VIP CLUB
Established in 1980

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A COMPUTER HISTORY REVIEW

Engineering Research Associates (ERA) - Minnesota's Computer Industry Wellspring

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UNIVAC 1960 => UNISYS 1994
BEE, University of Minnesota 1966

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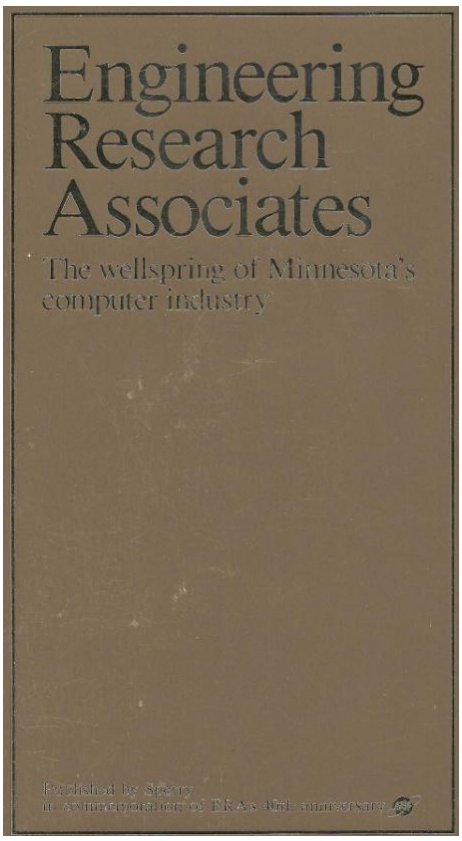
Introduction

A 2006 Lockheed Martin MS2 (LMCO) corporate flyer stated: "A pioneer in the computing industry, Maritime Systems & Sensors delivered the world's first stored-program computer in 1950. Today they are a premier systems integrator for customers worldwide." The veracity of that corporate flyer statement was challenged thus, the purpose of this computer history review is to clarify, verify, and/or rectify the publically known history of electronic computers. This paper shows the corporate progression from **E**ngineering **R**esearch **A**ssociates (ERA) to Lockheed Martin, recaps the first 25 years of computer history, then concludes with this author's observations and opinions.

The VIP Club logo shown atop these pages represents the retirees and former employees from the Twin Cities firms of UNISYS, Lockheed Martin MS2, and their corporate predecessors. As symbolized on the left, the VIP Club is in the process of documenting our 65+ year **I**nformation **T**echnology (IT) Legacy which began with ERA in 1946.

A 1986 Sperry[1] booklet [right] published in commemoration of ERA's 40th anniversary states: "The Navy's confidence was rewarded. The ATLAS I computer (the 'I' was added after design work had started on a more powerful successor, ATLAS II) was delivered to Washington, D.C. in October 1950. "It's my belief that ATLAS I was the first American stored-program electronic computer to be delivered – delivered in finished, working condition," observes Cohen.""



One of the ATLAS installation engineers was John 'Jack' Hill who passed away August 30, 2009 at the age of 99. In 2007, Jack had told a group at a periodic First-Friday luncheon with former co-workers that he was back home for Thanksgiving in 1950 – then returned to aid the customer with software development and operations during December. I [Lowell] remember his statement as I too had been part of several customer installations during my career – but did not recognize the significance of his comments at that time.

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Corporate History

Club member, Keith Behnke, a 40-year employee beginning in 1957 provided the corporation names and dates listed in Table I. In 1986, Burroughs bought Sperry to form **Un**ited **I**nformation **Sys**tems (UNISYS). In 1991, UNISYS renamed the defense industry portion of their holdings as PARAMAX, intending to do a spin-off with a separate Initial Public Offering of stock. When the general Wall Street feedback was that the IPO price would be much lower than hoped for, the IPO didn't proceed. The name PARAMAX Electronics Systems name was continued until 1994 when the defense business was again renamed as UNISYS Computer Systems Group, Electronic Systems. Then in 1995, this defense group was sold to LORAL. A key part of the defense group was the Air Traffic Control development and operations group. LORAL in turn sold the defense systems business to Lockheed Martin as the defense industry continued to shrink after 'perestroika.' In November 2010, Lockheed Martin announced that they would be closing the Eagan, MN facility by 2013 with just the Air Traffic Management group staying in the Twin Cities and three other engineering groups moving to NY, VA, and CA.

Table I - Corporate Name History – 65+ years

Date	Corporation	Twin Cities Company Name
January 1946	Engineering Research Associates	Engineering Research Associates
May 1952	Remington Rand	Engineering Research Associates Division
July 1955	Sperry Rand	Remington Rand, Engineering Research Associates Division
October 1955	Sperry Rand	Remington Rand UNIVAC, Military Division
January 1962	Sperry Rand	Remington Rand UNIVAC, Defense Systems Division
January 1967	Sperry Rand	Sperry Rand UNIVAC, Federal Systems Division
January 1973	Sperry Rand	Sperry UNIVAC, Defense Systems Division
August 1979	Sperry	Sperry UNIVAC
April 1983	Sperry	Sperry Computer Systems, DSD
November 1986	UNISYS	UNISYS Defense Systems, Computer Systems Div.
January 1990	UNISYS	UNISYS Defense Systems, Electronic & Information Systems Group
November 1991	UNISYS	PARAMAX Electronic & Information Systems Group
December 1991	PARAMAX	PARAMAX Electronics Systems
January 1994	UNISYS	UNISYS CSG, Electronics Systems
May 1995	LORAL	LORAL Defense Systems - Eagan
April 1996	Lockheed Martin Tactical Systems	Lockheed Martin Tactical Defense Systems
June 1997	Lockheed Martin	Lockheed Martin Tactical Defense Systems, Eagan
January 2000	Lockheed Martin	Naval Electronics & Surveillance Systems, Eagan
June 2000	Lockheed Martin	Naval Electronics & Surveillance Systems, Tactical Systems
August 2003	Lockheed Martin	Maritime Systems & Sensors (MS2), Tactical Systems, Eagan
March 2013	…	….

