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PROLOGUE

Mr. Ream and his teams developed computer systems.

Their engineering methodologies expanded within and beyond the U.S. Navy.

From Chuck Alcon, LCDR US Navy (ret.): By implementing the "Navy Standards Program" in the design, development, production, and deployment of Navy computers, peripherals, and software over multiple generations; Don Ream led the way in defining development and deployment approaches that saved the Navy tens or possibly hundreds of millions of dollars in logistic support, the training pipeline, and life cycle procurement costs in addition to enhanced levels of force readiness with similar "standard" equipment aboard all ships of the carrier battle groups. Possibly the most significant cost benefit was in the development and deployment of the operating systems, test software, and application software, available over the standard host computer platforms/NTDS systems, etc. etc. etc.

INTRODUCTION

Several retired Navy officers tried unsuccessfully to have a ship named after Mr. Ream in 2014, http://vipclubmn.org/Articles/DonReamNominated.pdf. Since Don was an ERA employee briefly in the early 50s, we have included him in our legacy anthology, http://vipclubmn.org/deceased.html#Ream. This paper 'to some degree' is an addendum to those articles. A book *When Computers Went to Sea* by David Boslaugh, Captain, US Navy (ret.) tells the story of Naval Tactical Data Systems (NTDS) development. That book also includes sections about the Dayton OH Naval Computing Laboratory as well as early computers; ATLAS, ENIAC, EDVAC, and WHIRLWIND.

Standardization? If you had had mechanics training for Chevrolets in the 50s; you would know how to repair Buick, Cadillac, GMC, Oldsmobile, and Pontiac vehicles because of design similarities and a few exchangeable parts.

Listed on the following pages are examples of standardization, i.e. re-use of hardware module designs or continuations of Instruction Set Architectures (ISA) – software re-use! Like most of our other legacy papers, this article has some Wikipedia-like links to other papers and websites.

The appendix shows the 1100, 418, and 490 commercial lines that benefited from the same standardization disciplines followed by the Minnesota ERA/UNIVAC/Sperry/Unisys/LMCO computer engineering organizations.

EXAMPLES

Legacy Committee co-chair John Westergren has refurbished this wall display of Navy computer models.

This display is available for viewing at the Lawshe Memorial Museum in South St. Paul, MN.

See more artifacts at the http://vipclubmn.org/Exhibits.html#Lawshe.

Table 1: Processors Models of the Don Ream Epoch.

Nomenclature	1st delivered	Built	Univac type #	Bits (ISA)/Memory
AN/USQ-17	Mar. 1958	6	M460	30/16k@8 usec
CP-642A	Sept. 1961	143	1206	30/32k@4 usec
CP-642B	Feb. 1963	239	1212	30/32k@4 usec
CP-667	Feb. 1964	3		36/131k@2 usec
CP-789	Apr. 1963	326	1218	18/16k@4 usec
CP-808	Sept. 1964	19	1213	30/32k@4 usec
CP-848	May 1965	367	1219	18/32k@ 2 usec
CP-855	July 1965	120	1230	30/32k@ 2 usec
CP-890	June 1967	164	1236	30/64k@1 .8 usec
AN/UYK-7	April 1969	3250	3250	32/48k in a single bay unit @ 1.5 usec.

Standardization Examples: Relationships of computer types and nomenclatures are described hereunder. (source ERA/UNIVAC/Sperry/UNISYS/LMCO retirees' website http://vipclubmn.org/Computers.html.)

- The first NTDS computers were the AN/USQ-17 units, identified in an early paper as the M-460. It was based on laboratory study that had built the 24-bit MAGTECH (Magnetic circuits technology) and TransTec machines to evaluate technologies to replace low reliability vacuum tubes - transistors were selected, http://vipclubmn.org/Articles/PreATHENA.pdf.
- After the USQ-17, seventeen CP-642 service test units were built for shipboard testing. Production nomenclature was the CP-642A, then a change from germanium to silicon transistors created the CP-642B as part of the AN/USQ-20B systems. The Computer History Museum in CA has a 642B unit on display, https://computerhistory.org/.

