a doubt, patents play an important role in the remarkable progression of AI; disclosing valuable information about pioneering innovations, and me-too efforts, that stimulate future improvements. I discovered during this amazing journey that many of the inventors were brilliant and their ideas profound, but an uncertainty lingers in that there have been publicized statements on the potential threat of AI to civilization. Dynamic individuals including Stephen Hawking and Elon Musk have given warnings about AI. From my plain-spoken and hopeful perspective, mankind's relationship with AI will develop into a working friendship in that "friends let friends reboot".

This book could not have been constructed without an Internet guided by AI. It is patently clear that personal computers, and their ability to create networks, inspired the formation of the Internet during the early 1990s. Forthwith, AI is being used to regulate the traffic of information to produce a faster internet. Therefore, kudos and enormous gratitude is bestowed upon Paul Allen, Bill Gates, Steven Jobs, and Stephen Wozniak for providing a helping hand to personal computers during their infancy.

ACKNOWLEDGEMENT

Ethan Nelson-Moore, your capacity to diagnose and fix an AI disability will be remarkable. Thanks for your support and friendship in our great community of Iowa City, home of the Hawkeyes.

INTRODUCTION

It's learning from you and you're learning from it. In some sense, the internet is already that: it's a combination of people and machine intelligence to make our lives better.

– Larry Page (American computer scientist and internet entrepreneur who co-founded Google)

Loss of control of A.I. systems has become a big concern, it scares people. Rather than simply dismiss these dystopian claims scientists instead must monitor and continually evaluate the technologies.

– Eric Horvitz (American computer scientist and managing director of Microsoft Research.)

The notion that computers could be "intelligent" was discussed by Alan Turing in the paper *Computing Machinery and Intelligence* (1950) in which he proposed what became known as the Turing test: if a machine could convince you through conversation that it was human, it was doing as much as any human could to prove it was truly thinking. Today, artificial intelligence invokes a sense of wonder and amazement in many people, but for some, it's a financial-gain opportunity. From the years 1987 to 2017, at least one hundred fifty patents with the phrase "artificial intelligence" in the title have been granted by the United States Patent and Trademark Office. This important book provides an easy-to-read summary of such patents. Within many of the summaries, there are inventor profiles and news articles that are insightful and thought-provoking. Pioneering inventors hail from China, Denmark, France, Germany, Italy, Japan,

Korea, New Zealand, Russia, and Taiwan. Prominent organizations include Amazon, Disney, Ford, IBM, Intel, Microsoft, and Sony. Diverse quotes present the emotional impact of artificial intelligence. In the final chapter, anticipation builds with the thought of artificial intelligence evolving from an inventor to a patent assignee. In reverence to Alan Mathison Turing (1912-1954), widely considered the father of artificial intelligence, this book explores novel aspects of computing machinery that can process a vast amount of information to the nth power in a blink.

CHAPTER ONE

US PATENTS THAT TEACH ARTIFICIAL INTELLIGENCE

I don't fear artificial intelligence.

– Neil deGrasse Tyson (American astrophysicist, author, and science communicator)

The development of full artificial intelligence could spell the end of the human race. We cannot quite know what will happen if a machine exceeds our own intelligence, so we can't know if we'll be infinitely helped by it, or ignored by it and sidelined, or conceivably destroyed by it.

– Stephen Hawking (English theoretical physicist, cosmologist, author and Director of Research at the Centre for Theoretical Cosmology within the University of Cambridge)

Since the year 1987, over a thousand US patents have made a claim with the phrase "artificial intelligence". The quote below provides a simple explanation of a patent:

A patent, or invention, is any assemblage of technologies or ideas that you can put together that nobody put together that way before. That's how the patent office defines it. That's an invention.

– Dean Kamen (holds more than 440 US and foreign patents and is the inventor of the Segway, the first drug infusion pump, and many other innovations)

The United States Patent and Trademark Office (USPTO) is the federal agency for granting patents. The USPTO fulfills the mandate of Article I, Section 8, Clause 8, of the Constitution. This effort promotes the progress of science by securing for limited times to inventors the exclusive right to their discoveries.

The first US Patent with the phrase "artificial intelligence" in the title was issued on June 2, 1987. Thirty years later, about 150 such patents have been granted. It is interesting to note that in the patents described in the following chapters, there were 426 male inventors and 17 female inventors. Therefore, ninety-six percent of the inventors in such patents were male.