The corporate icons (logos) on the next page were provided by John Skonnord of the LMCO Publications Department, a 2010 retired employee. These logos illustrate the ERA to LMCO defense industry corporate history over five decades.

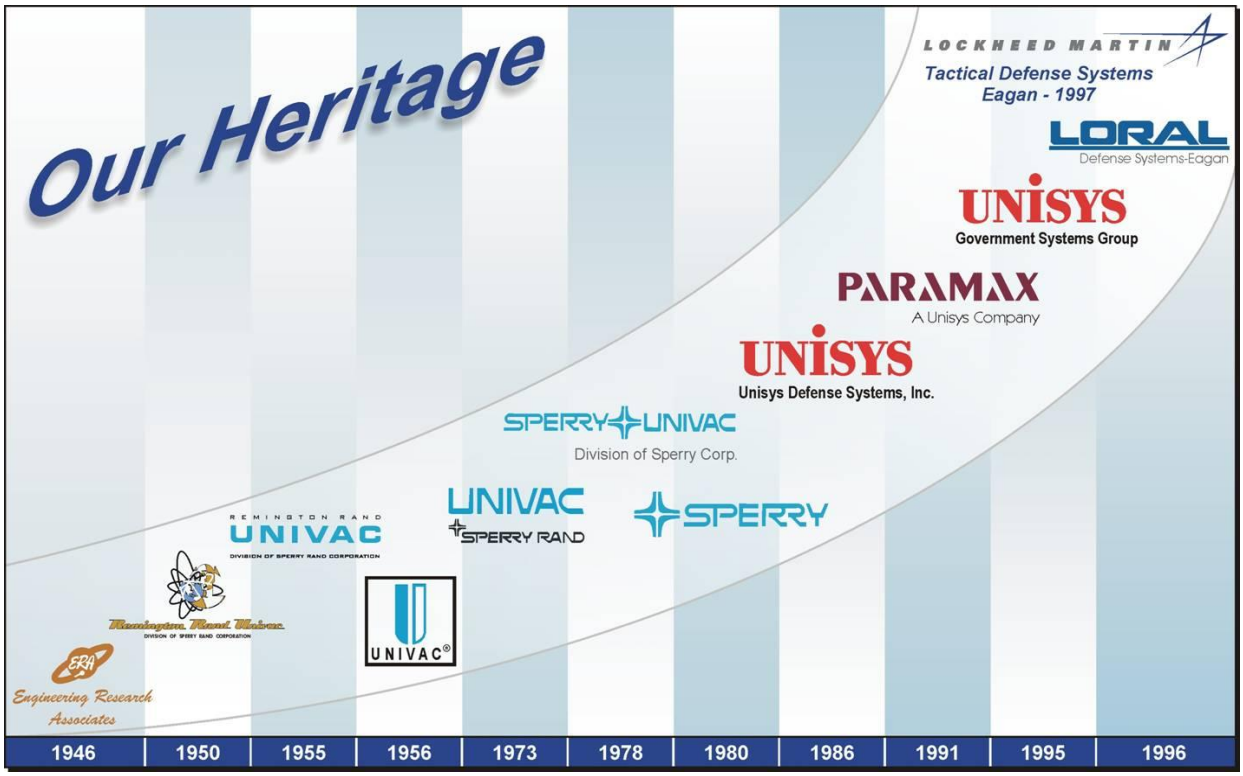

Figure 1 - Corporate Name Logo History.

Although not shown in Figure 1, UNISYS commercial systems operations are still active in St. Paul, MN. The UNISYS commercial heritage goes back to both ERA and the Eckert Mauchly Computer Corporation (EMCC) which sprang from the Moore School of Engineering in Philadelphia, PA. This corporate heritage is well known to those of who worked at one or more of these companies.

Computer History Recap – first quarter century

Web sites referenced herein and numerous publications provide many statements as to 'Who did what first.' The Computer History Museum[2], has many pieces of hardware on display in California. Their presentation theme is **Time Line of Computer History**. They don't cite specific sources of their web site information. Extracts from this web site are preceded with [2].

The second site referenced herein is History of Computing by Lexikon Services[3]. Their theme is **Who Was First in Computing?** On this site many corporations and educational institutes are named, however not specifically cited as information sources. Extracts from this web site are annotated with [3]. Entries from these two sites up to 1961 are copied hereunder.

The Computer History Museum and Lexikon Services sites are in general agreement. They, however do not identify the many defense industry computers which were developed during the first 25 years of computers. This paper will identify some computers from the ERA lineage.

1936 – 1938

- [2] See 1945 for reference to Z1 computer
- [3] First programmable computer - Name: Z1 Machine - Developers: Konrad Zuse - Approximate Development Period: 1936-1938

1939

- [2] The Complex Number Calculator (CNC) is completed. In 1939, Bell Telephone Laboratories completed this calculator, designed by researcher George Stibitz. In 1940, Stibitz demonstrated the CNC at an American Mathematical Society conference held at Dartmouth College. Stibitz stunned the group by performing calculations remotely on the CNC (located in New York City) using a Teletype connected via special telephone lines. This is considered to be the first demonstration of remote access computing.