- CP-667, only three were built in the early 60s. This was an experimental 36-bit machine with 131k of 2 usec core memory. *With a manual select switch, the machine would operate in 30-bit mode and execute the CP-642 instruction set.* This 60s design had some early hybrid circuits in T-05 packages, almost Integrated Circuits! Two units were shipped to the Navy, one installed on-board a ship for testing. Then after a ship fire, the 2nd was used to re-furbish the first.

  The third CP-667 was used at Sperry for a variety of developments. Ironically, if there had not been a Navy budget crunch, the AN/UYK-7 may never have happened {LABenson opinion.}

  Jorgen Andersen - I transferred a CS-1 compiler from the 1206 (CP-642A) and constructed a FORTRAN IV compiler for the CP-667 during the late 60's.

- The CP-788, UNIVAC Type # 1215, was built using printed circuit cards from the 1218 computer, with many of the same salient features but 15 bits instead of 18 - a lesser memory addressing capacity. The memory speed was 8 usec. Don Mager was the lead logic designer for this development. First unit delivered July 5th, 1962. Known as the Universal Digital Trainer, this had a commercial U-422 type designation, http://vipclubmn.org/cpothers.html#CP-788.

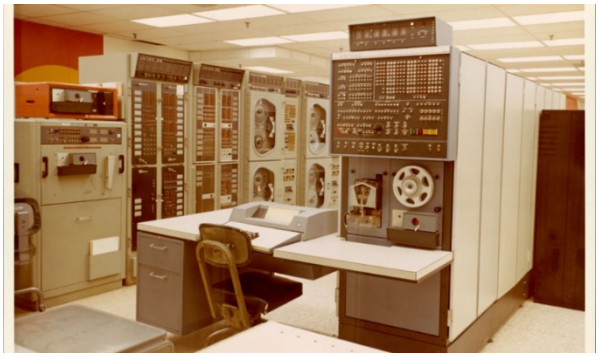
  The UDT was used in the 60s as part of Data Systems "A" school curriculum at The Great Lakes Navy Training Center. Les Nelson, a current retiree recalls learning programming on the UDT at the U of MN in 1968/69. The Southwest Museum of Engineering, Communications and Computation in AZ has a unit, https://www.smecc.org/univac_422.htm.

- The Naval Tactical Data Systems (NTDS) used the CP-789 (UNIVAC Type 1218) to process the Identification Friend or Foe (IFF) transponder signals before passing aircraft IDs to the CP-642A & CP642B processors for tactical display coordination. The 18-bit CP-789 had many 15-pin circuit cards common with the 30-bit CP-642A!

  As the FAA began their Automated Radar Tracking Systems (ARTS I) in the early 60s, they used the Type 1218 computers to process transponder signals from commercial aircraft to pass flight IDs and aircraft information to Air Traffic Controller display systems.

- The Navy also used the CP-789 as a database processor to do 'Stores Management'. This helped them keep track of on-board foodstuffs, munitions, and fuel. Plus, the 1218 and later the 1219, computers were used on multiple ship classes as Control Formatting Units (CFU).

- This NASA installation has (left to right) a UNIVAC 1232 I/O Console, two UNIVAC 1218 computers, two UNIVAC dual transport 1240 magnetic tape units, and a UNIVAC 418 computer with operator keyboard/printer. The elapsed time mission clock above the 418 operator/maintenance console shows 14:42.83 hours/minutes.



  The last remaining mainframe computer used by NASA for the Apollo Moon Missions, was the UNIVAC 418-II used at Mission Control in Houston. It is now at the American Computer Museum in Bozeman, MT. {photo from Lawshe Museum archives}