The United States economy is a better place when ideas are disclosed, patented, and attain financial success. If you have a novel and useful idea on how to improve artificial intelligence or a new use, the USPTO will reward you with patent protection. A well-earned patent can be part of a strategic business plan that allows you to exclude others from making, using, offering for sale, or selling your invention throughout the US. If you're the assignee (i.e., owner) of a pioneering patent, you may obtain twenty years of legal protection to acquire exclusive financial-gain.

In an article through Business Insider (2015) titled, *Who's set to make money from the coming artificial intelligence boom?* author Jonathan Fischer writes, "So who are the players going to be? First, several big tech companies have been storing up patents related to the field. IBM is the leader, with about 500 patents related to artificial intelligence. IBM's super-computer —Watson— is an example of the shift to AI, as it entered the healthcare sector in 2013 and helped lower the error rate in cancer diagnoses by physicians. Other big patent players in the space include Microsoft, Google, and SAP." [1]

Although the financial success of a Patent is a most important measuring stick, the value of a patent may also be appraised by the number of times it

has been cited by global patent publications. Such information is provided herein to quantify a patent's pioneering-effect on future innovations.

Reference

[1] Jonathon Fischer. 2015. "Who's set to make money from the coming artificial intelligence boom?" *Business Insider* Accessed September of 2017. http://www.businessinsider.com/artificial-intelligence-how-to-invest-2015-2

CHAPTER TWO

YEARS 1987 TO 1995: "ARTIFICIAL INTELLIGENCE" IN TITLE

I'm not worried at all.

– Steve Mnuchin (American banker and United States Secretary of the Treasury under the Trump administration)

The next wave of economic dislocations won't come from overseas, it will come from the relentless pace of automation that makes a lot of good, middle-class jobs obsolete.

– Barack Obama (American politician who served as the 44th President of the United States from 2009 to 2017)

In a paper from Oxford University (2013) titled, *The Future of Employment: How Susceptible Are Jobs to Computerisation?* authors Carl Benedik Frey and Michael A. Osborne disclose that 47 percent of U.S. jobs could fall to automation in the next 20 years. The researchers concluded, "Our model predicts a truncation in the current trend towards labour market polarisation, with computerisation being principally confined to low-skill and low-wage occupations. Our findings thus imply that as technology races ahead, low-skill workers will reallocate to tasks that are non-susceptible to computerisation – i.e., tasks requiring creative

and social intelligence. For workers to win the race, however, they will have to acquire creative and social skills.” [1]

Artificial Intelligence System

(Schramm in Patent number 4,670,848 - June 2, 1987)

This describes a system for accepting a natural language statement, understanding the statement, and making a response to the statement based upon at least a partial understanding of the statement.

The inventor explained that the system is characterized by its interaction with a user, which may be a person or machine, in gathering additional statements through inquiries to develop the most specific understanding possible by matching of the statements with a data base.

Patent number 4,670,848 (Schramm) is expired and has been cited by 121 patent publications. [2]

David A. Schramm (inventor) received a MBA in financing from Crummer School Business,1994. Mr. Schramm was the president and chief scientist at Standard Systems Corporation from 1984-1986. [3]

Standard Systems Corporation - Alvin (assignee) had goods and services directed at computer programs, reference library recorded on diskette, and user manuals all sold as a unit. The company was in Tampa, Florida. [4]

Computer Assisted Vehicle Service featuring Signature Analysis and Artificial Intelligence

(Boscove, et al. in Patent number 4,796,206 - January 3, 1989)

This describes a computerized automotive vehicle diagnostic-apparatus having improved performance.

It was explained that with the use of artificial intelligence concepts, a technician terminal can become "smarter" in its ability to diagnose more vehicle problems.

Patent number 4,796,206 (Boscove, et al.) is expired and has been cited by 104 patent publications. [5]

Joseph A. Boscove (first inventor listed with three co-inventors) was an engineer with the IBM Corporation.