- [3] Operational, electromagnetic relay calculator - Name: Bell Labs Model 1 (Stibitz Complex Calculator) - Developers: George Stibitz and Samuel B. Williams at Bell Labs - Approximate Development Period: April 1939 to October 1939.

1941

- [2] Konrad Zuse finishes the Z3 computer. The Z3 was an early computer built by German engineer Konrad Zuse working in complete isolation from developments elsewhere. Using 2,300 relays, the Z3 used floating point binary arithmetic and had a 22-bit word length. The original Z3 was destroyed in a bombing raid of Berlin in late 1943. However, Zuse later supervised a reconstruction of the Z3 in the 1960s which is currently on display at the Deutsches Museum in Berlin.

- [3] First fully functional, automatic, programmable, general purpose, digital computer - Name: Z3 Machine (my vote for the first real computer, site editor) - Developer: Dr. Konrad Zuse - Approximate Development Period: 1938-1941.

1942

- [2] The Atanasoff-Berry Computer is completed. Built at Iowa State College (now University), the Atanasoff-Berry Computer (ABC) was designed and built by Professor John Vincent Atanasoff and graduate student Cliff Berry between 1939 and 1942. While the ABC was never fully-functional, it won a patent dispute relating to the invention of the computer when Atanasoff proved that ENIAC co-designer John Mauchly had come to see the ABC shortly after it was completed.

- [3] First functioning prototype electronic digital computer - Name: Atanasoff-Berry Computer (ABC computer) - Developers: John V. Atanasoff, Clifford Berry - Approximate Development Period: 1939-1942.

1943

- [2] Project Whirlwind begins. During World War II, the U.S. Navy approached the Massachusetts Institute of Technology (MIT) about building a flight simulator to train bomber crews. The team first built a large analog computer, but found it inaccurate and inflexible. After designers saw a demonstration of the ENIAC computer, they decided on building a digital computer. By the time the Whirlwind was completed in 1951, the Navy had lost interest in the project, though the U.S. Air Force would eventually support the project which would influence the design of the SAGE program.

- [3] First programmable, electronic digital, code-breaking computer - Name: Colossus - Developers: Allied wartime efforts at Bletchley Park, England - Approximate Development Period: 1939-1943.

1944

- [2] Harvard Mark-1 is completed. Conceived by Harvard professor Howard Aiken, and designed and built by IBM, the Harvard Mark-1 was a room-sized, relay-based calculator.

The machine had a fifty-foot long camshaft that synchronized the machine's thousands of component parts. The Mark-1 was used to produce mathematical tables but was soon superseded by stored program computers.

- [3] First large scale, automatic, electromechanical computer - Name: HARVARD MARK I (a.k.a. IBM Automatic Sequence Controlled Calculator - "ASCC") - Developers: Howard H. Aiken and others - Approximate Development Period: 1937-1944.

1945

- [2] John von Neumann wrote "First Draft of a Report on the EDVAC" in which he outlined the architecture of a stored-program computer. Electronic storage of programming information and data eliminated the need for the more clumsy methods of programming, such as punched paper tape — a concept that has characterized mainstream computer development since 1945. Hungarian-born von Neumann demonstrated prodigious expertise in hydrodynamics, ballistics, meteorology, game theory, statistics, and the use of mechanical devices for computation. After the war, he concentrated on the development of Princeton´s Institute for Advanced Studies computer and its copies around the world.

- [3] Konrad Zuse began work on Plankalkul (Plan Calculus), the first algorithmic programming language, with an aim of creating the theoretical preconditions for the formulation of problems of a general nature. Seven years earlier, Zuse had developed and built the world´s first binary digital computer, the Z1. He completed the first fully functional program-controlled electromechanical digital computer, the Z3, in 1941. Only the Z4 — the most sophisticated of his creations — survived World War II.

1946

- [2] In February, the public got its first glimpse of the ENIAC, a machine built by John Mauchly and J. Presper Eckert that improved by 1,000 times on the speed of its contemporaries. Programmed: plug board and switches – Speed: 5,000 operations per second – Input/output: cards, lights, switches, plugs – floor space: 1,000 square feet – Project leaders: John Mauchly and J. Presper Eckert.

- [3] First large scale, general purpose, electronic digital computer - Name: ENIAC (Electronic Numerical Integrator and Computer) - Developers: John Mauchly and J. Presper Eckert - Approximate Development Period: 1943-1946.

- [4] Extracted from http://www.hagley.lib.de.us/2015.htm[4]. In the fall of 1946, ERA received its first major contract from the Office of Naval Research (ONR) to compile a report on "High Speed Computing Devices"[5]. This report, which became the definitive study of the infant state of computing, was later published in book form by McGraw Hill. During this project, ERA personnel was given access to classified government reports and worked with computer pioneers John Mauchly and J. Presper Eckert, inventors of the ENIAC, and John von Neumann, of Princeton University's Institute for Advanced Study. {Author's note: *This book subsequently became the fourth in the 'Reprint Series for the History of Computing' published in 1983 by the **C**harles **B**abbage **I**nstitute (CBI).*}

1947

- [2] Computer pioneers Presper Eckert and John Mauchly founded the Eckert-Mauchly Computer Corp. to construct machines based on their experience with ENIAC and EDVAC. The only machine the company built was BINAC. Before completing the UNIVAC (UNIVersal Automatic Computer), the company became a division of Remington Rand.

- [3] First functioning prototype Business Computer - Name: Remington Rand (Model 2) - Developer: Loring P. Crosman, Remington Rand - Approximate Development Period: 1943-1947.