- The Jet Propulsion Laboratory used UNIVAC type 1218 for space telemetry signal pre-processing.
- The Marine Corps used the CP-808, a shelter housed, air-cooled version of the CP-642B for the Marine Tactical Data Systems (MTDS), http://vipclubmn.org/sysmarines.html#MTDS. MTDS communicated with NTDS via Link 11 (from Collins) and the AN/UYA-4 displays from Litton.
- CP-818, Univac Type 1224: The 1224 was an off-shoot of the 1218 computer we designed for the National Security Agency (NSA). It was the processor for the AN/GYK-8 FLEXCOP system used by the USAF. At the time [1964], I reported to Hy Osofsky as the Project Engineer. Leroy Olson designed the I/O section, and I designed the CPU and control sections. I recall one of the cryptographic analysis instructions was so complex that I flow charted it - to make sure it was correct! After initial delivery, I made a couple trips to NSA – interesting place. [Don Mager]
- CP-823, type 1830 http://vipclubmn.org/Articles/CP823CommLog.pdf: During the Cuban Missile Crisis, the Navy realized that their systems were inadequate to detect and track nuclear submarines. The Navy launched the ANEW program, developing the P-3C aircraft. The prototype airborne CP-823 was software compatible with the CP-642A, NADC used a 1206 for their software development center – testing was at NATC, http://vipclubmn.org/flyingps.html.
- The CP-848 (UNIVAC Type 1219) was a software compatible technology upgrade of the CP-789, silicon versus germanium transistors. The Navy used the CP-848 for launch control of their Talos, Tarter, and Terrier shipboard missile systems. The Vintage Computer Federation has a restored 1219B from Johns Hopkins Laboratory, http://vipclubmn.org/Exhibits.html#VCFED.
- As the Space Age emerged, NASA procured the CP-855 (UNIVAC type 1230 processors), some parts were common with the CP-642B and the CP-855s were software compatible with the Navy's compilers. The AF implemented around the world missile tracking stations with CP-855s.
- Now de-classified, the later 1230 MTC dual processor, CP-855/642B software compatible computer was the heart of the system that tracked and guided AF planes over the Pacific as those planes 'caught' film canisters parachuted from surveillance satellites.
- The Navy needed an exceptionally reliable computer to navigate Polaris submarines under the polar ice cap. The result was the CP-890 integrated circuit computer that was software compatible with the CP-642B and physically could-be-lowered through a submarine hatch.
- The CP-901, type 1830A became the production unit for P-3C's production on-board AN/ASQ-114 system, an integrated circuit (IC) implementation of the CP-823/642A instruction set. First unit delivered in September 1967. {The P-3C is in the book and movie *Hunt for Red October*.}

  Over the years, the Norwegians, the Dutch, the Germans, the Japanese, and the Australians have also had P-3 aircraft with versions of the CP-901 based operational software. {In 2012, there were still 50 CP-901 processors in use in Japanese P-3 ocean surveillance aircraft; per Bob Pagac, then the program manager.}
- In 1967 the Navy began development of the 32-bit integrated circuit based AN/UYK-7, http://vipclubmn.org/Articles/AnotherComputerWasBorn.pdf. The engineers used the CP-901 Printed Circuit (PC) mechanical designs, DTL ICs, and conduction/convection cooling.

Procurement of common ICs for multiple computer types and peripherals provided bulk-order price advantages to multiple programs. A software 'conversion compiler' facilitated re-use of many 30-bit (CP-642B) operational programs by the 32-bit AN/UYK-7.

- AN/UYK-8 was developed for the Marine Corps as a new technology update to the CP-808. It had mechanical chassis almost identical to those of the AN/UYK-7, however kept the ISA of the CP-808/CP-642B. Plus, the Input/Output circuit cards were the same as the AN/UYK-7.
- When the FAA needed a processor to drive Air Traffic Control displays in the late 60s, they went to UNIVAC for an IC based Input/Output Processor (IOP), which was software compatible with the CP-642B. John Bonnes did much of the logic design after working on the logic design of the CP-901. The first IOP 30-bit machine went into service at Chicago's O'Hare 9/29/71, the last IOP was retired from Dayton, OH June 4, 2011. 40-years! We have a fairly complete ATC systems history - http://vipclubmn.org/aircontrol.html#Genealogy.
- The Navy wanted a carrier-based Anti-Submarine Warfare aircraft to provide fleets with the same submarine detection as the shore-based P-3C. The solution was the S-3A/B aircraft, which had the AN/AYK-10 dual processor, type 1832. This AYK-10 was software compatible with the shipboard AN/UYK-7 computer. A subsequent processor update gave the S-3 Harpoon missile launch capability.