In an article through the Coastal Star (2015) titled, *Obituary: Joseph Anthony Boscove* author Steven J. Smith writes, "Joseph Boscove made his mark as a career engineer with technology giant IBM. But his daughter, Joy Boscove says that his friendliness, generosity of spirit and the ability to guide her and her siblings in life were the endearing traits for which she will always remember him. Joseph was born in New York City and achieved notoriety in engineering circles for designing computer systems used in automobiles. 'He has four patents for those,' she said. 'His systems helped diagnose problems in cars. He made many trips to General Motors on behalf of IBM, because he was their consultant for in-car computer systems.'" [6]

International Business Machines Corporation (assignee) provides computer solutions using advanced information technology. The Company's solutions include technologies, systems, products, services, software, and financing. IBM offers its products through its global sales and distribution organization, as well as through a variety of third party distributors and resellers. IBM is headquartered in Armonk, New York, United States. [7]

In a communication through IBM (2017) titled, *The Evolution of Maintenance* author Matt Bellias writes, "Prescriptive maintenance is the future. It uses advanced analytics to make predictions about maintenance, but the difference is that prescriptive systems not only make recommendations but also act on recommendations. Prescriptive maintenance requires that various asset management and maintenance systems are well integrated. For example, a predictive maintenance solution might recommend that a piece of equipment get overhauled based on analysis of vibration and temperature readings, but a prescriptive system would kick off a work order to field technicians based on this information and oversee the entire maintenance workflows. Systems like

this must be ‘cognitive’, or have the ability to think. This technology is at the intersection of big data, analytics, machine learning, and artificial intelligence. Companies such as IBM, with cognitive systems such as Watson and comprehensive enterprise asset management systems such as Maximo, are pioneering in this space. By evolving from time based, to condition based, to predictive and prescriptive maintenance, companies are evolving their maintenance systems from being simply efficient to becoming truly strategic. Beyond maintenance, cognitive systems can integrate maintenance and operations data with other data sources, such as quality, warranty and engineering data, to become critical to how entire companies operate.” [8]

Semantic Network Machine for Artificial Intelligence Computer

(Oyanagi, et al. in Patent number 4,815,005 - March 21, 1989)

This describes a semantic network system that can perform high-speed inferential retrieval processing of an artificial intelligence knowledge base system.

Patent number 4,815,005 (Oyanagi, et al.) is expired and has been cited by 34 patent publications. [9]

Shigeru Oyanagi (first inventor listed with two co-inventors) received a PhD in engineering from Koyoto University. Dr. Oyanagi is a professor at Ritsumeikan University in Kyoto, Japan. [10]

TOSHIBA
Leading Innovation

Toshiba (assignee) is a multinational conglomerate corporation headquartered in Tokyo. Its products include information technology and communications equipment, electronic components, power systems, consumer electronics and household appliances. The number of employees is 199,000. The sales in FY 2015 were JPY 6.6 trillion. Toshiba has developed a new analytics system based on AI for use at its mainstay flash memory plant in Japan. AI is being used to monitor the semiconductor yield rate and will automatically classify defects and detect causes as well as analyze incident trends. Toshiba has also developed a dialogue-based virtual assistant specialized for inheritance advice. [11]

In a communication through Toshiba (2017) titled, *Toshiba's Communication AI: Evolving AI-related Technologies Long Cultivated by Toshiba* it is written, "Toshiba has long been in the vanguard of recognition technologies, and has now integrated its image recognition, speech recognition and language and knowledge technologies into AI services that support interpersonal communications. For example, one technology can transform speech to text and automatically use it to create a report, while another can understand situations and predict the future based on the attributes and actions shown in a video. Mr. Hideo Umeki, who leads media intelligence technology development at Toshiba Industrial ICT Solutions Company, says, 'To realize a society where people and AI cohabit safely and comfortably, AI-based control and judgment needs to take into consideration human senses and human knowledge acquired from experience. Even when we cannot pick up every word in a conversation, we can still communicate with the help of context. We can talk about multiple topics by preparing corresponding scenarios on each topic inside our head. Furthermore, we can accumulate knowledge and revise it if necessary. Toshiba's communication AI understands situations and human intentions comprehensively in the same way we do, from human facial expressions, tone of voices and actions, and provides appropriate response and treatment.'" [12]

Test System and Method using Artificial Intelligence Control

(Hogan, Jr., et al. in Patent number 4,841,456 - June 20, 1989)

This describes an automatic test system for electronic equipment.

The inventors explained that there have been some preliminary attempts to use artificial intelligence systems to facilitate the functional testing of electronic systems. The use of an artificial intelligence system to quote the automatic test system and to carry out diagnostic procedures results in a highly efficient testing process in which knowledge, in the form of knowledge base rules, can be continually refined and enhanced as experience with a unit under test is required.