- [4] Extracted from http://www.hagley.lib.de.us/2015.htm. ERA was dependent on government funded cost-plus--fixed-fee contracts. In August 1947, it began work for the Navy on Task 13 - a project to design a general all-purpose stored-program computer. During this project ERA developed the first magnetic storage drum; the technology upon which the next two generations of computers was based. In October, 1950, ERA completed work on the ATLAS computer - America's first electronic stored-program computer. The ATLAS with its 2,700 vacuum tubes was capable of running twenty-four hours a day with only 10% of the time allotted for maintenance.

- [6] VIP Club web site milestones[6] page. From 1947 when Goldberg I, the electronic data-processing system with the first magnetic drum, was invented, up to 1959 when the G-40 Command Computer was developed, the design of high-speed, digital, data-processing systems has been a continuing challenge to Remington Rand Univac, St. Paul, Design engineers.

1948

- [2] IBM´s Selective Sequence Electronic Calculator computed scientific data in public display near the company´s Manhattan headquarters. Before its decommissioning in 1952, the SSEC produced the moon-position tables used for plotting the course of the 1969 Apollo flight to the moon. Speed: 50 multiplications per second – Input/output: cards, punched tape – Memory type: punched tape, vacuum tubes, relays – Technology: 20,000 relays, 12,500 vacuum tubes - Floor space: 25 feet by 40 feet – Project Leader: Wallace Eckert.

- [3] First prototype, electronic stored-program computer - Name: Manchester Mark I - Developers: F. C. Williams, Tom Kilburn, and Max Neuman - Royal Society Computing Machine Laboratory, Manchester University - Approximate Development Period: 1946-1948 - First stored program run June 21, 1948.

- [6] Delivered the Demon I and II 'Analytic Machines' to be used for cryptography work by the U.S. Government. These 24-bit machines were programmed with plug boards while using the drums for data storage and manipulation. These drum memories were the world's first delivered, operational hard drives. This was also a 34 inch drum, but rotated at 240 rpm, equivalent to a data transmission rate of 20,000 pulses per second. Five DEMONs were delivered in Oct. 1948.

1949

- [7] "History of National Security Agency General-Purpose Electronic Digital Computers7" - declassified in 2009. Shortly after the completion of the ATLAS I design in 1949, a decision was made to construct a relay analog of the equipment, to assist in training programmers and to "debug" its programs (at least logically) before it was delivered. ABEL (fig. 5) was designed and constructed by CSAW personnel in about four months. Logically it was identical to ATLAS I, but its memory drum capacity was 2,047 words instead of 16,384, and its relay circuitry made it several hundred times slower.
- [2] Maurice Wilkes assembled the EDSAC, the first practical stored-program computer, at Cambridge University. His ideas grew out of the Moore School lectures he had attended three years earlier. For programming the EDSAC, Wilkes established a library of short programs called subroutines stored on punched paper tapes. Technology: vacuum tubes – Memory: 1K words, 17 bits, mercury delay line – Speed: 714 operations per second.

- [2] The Manchester Mark I computer functioned as a complete system using the Williams tube for memory. This University machine became the prototype for Ferranti Corp.´s first computer. Start of project: 1947 – Completed: 1949 – add time: 1.8 microseconds – Input/output: paper tape, teleprinter, switches – Memory size: 128 + 1024-digit words – Memory type: cathode ray tube, magnetic drum – Technology: 1,300 vacuum tubes – Floor space: medium room – Project leaders: Frederick Williams and Tom Kilburn.

- [3] First large scale, fully functional, stored-program, electronic digital computer to operate a regular computing service. Name: EDSAC (Electronic Delay Storage Automatic Computer) - Developer: Maurice Wilkes and others at University Mathematical Laboratory, Cambridge University, England - Approximate Development Period: 1946-1949 - First successful program run May 6, 1949.

1950

- [2] Engineering Research Associates of Minneapolis built the ERA 1101, the first commercially produced computer; the company´s first customer was the U.S. Navy. It held 1 million bits on its magnetic drum, the earliest magnetic storage devices. Drums registered information as magnetic pulses in tracks around a metal cylinder. Read/write heads both recorded and recovered the data. Drums eventually stored as many as 4,000 words and retrieved any one of them in as little as five-thousandths of a second.

- [2] The National Bureau of Standards constructed the SEAC (Standards Eastern Automatic Computer) in Washington as a laboratory for testing components and systems for setting computer standards. The SEAC was the first computer to use all-diode logic, a technology more reliable than vacuum tubes, and the first stored-program computer completed in the United States. Magnetic tape in the external storage units stored programming information, coded subroutines, numerical data, and output.

- [3] The National Bureau of Standards completed its SWAC (Standards Western Automatic Computer) at the Institute for Numerical Analysis in Los Angeles. Rather than testing components like its companion, the SEAC, the SWAC had an objective of computing using already-developed technology.

- [3] First real-time processing computer - Name: Whirlwind I - Developer: J. Forrester and others at MIT - Approximate Development Period: 1946-1953.

- [5] "High Speed Computing Devices," May, 1950, Engineering Research Associates. Table 10-1 of this book lists twenty 'Large-scale Digital Computing-Machine Projects in the United States.' They are: Harvard Mark I; IBM Pluggable Sequence Relay Calculator; ENIAC; BTL computer, Model V; Harvard Mark II; IBM Selective Sequence Electronic Calculator; BINAC; BTL computer, Model VI; Whirlwind; EDVAC; SDC Raytheon Computer; IAS Digital Computer; ORDVAC; University of Illinois Computer; California Digital Computer; Zephyr; NBS Interim Computer; GE Computer; and UNIVAC. {Author's note: *It is no surprise that the then classified ERA analytic machines [ATLAS, Demon, Goldberg, Hecate, and Robin] are not included in this list. It is a surprise that the SEAC and SWAC aren't in the list.*}

1951

- [2] MIT's Whirlwind debuted on Edward R. Murrow's "See It Now" series. Project director Jay Forrester described the computer as a "reliable operating system," running 35 hours a week at 90 percent utility using an electrostatic tube memory. Start of project: 1945 – Completed: 1951 – Add time: 0.5 microseconds – Input/output:: cathode ray tube, paper

tape, magnetic tape – Technology: 4,500 vacuum tubes, 14,800 diodes – floor space 3,100 square feet.