The Canadians also used the type 1832 in their CP-140 Aurora 'search' aircraft, their nomenclature was AN/AYK-502.

- In 1969 the German Navy asked the US Navy for an upgrade to the 642B computers to be used in their new Fast Patrol Boats. Via the Foreign Military Sales process, Germany received the CP-642B software compatible CP901 repackaged for shipboard use, UNIVAC Type 1830B. Again, common parts with other computer lines even provided our NATO ally with cost benefits. The 1830B incorporated AN/UYK-7 interface PC cards for inter-computer data transfers with the German Navy's CP-642Bs.

This German Navy Schnell Boat computer system was in turn imported back to the states for use by the US Navy on the Pegasus, the Boeing prototype hydrofoil ship. The ensuing four hydrofoil ships used AN/UYK-7 based systems.

- AN/UYK-15, type 1616 was a new 16-bit Instruction Set Architecture that was used in an Army counter battery program. A key feature of the 1616 was the RS-232 serial interface to complement the previous parallel channels. A 1616 unit was favorably tested aboard a submarine resulting in a proposal baseline for the Navy's next generation AN/UYK-20.

The Univac type 3760 was a digital communication processor variation of the Type 1616 – after design and prototyping in St. Paul, production transferred to Salt Lake City (SLC) facilities. Unique to this processor was a byte wide daisy chain I/O that connected directly to IBM peripherals.

- When the Navy needed a newer technology small shipboard computer to replace 2nd generation CP-789 and CP-848, they developed the AN/UYK-20 desktop sized processor. The UYK-20 ISA came from the Univac Type 1616. The AN/UYK-20 used Micro Program Control (MPC) logic and 4-bit arithmetic Medium Scale Integration circuits for ISA implementation. SLC subsequently designed and built the DCP-40 to replace the 3760, using MSI circuits like UYK-20. A minor point, Lew Carlson, a UYK-20 designer moved to SLC to lead the DCP-40 engineering.

  The U. S. Coast Guard used AN/UYK-20s aboard their coastal patrol ships.

- In March of 1981, the Navy did a Fleet wide assessment of UNIVAC's tactical computer reliability with the following MTBF results: CP642B @ 4,128 hours, AN/UYK-7 @ 2,528 hours and AN/UYK-20 @ 12,096 hours. (source: Mike Svendsen's Semi-Conductor 'history' paper. {small world tidbit, look for Mike's uncle in the Boslaugh book.})

- The Army Security Agency (ASA) needed a small computer for their air-borne foreign border detection & classification of non-US radar systems. The result was the AN/UYK-23 computer, which was software compatible with the AN/UYK-20. It used a conduction cooled variation of the AN/UYK-20 printed circuit cards in an ATR rack mountable chassis.

  In addition to ASA use on this Grumman Mohawk (the rectangular pods outboard from the missile like wing spare gas-tanks were filled with various sensors), the AN/UYK-23 was also aboard a few NASA U2 weather planes. A special version of the AN/UYK-23 went aboard the SR-71.

  Then when the Navy needed, an airborne version of this 16-bit Instruction Architecture; Control Data Corporation won the contract to develop the AN/AYK14 computer to be program compatible with the AN/UYK-20. Several years later, Sperry competed and won a contract for second source manufacturing of the AN/AYK-14.

- The AN/UYK-11 was the Minuteman missile launch computer. These computers used the CP-789 basic 18-bit instruction set, however mapped it onto a 36-bit hardware structure with radiation hardened memory. These were installed in underground operations rooms near silos. These machines ran continuously running test programs to assure the readiness of the missiles for launch. Because of their design and benign environment, most of these units operated for seven days a week, 24 hours per day over 5 years without experiencing any hardware failures.

- AN/UYK-502: A Sperry R & D project mapped the 16-bit ISA onto a set of 6" x 9" printed circuits with Dual-in-line integrated circuits versus the flat pack circuits used in other machines. These in turn were packaged into a UYK-20 like chassis for production at the Sperry Winnipeg factory. These were used aboard the Canadian Patrol Frigates as part of the Shinpads distributed processing system.