Patent number 4,841,456 (Hogan, Jr., et al.) is expired and has been cited by 68 patent publications. [13]

Jon J. Kasprick (second inventor listed with three co-inventors) received a MS degree in engineering management from Washington State University. Mr. Kasprick was an electronic systems & software engineer at Boeing

from 1980 to 2010. In a LinkedIn profile for Jon Kasprick it states, “My experience at Boeing covers the two principle domains of electronics and software. It begins with calibration and repair of electronic equipment, automated test systems and integrated diagnostics. Several research projects resulted in a patent using artificial intelligence for automated diagnostics. Various software projects led to my transition into mission computing software development for international airborne warning and control systems. Of course, along the way, I gained training and experience in team leadership, project management, and critical elements of the software product life cycle.” [14]

The Boeing Company (assignee) is the world's largest aerospace company and leading manufacturer of commercial jetliners and defense, space and security systems. A top U.S. exporter, the company supports airlines and U.S. and allied government customers in 150 countries. Boeing products and tailored services include commercial and military aircraft, satellites, weapons, electronic and defense systems, launch systems, advanced information and communication systems, and performance-based logistics and training. [15]

In a communication through Boeing titled, *Innovation Quarterly* author Harish Rao writes, *“*Every day at Boeing, we generate an enormous amount of data. Imagine you have to read 10 pages of handwritten notes, find symptoms, diagnose the problem, correlate the problems and suggest recommendations. This may sound easy enough to a data expert—but it can be time consuming. Now imagine this same exercise for 500 million pages. The time, effort, accuracy and cost required would be overwhelming. At Boeing, we have successfully built and trained machine-learning algorithms that can identify patterns in data, and make recommendations accurately within just a few minutes. Our aircraft remain in service for several years after they are built. Detecting and preventing problems before they occur builds confidence and paves the way for higher customer satisfaction. By deciphering usage patterns such as flight conditions, location, temperature, altitude, wind speed and direction, we could predict with confidence when a part needs maintenance, repair or replacement. By collating the data from sensors, we can deliver predictive solutions to help our customers better plan their operations and reduce total maintenance costs over the life of the aircraft they purchase from us.

Boeing is driving these innovations through data analytics to lead the fourth industrial revolution." [16]

Method for Optimized RETE Pattern Matching in Pattern-directed, Rule-based Artificial Intelligence Production Systems

(Loeb, et al. in Patent number 4,849,905 - July 18, 1989)

Coalescing Changes in Pattern-directed, Rule-based *Artificial Intelligence* Production Systems

(Loeb, et al. in Patent number 4,890,240 - December 26, 1989)

In Patent number 4,849,905, the inventors describe optimizing the pattern-matching phase of a cyclic, rule-based, data-sensitive AI production system.

In Patent number 4,890,240, the inventors describe an artificial intelligence production system for uniting a sequence of changes to working memory objects while deferring matching of the working memory to system rules.

Patent number 4,849,905 (Loeb, et al.) is expired and has been cited by 44 patent publications. [17]

Patent number 4,890,240 (Loeb, et al.) is expired and has been cited by 35 patent publications. [18]

Keith R. Milliken (second inventor listed with a co-inventor) has over 30 years of experience in high technology professional activities. He was a member of the Institute for Advanced Study in Princeton, New Jersey, and for four years he was a professor in the mathematics department at California Polytechnic State University. For ten years, Dr. Milliken was a research computer scientist and senior manager at the IBM Watson Research Center. Thereafter he was vice president of research and development at MVS Software Corporation and later at Enterprise Software---both companies dedicated to automating the operation of corporate data centers. Dr. Milliken holds patents on algorithms used in several software products. His publications include thirty research papers and a book "Expert Systems in Data Processing" (Addison-Wesley). He is the recipient of seven awards from IBM including four for Outstanding Technical Achievements. [19]

International Business Machines Corporation (assignee) provides computer solutions using advanced information technology. The Company's solutions include technologies, systems, products, services, software, and financing. IBM offers its products through its global sales and distribution organization, as well as through a variety of third party distributors and resellers. IBM is headquartered in Armonk, New York, United States. [20]

Telephone Answering Device with Artificial Intelligence

(Hashimoto in Patent number 4,850,005 - July 18, 1989)

This describes a telephone answering device wherein artificial intelligence sends an outgoing message to the caller upon receipt of an incoming call.

The inventor explained that when the caller responds, the artificial intelligence determines whether the caller's voice is registered with the device, and if so, messages are played to the caller. If the caller's voice is not registered, the caller is notified by the device, and he may receive his specific message by sending a touch tone code (e.g., telephone number) from his telephone.