- [2] England´s first commercial computer, the Lyons Electronic Office, solved clerical problems. The president of Lyons Tea Co. had the computer, modeled after the EDSAC, built to solve the problem of daily scheduling production and delivery of cakes to the Lyons tea shops. After the success of the first LEO, Lyons went into business manufacturing computers to meet the growing need for data processing systems.

- [2] The UNIVAC I delivered to the U.S. Census Bureau was the first commercial computer to attract widespread public attention. Although manufactured by Remington Rand, the machine often was mistakenly referred to as the "IBM UNIVAC." Remington Rand eventually sold 46 machines at more than $1 million each. F.O.B. factory $750,000 plus $185,000 for a high speed printer. Speed: 1,905 operations per second – Input/output: magnetic tape, unityper, printer – Memory size: 1,000 12-digit words in delay lines – Memory type: delay lines, magnetic tape – Technology: serial vacuum tubes, delay lines, magnetic tape – Floor space: 943 cubic feet – Project leaders: J. Presper Eckert and John Mauchly.

- [3] First commercially available computer. Also first commercially available machine to use stored programs and a compiler. Name: UNIVAC I - Developers: John Mauchly and J. Presper Eckert - Approximate Development Period: 1948-1951 - 1952 - Considered by some to be the First Stored Program Computer.

- [3] First Business Computer established in an office environment - Name: LEO-I (Lyons Electronic Office) - Developers: Lyons - Approximate Development Period: 1947-1951 (and refinements through 1954**)**.

- [3] Remington Rand Model 3 - Name: Remington Rand Model 3 (precursor to the Rand 409) - Developers: Frank Hannon, Loring P. Crosman, and others at Remington Rand - Approximate Development Period: 1947-1951.

- [3] Name: EDVAC "Electronic Discrete Variable Automatic Computer" - Developers: John Mauchly and J. Presper Eckert - Approximate Development Period: 1951-1952.

- [3] December. Remington Rand acquires Engineering Research Associates (ERA), another early computer company based in St. Paul, Minnesota. ERA had a tabulating machine which it had built at its Norwalk, Connecticut plant. {Author's note: *It was Remington Rand that built the tabulating machines in Norwalk, not ERA.*}

1952

- [2] John von Neumann´s IAS computer became operational at the Institute for Advanced Studies in Princeton, N.J. Contract obliged the builders to share their designs with other research institutes. This resulted in a number of clones: the MANIAC at Los Alamos Scientific Laboratory, the ILLIAC at the University of Illinois, the Johnniac at Rand Corp., the SILLIAC in Australia, and others.

- [3] J. Presper Eckert, John Mauchly, John von Neumann, Herbert Goldstine, and A. W. Burks teamed to work on a computer called the EDVAC. The conceptual design for the EDVAC was completed in 1946 and the system was delivered to the Ballistic Research Laboratories at Aberdeen, Maryland in 1949. The EDVAC was completed in 1952. The EDVAC utilized 3,600 vacuum tubes and was the first stored program computer. The

EDVAC was used at the Ballistic Research Laboratories at Aberdeen, Maryland. It was operational until December 1962.

- [6] Delivered the UNIVAC Scientific Model 1102, the first on-line scientific computer based on the then classified ATLAS II.

1953

- [2] At MIT, Jay Forrester installed magnetic core memory on the Whirlwind computer. Core memory made computers more reliable, faster, and easier to make. Such a system of storage remained popular until the development of semiconductors in the 1970s.

- [3] First Transistorized electronic digital computer - Name: TX-0 - Developer: MIT Lincoln Labs - Approximate Development Period: 1951-1953.

- [3] First IBM electronic digital computer - Name: IBM 701 (aka "Defense Calculator") - Developer: IBM - Approximate Development Period: 1951-1953.

- [3] World's first Supercomputer - Name: IBM 704 - Developer: IBM - Approximate Development Period: 1951-1953.

- [6] Completed the UNIVAC Flight Plan Storage System for automatically accepting, storing, and delivering flight plans and weather information. FAA Air Traffic Control predecessor. ERA Speed Tally System installed at John Plain and Company of Chicago.

1954

- [2] The IBM 650 magnetic drum calculator established itself as the first mass-produced computer, with the company selling 450 in one year. Spinning at 12,500 rpm, the 650´s magnetic data-storage drum allowed much faster access to stored material than drum memory machines.

1955

- [2] Felker and Harris program TRADIC, AT&T Bell Laboratories announced the first fully transistorized computer, TRADIC. It contained nearly 800 transistors instead of vacuum tubes. Transistors — completely cold, highly efficient amplifying devices invented at Bell Labs — enabled the machine to operate on fewer than 100 watts, or one-twentieth the power required by comparable vacuum tube computers.

- [6] Developed the UNIVAC II providing flexibility of instruction repertoire executing out of a core memory. {Author's note: *A UNIVAC I was installed at the ERA Minnehaha Ave plant as the UNIVAC II Prototype, ERA engineers did the core memory work based on their experiences with ATLAS II.*}
- [6] UNIVAC File Computer Model 0 developed.