- In 1992 the Marine Corps put a unit of their Marine Air Traffic Control and Landing System (MATCALS) in Somalia to aid in controlling air space (helicopter missions). MATCALS shelter systems had Navy AN/UYK-20 computers, http://vipclubmn.org/Articles/MATCALSdesc3.pdf.

- CP-2044 – in the early 90s we developed a technology update to the CP-901. It had three embedded Motorola 64020 microprocessor chips to emulate the CP-901 logic of thus keeping the operational software. There is a CP-2044 at the Lawshe Memorial Museum in S. St. Paul, MN – donated by the LMCO Clearwater, FL manufacturing facility.
- The AN/UYK-43 is the third generation (USQ-20 [1st] to UYK-7 [2nd] to UYK-43) NTDS computer and was specified as the emerging UYK-7 replacement. It was a high technology evolution from the AN/UYK-7 computer, http://vipclubmn.org/cp32bit.html#UYK43.
- The AN/UYK-507 was the last development in the line of 16-bit computers, developed in the early 1990's by our Winnipeg facility, http://vipclubmn.org/cp16bit.html#UYK507. The AN/UYK-507 re-used the AN/UYK-502's chassis and power supplies and adopted its 6x9 inch circuit card format. Other than a modified maintenance panel, the AN/UYK-507 looked like the UYK-502, but inside it had gate-array technology – used aboard the Canadian Patrol Frigates.
- AN/UYK-44 was a high technology evolution from the AN/UYK-20 computer, reference page 9 of http://vipclubmn.org/Articles/CPFwin.pdf.

EPILOGUE

NTDS is alive and well today – the systems evolved with technology changes during Mr. Ream's 25-year tenure with BUSHIPS/NAVBSHIPS and the 35+ years since his retirement.

Today's NTDS and other shipboard systems use the AN/UYQ-70 products as the primary operating unit for multiple tasks aboard ships. Unisys wrote the proposal in the winter of 1993, as I recall Bill Poblete was the technical lead – I wrote the micro-processor section. The Q-70 is a variable configuration display unit with embedded microprocessors. In September 2013 when the Navy launched the USS Minnesota submarine, SSN 783, it included a dual screen Q-70, Serial Number 8,000 – designed by Unisys engineers in Eagan, MN and manufactured in Clearwater, FL. The Lawshe Memorial Museum has a couple Q-70 units on display, http://vipclubmn.org/Exhibits.html#Lawshe.

Peripheral device engineering: The processor examples on pages 1 through page 6 are not the only re-use of printed circuit modules. The Univac 1240 magnetic tape units and 1232 keyboard/paper tape consoles used many of the same logic cards as the CP-642A. The UNIVAC 1540 magnetic tape units and 1532 console used the same logic cards as the CP-642B. The RD-358 magnetic tape units used the same I/O cards as the AN/UYK-7. These peripherals were used on-board ships, in Marine Corps shelters, software development centers, integration test sites, and operations centers.