Patent number 4,850,005 (Hashimoto) is expired and has been cited by 41 patent publications. [21]

Kazuo Hashimoto (inventor) was a Japanese inventor who registered over 1,000 patents throughout the world, including patents for Caller-ID system and telephone answering machine. He patented his first telephone answering machine, the Ansa Fone, in Japan in 1954, followed by the United States in 1960. He patented Caller-ID in Japan in 1976, and received a United States patent in 1980. In 1983 he invented a digital telephone answering device. He was a recipient of Japan’s Medal of Honor, the Yellow Ribbon, and was designated as a Living National Treasure. Hashimoto was awarded an honorary 'Doctor of Science' degree ('honoris causa') by New Jersey Institute of Technology in 1994 for his outstanding contributions to the field of telephony.

Hashimoto Corporation (assignee) is an expert coordinator of industrial rubber, plastic, assembling metal equipment's, and facilities of machinery. The company was founded in 1925 and is in Tokyo, Japan. [22]

In an article through gizmodo.com (2016) titled*, Today's Hero Made an AI That Annoys Telemarketers for As Long as Possible* author Andrew Liszewski writes, "Hanging up on annoying telemarketers is the easiest way to deal with them, but that just sends their autodialers onto the next unfortunate victim. Roger Anderson decided that telemarketers deserved a crueler fate, so he programmed an artificially intelligent bot that keeps them on the line for as long as possible. Anderson, who works in the telecom industry and has a better understanding of how telemarketing call-in techniques work than most, first created a call-answering robot that tricked autodialers into thinking there was an actual person answering the phone. So instead of the machine automatically hanging up after ten seconds, a simple pre-recorded 'hello?, hello?' message would have the call sent to a telemarketer who would waste a few precious moments until they realized there really wasn't anyone there. But Anderson then wondered just how long his robot could keep a telemarketer on the line for. It turns out, for surprisingly long. After the initial 'hello?, hello?,' Anderson's sophisticated algorithm makes telemarketers think there's an actual person on the line with random affirmations like 'yes, uh huh, right.' It can even detect when a telemarketer is getting suspicious, triggering a completely inane response that usually convinces them otherwise. It's absolutely brilliant when it works flawlessly. Anderson started recording the phone calls as his artificially intelligent call screener got especially skilled at its job, and now posts them on his website for all to enjoy. And before you feel bad for the people making these calls, it's important to remember that they're often using spoofed numbers to get around the FCC's do not call lists. Occasionally non-telemarketers do end up getting connected to Anderson's creation, but the results are still entertaining." [23]

Artificial Intelligence for Adaptive Machining Control of Surface Finish

(Wu, et al. in Patent number 4,926,309 - May 15, 1990)

This describes using a mathematical model to adaptively control surface roughness when machining a series of workpieces or segments.

It was explained that the mathematical model is an algorithm derived by imposing the centerline average method of measuring roughness onto a geometrical surface model of circular segments, solving for a portion of a leg of a triangle described within one of such segments by use of Pythagoras' Theorem.

Patent number 4,926,309 (Wu, et al.) is expired and has been cited by 21 patent publications. [24]

Charles L. Wu (first inventor listed with a co-inventor) received a PhD in mechanical engineering from the University of London (1974). Dr. Wu was director of manufacturing and vehicle design research and advanced engineering in Dearborn, Michigan. [25]

Ford Motor Company (assignee) is an automaker headquartered in Dearborn, Michigan, USA.

In an article through The Verge (2017) titled*, An inside look at Ford’s $1 billion bet on Argo AI* author Kirsten Korosec writes, “Argo is developing self-driving technology that Ford can use to deploy fully autonomous Level 4-capable vehicles for commercial on-demand service. In other words: something like a self-driving taxi service. Level 4 is a designation by SAE International that means the car takes over all of the driving in certain conditions. Argo is tasked with developing the entire ‘virtual driver system,’ which means all of the sensors like cameras, radar, light detection, and ranging radar known as LIDAR, as well as the software and compute platform. Ford has also charged Argo with how to create high-definition maps, keep them ‘fresh,’ and sustain that over time, Ford’s CTO and vice president of research and advanced engineering Ken Washington the during a presentation at *The Information’s* autonomous vehicle summit in June. ‘The end result is a full-stack system designed just for Ford’s self-driving vehicles so they know where they are in the world, can detect and understand objects in their environment, and then make the right decisions.’” [26]

Network Connectivity Control by Artificial Intelligence

(Lee in Patent number 4,999,833 - March 12, 1991)

This describes the use of artificial intelligence to determine the routing and connectivity of a radio, static, or mixed network.