1956

- [2] MIT researchers built the TX-0, the first general-purpose, programmable computer built with transistors. For easy replacement, designers placed each transistor circuit inside a "bottle," similar to a vacuum tube. Constructed at MIT´s Lincoln Laboratory, the TX-0 moved to the MIT Research Laboratory of Electronics, where it hosted some early imaginative tests of programming, including a Western movie shown on TV, 3-D tic-tac-toe, and a maze in which mouse found martinis and became increasingly inebriated.

- [3] First successfully marketed toy digital computing device - Name: Geniac - Developer: Edmund C. Berkeley - Approximate Development Period: 1955-1956.

1957

- [2] In Minneapolis, the original Engineering Research Associates group led by Bill Norris left Sperry Rand to form a new company, Control Data Corp., which soon released its model 1604 computer.

- [3] First fully solid-state business computer - Name: NCR 304 - Developer: NCR Corporation - Approximate Development Period: 1955-1957.

- [3] First commercial disk drive with moving read/write heads - Name: IBM 305 RAMAC - Developer: IBM.

- [6] Delivered the **Bomarc** Guidance Computer to the Air Force. This hardware and its Athena successor plus associated UNIVAC developed software is credited with over 300 successful launches from the Cape and Van den Berg Air Force Base.

1958

- [2] SAGE — Semi-Automatic Ground Environment — linked hundreds of radar stations in the United States and Canada in the first large-scale computer communications network. An operator directed actions by touching a light gun to the screen. The air defense system operated on the AN/FSQ-7 computer (known as Whirlwind II during its development at MIT) as its central computer. Each computer used a full megawatt of power to drive its 55,000 vacuum tubes, 175,000 diodes and 13,000 transistors.

- [6] Delivered the first Naval Tactical Data System (NTDS) USQ-17 computer to counter the power of a growing airborne threat to the U.S. fleet. This system included advanced digital techniques.

- [6] Delivered (donated) an 1103 computer to the University of Minnesota, the beginning of their Computer Science department in their Institute of Technology.

1959

- [2] IBM´s 7000 series mainframes were the company´s first transistorized computers. At the top of the line of computers — all of which emerged significantly faster and more dependable than vacuum tube machines — sat the 7030, also known as the "Stretch." Nine of the computers, which featured a 64-bit word and other innovations, were sold to national laboratories and other scientific users. L. R. Johnson first used the term "architecture" in describing the Stretch.

- [3] IBM's first mass-produced digital, all-transistorized, affordable business computer - Name: IBM 1401 - Developer: IBM - Approximate Development Period: 1958-1959.

- [3] First successful and affordable minicomputer - Name: PDP-1 - Developer: Digital Equipment Corporation - Approximate Development Period: 1957-1959.

- [6] Delivered the UNIVAC SCIENTIFIC Model 1105, a high-speed digital computer with great programming versatility and large internal & external storage capacity.

- [6] Delivered the first Athena missile launch computer to the USAF.

1960

- [2] The precursor to the minicomputer, DEC´s PDP-1 sold for $120,000. One of 50 built, the average PDP-1 included with a cathode ray tube graphic display, needed no air conditioning and required only one operator. It´s large scope intrigued early hackers at MIT, who wrote the first computerized video game, Space War!, for it. The 'Space War!' creators then used the game as a standard demonstration on all 50 computers.

- [3] First standardized business computer programming language - Name: COBOL (Common Business Oriented Language) - Developers: Conference on Data System Languages (CODASYL) - Approximate Development Period: 1959-1960.

- [6] Delivered the **T**arget **I**ntercept **C**omputer for the Nike Zeus anti-missile system.

- [6] Delivered the AN/USQ-20 for NTDS service test at NEL, and eventually in the USS ships King, Mahan, and Oriskany.

1961

- [2] IBM 1301 Disk Storage Unit is released. The IBM 1301 Disk Drive was announced on June 2nd, 1961 for use with IBM's 7000-series of mainframe computers. Maximum capacity was 28 million characters and the disks rotated at 1,800 R.P.M. The 1301 leased for $2,100 per month or could be purchased for $115,500. The drive had one read/write arm for each disk as well as flying heads, both of which are still used in today's disk drives.

- [6] AN/USQ-20 computer installed in the USS BAYA (AGSS318). First installation of a USQ-20 aboard a US Submarine. Computer was used as an integral part of LORAD.

- [6] UNIVAC ADD-1 Aerospace Computer announced. This was the compact completely solid state airborne computer capable of computations previously available in large scale ground based computer installations.

2011

Fast forward fifty years – Stored-program machines are ubiquitous, mostly as microchips in smart phones, GPS units, IPADs, etc. Yet, debates continue as to who did what first in the computing industry! At a November 2009 University of Minnesota presentation, Dr. Tom Misa used the slide at the right to discuss and make points about the early computers.

This chart shows the year that the unit was functional, whether it was a binary or decimal machine, the computation mechanism, and the program storage methodology.

Dr. Misa is the current director of the Charles Babbage Institute (CBI) at the University of Minnesota. As such, he also holds the Engineering Research Associates Land-Grant Chair in the History of Technology.

	Year	01?	compute	program
Zuse Z3	1941	B	mechanical	film stock
ABC	1942	B	electronic	(no)
Colossus	1944	B	electronic	patch cables + switch
Harvard Mk1	1944	D	mechanical	paper tape
ENIAC	1945	D	electronic	patch cables + switch
Manchester	6/48	B	electronic	stored: Williams tube
EDSAC	5/49	B	electronic	stored: 32 delay lines
BINAC	9/49	B	electronic	stored: 2 delay lines
NBS SEAC	5/50	B	electronic	stored: delay line
ERA Atlas	10/50	B	electronic	stored: magnet drum
EDVAC	49-51	B	electronic	stored: 64 delay lines

Figure 2. Early Computer Information

In 1966 Dr. Kenneth Knight analyzed the performance of 225 computers. (Knight[8], "Changes," *Datamation*, pp. 40–54, and "Evolving Computer Performance," pp. 31–35). He used two formulae to ascertain scientific and commercial operations per second. In the 70's and 80's performance was measured as Millions of Instructions per Second (MIPS), or earlier as Thousands of Instructions per Second (KIPS.) In this century, computer performance is measured with a variety of bench mark programs.