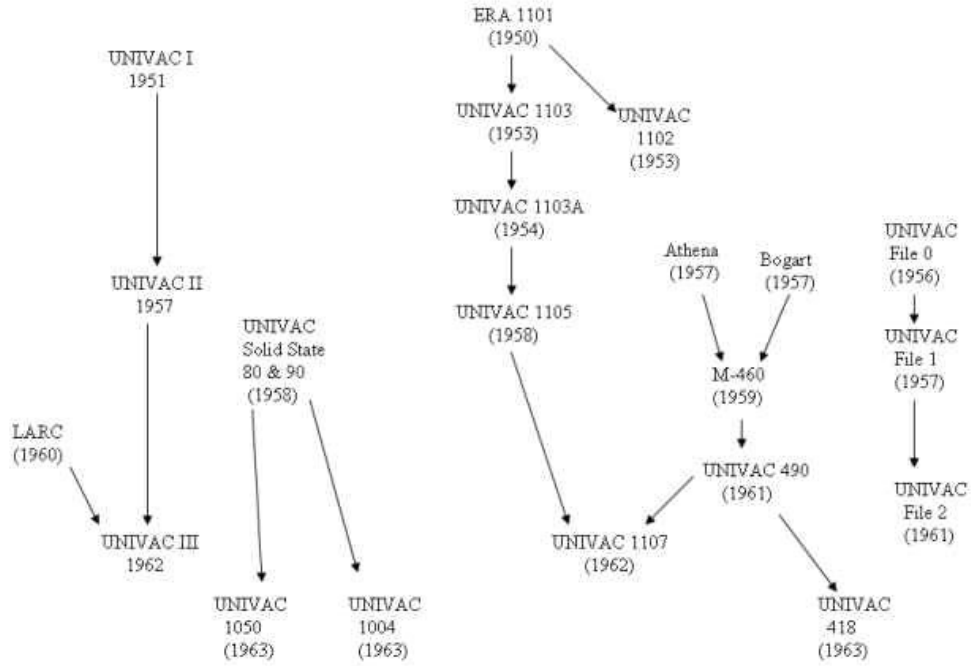
Thanks to Keith Myhre, http://vipclubmn.org/People5.html#Myhre and John Westergren, http://vipclubmn.org/People7.html#Westergren, for factual and editorial reviews.

Personally, I was fortunate to have met Mr. Ream as well as ~35 of the 300 people mentioned in Capt. Boslaugh's book. Also I had had experiences with many of the computer types mentioned herein, http://vipclubmn.org/PeopleDocImg/Vol01Book1.pdf.

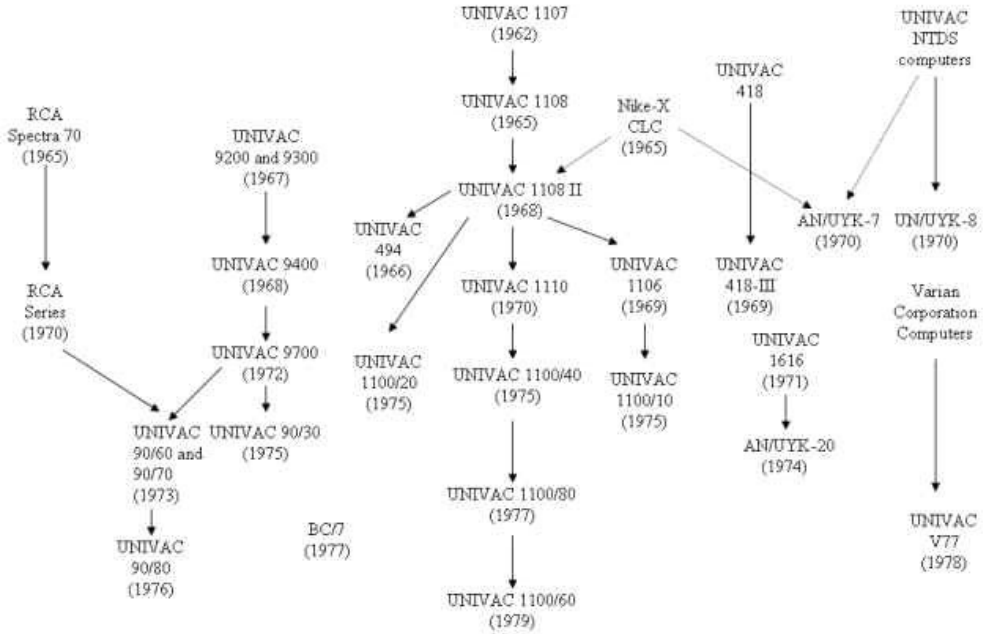
LABenson - IT Legacy webmaster 2006-2019 and VIP Club president 2011 & 2014/15. 😊