The inventor explained that the self-learning AI system can provide several solutions with a very rapid response during actual routing operations.

Patent number 4,999,833 (Lee) is expired and has been cited by 74 patent publications. [27]

William C. Lee (inventor) received a PhD in electrical engineering from Ohio State University and an MS degree from the ROC Naval Academy. Dr. Lee is considered the world's leading scholar in wireless systems. His books on cellular technology are considered the "standard" references for cellular telecommunications education and have been used to train an entire generation of engineers in the wireless industry. Lee has published more than 300 articles and seven textbooks on wireless communications. He holds 35 patents with five more pending. [28]

ITT Corporation (assignee), which is now ITT, Incorporated, is an American manufacturing company based in White Plains, New York. ITT is a leading manufacturer of highly engineered, customized solutions for the energy, transportation and industrial markets. [29]

In a communication through Ohio State University (2016) titled, *William C. Y. Lee wins alumni award for impact on wireless industry* the authors described as the *College of Engineering communications team write, "*William C.Y. Lee, a pioneer in the advancement of cell phone technology, is the recipient of the Ohio State Alumni Association's Archie M. Griffin Professional Achievement Award. The Griffin Award is presented to alumni who have superb records of distinguished career accomplishments and who have made outstanding contributions to their professions." [30]

Artificial Intelligence based Crowd Sensing System for Elevator Car Assignment

(Thangavelu in Patent number 5,022,497 - June 11, 1991)

Relative system response elevator dispatcher system using artificial intelligence to vary bonuses and penalties

(Thangavelu in Patent number 5,024,295 - June 18, 1991)

Artificial Intelligence based learning system predicting Peak-Period times for elevator dispatching

(Thangavelu in Patent number 5,035,302 - July 30, 1991)

Learning methodology for improving traffic prediction accuracy of elevator systems using artificial intelligence

(Thangavelu, et al. in Patent number 5,168,136 - December 1, 1992)

“Artificial intelligence, based learning system predicting peak-period” ti

(Thangavelu in Patent number 5,241,142 - August 31, 1993)

In Patent number 5,022,497, the inventor describes using artificial intelligence for predicting crowds at the floor and assigning cars based on predicted crowd size and car load when the car leaves the floor of the hall call.

In Patent number 5,022,497, the inventor explained that the crowd sensing feature uses numerical integration techniques and does not require separate sensors to monitor the crowds.

Patent number 5,022,497 (Thanagavelu) is expired and has been cited by 29 patent publications. [31]

Patent number 5,024,295 (Thanagavelu) is expired and has been cited by 39 patent publications. [32]

Patent number 5,035,302 (Thanagavelu) is expired and has been cited by 64 patent publications. [33]

Patent number 5,168,136 (Thanagavelu, et al.) is expired and has been cited by 9 patent publications. [34]

Patent number 5,241,142 (Thanagavelu) is expired and has been cited by 8 patent publications. [35]

Kandasamy Thanagavelu (inventor): Unknown

Otis Elevator Company (assignee) is the world leader in the manufacture, maintenance, and service of elevators, escalators, moving walkways, and other horizontal transportation systems. After more than a century in business, Connecticut-based Otis has more than 1.2 million elevators and escalators in operation, controlling about 22 percent of the world's elevator market. Almost 80 percent of the company's business is done overseas. In an article through encyclopedia.com titled, *Otis Elevator Company, Incorporated* author Robert Halasz writes, **"**New artificial intelligence software patented by Otis in 1993 used 'fuzzy logic' to estimate how many people were waiting for elevators at a given moment in office buildings or hospitals where several elevators were operational and traffic patterns changed throughout the day. The program tracked traffic flow by compiling information about time elapsed between stops at the same floor, the number of buttons pushed by people boarding a car, and the car's changing weight load. It then combined this data to arrive at an estimate of the number waiting and decided which car to send—not necessarily the closest one. The first Otis elevator system incorporating fuzzy logic modules was installed at the Hyatt Osaka Regency Hotel in Osaka, Japan, which opened in 1994." [36]

Artificial intelligence processor

(Hino, et al. in Patent number 5,097,407 - March 17, 1992)

This describes a processor capable of being programmed for and executing any one of the known artificial intelligence languages.