To show the performance levels of the early machines which Dr. Misa had listed, I've created a table of performance measures using data extracted from Dr. Knight's report

Table II. Dr. Knights Computer Performance Analysis – Selected Computers

Computer Name	Scientific ops	Commercial ops	year	notes
Harvard Mark I	0.0379	0.406	1944	
ENIAC	7.448	44.65	1946	
BINAC	21.75	11.70	1949	
SEAC	102.8	253.8	1950	
Whirlwind I	110.7	45.57	1950	
ERA 1101	682.5	301.8	1950	ATLAS I
UNIVAC I	140.1	271.4	1951	
EDVAC	31.56	14.86	1952	
IBM 650	110.8	291.1	1953	

Why include performance in this the early computer history review? Because it shows that the ERA machine had performance levels significantly higher than other early machines. I'd attribute the much faster speeds of the ERA 1101 and IBM 650 to their drum memories versus the slower delay line memories or Williams tube memories of the other early units.

A web site chart[9], Figure 3 below, compares the add times of several of these early machines. This web site was developed under the direction of John Mauchly's daughter, Kay McNulty Mauchly. In Ms. Mauchly's chart, the UNIVAC I, IBM 650, and ENIAC additions per second are between 1,000 and 10,000 per second. The same machines according to Dr. Knight's analysis have significantly less computational power than the ERA 1101. Or, the 1101 was six times more powerful than the IBM650 for scientific operations and about even for commercial operations even though the IBM came along three years later. {Author's note: *It is somewhat ironic that Ms McNulty Mauchly would add credence to opinions that early machines were just super calculators by comparing ADD times!*}

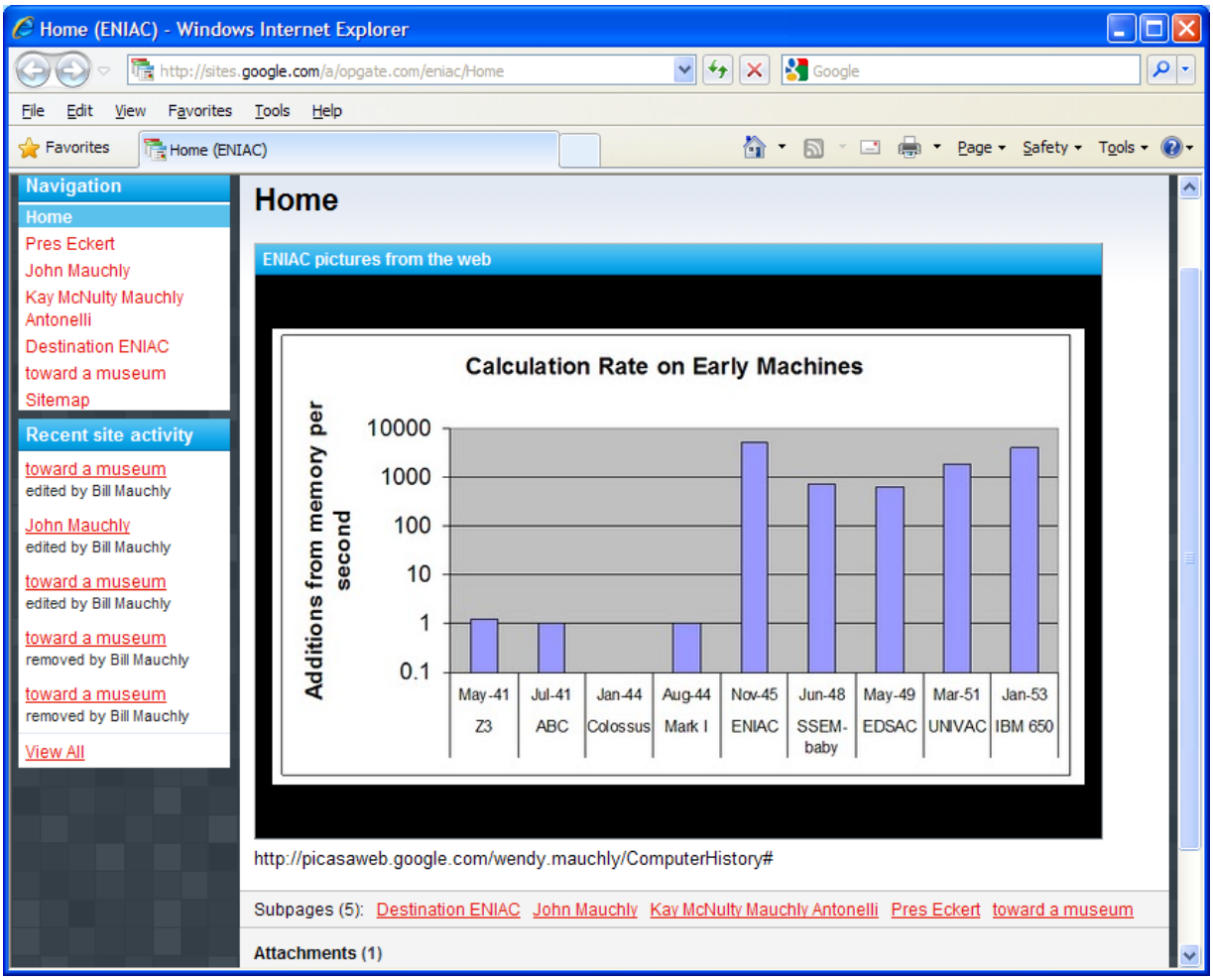

Figure 3. Early Machine Calculation Rates.

OBSERVATIONS and OPINIONS

Dozens or perhaps even hundreds of books have been written about various aspects of early computers. Many web sites are also now available with information and opinions about computers, computer projects, and computerized systems.

I don't believe that is very important to be the first – it is important to note which 'first' claimants became a viable part of the computer industry. Today, many would say Microsoft – IBM – Control Data – Apple – Intel – Bill Gates – Steve Jobs – Seymour Cray, etc. Of these, only IBM has had the staying power of engineering successes like those that began with Engineering Research Associates in 1946.

Yes, there were a couple of laboratory stored-program computer concept demonstrations before the ATLAS delivery, however their memory sections used various storage tube hardware that lost both data and programs when power was interrupted – volatile memory necessitated a 're-boot'.

The ATLAS, a magnetic drum based system, kept the data and programs when power was off thus could easily and quickly resume operations. ERA's then president, John Parker, got government permission to build and market a commercial version of this ATLAS computer. Since the ATLAS

was designed and built under Task 13, Jack Hill, a versatile ERA engineer suggested that the commercial version be numbered the 1101, 13 in binary. Subsequent models transitioned from ERA 1101, ERA 1102, ERA 1103, UNIVAC 1103, UNIVAC 1103A (UNIVAC Scientific). The series then had the UNIVAC 1105, 1107, 1108, Sperry 1106, 1110, UNISYS 1110, Unisys 2200, Clear Path, … continuing in production today using embedded Intel chips as their processing core.

- Most early machines had one or two 'inventor' names associated with them, in reality all were built by teams of people – not just the 'named' individuals.
- The ATLAS 'claim to fame' is that it was delivered and operational in the customer's facility compared to the others which were only functional in the design/ development laboratories.
- The machines through 1949 were large scale electro-mechanical calculators because they were not of a 'stored-program' design. Although plug boards held 'programs', mechanical work was needed to change the sequence of instruction executions.
- The Zuse machines were in Germany, most data was lost during the WWII.
- The ABC was at the University of Iowa, a single purpose machine.
- The Colossus was an analytic machine in England used for code analysis – note that the ATLAS was initially termed an analytic machine, not a computer.
- During the first 25 years of "computer infancy", Minnesota was one of four Centers of Knowledge: the others being central New York (IBM), Philadelphia (EMCC-UNIVAC) and Boston (PDP, MIT). ERA along with its spin-off companies and eventually the U of MN were the Midwest core. It was only decades later that Silicon Valley (CA), Research Triangle (NC) and others came about – not part of this early computer history review.

CONCLUSION

The LMCO flyer statement "A pioneer in the computing industry, Maritime Systems & Sensors delivered the world's first stored-program computer in 1950. Today they are a premier systems integrator for customers worldwide" is not false!

1. The corporate lineage from ERA to LMCO MS2 is clear and well documented. In March of 2011 they delivered S/N 8,000 AN/UYQ-70 to the US Navy – the design of this unit came out of ERA's home town, St. Paul, Minnesota.
2. The shipping of the ATLAS in October 1950 via rail car and subsequent customer acceptance in December 1950 by the CSAW was a delivery, not just a benchmark in a laboratory. The baseline magnetic drum memory for data and instructions was non-volatile therefore indeed a stored-program computer.

However - The Digitization of the United States Navy[10] also reviews early computer history. It discusses the ABEL built in 1949, also known as a baby ATLAS. Cryptologists used the relay based ABEL to compute reference tables for two years, then it was given back to the Office of Naval Research who moved it to the George Washington University where it provided support to a Navy logistics research project. ABEL had a drum memory [non-volatile], thus it too was a true stored-program computer quite likely in operation before BINAC, SEAC, and ATLAS.

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VIP Club: Created in 1980 by as the Sperry retirees club – a non-profit social and services club. In October 2005, we formed the Legacy Committee at the request of LMCO. In 2006 we began a web page to hold employee and retiree Legacy articles. In the fall of 2007, we merged the Club and Legacy sites into http://vipclubmn.org.

I'd like to acknowledge the efforts of the Legacy Committee who have gathered and catalogued over 1,200 documents in support of our heritage, including the books referenced herein. These documents are being transferred to CBI during 2012. Thanks to the 250+ former employees who have contributed written items to our Legacy web site.

ACRONYMS

BINAC	**BIN**ary **A**utomatic **C**omputer
CSAW	**C**ommunications **S**upplementary **A**ctivity--**W**ashington
EDSAC	**E**lectronic **D**iscrete **V**ariable **C**omputer
EDVAC	**E**lectronic **D**iscrete **V**ariable **A**utomatic **C**omputer
EMCC	**E**ckert-**M**auchly **C**omputer **C**orporation
ENIAC	**E**lectronic **N**umerical **I**ntegrator and **C**omputer
ERA	**E**ngineering **R**esearch **A**ssociates, Inc.
IBM	International Business Machines
NSA	**N**ational **S**ecurity **A**gency
NTDS	**N**aval **T**actical **D**ata **S**ystems
RRU	**R**emington **R**and **U**nivac
UNISYS	**Un**ited **I**nformation **SYS**tems
UNIVAC	**UNIV**ersal **A**utomatic **C**omputer