Appendix – Commercial 'Standardized lines' & Computer Genealogy

Family Tree of Remington Rand/Sperry Rand Computers
1950-1963

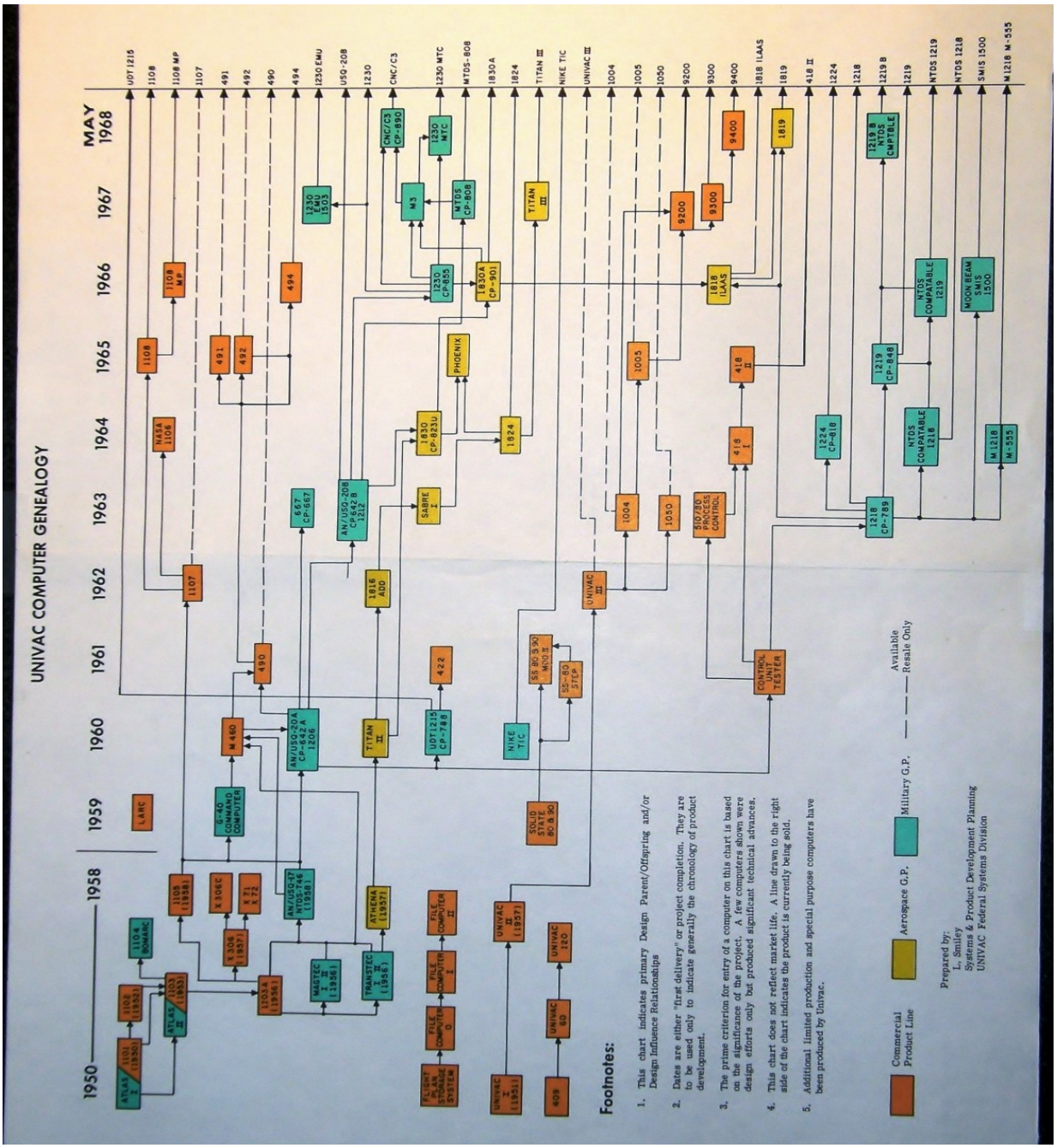


Family Tree of Sperry Rand Computers
1962-1980



1. Thanks to Unisys Fellow Ron Q. Smith for these two charts.

The orange boxes at the top of this 1968 diagram are the 1100 and 490 commercial computer series. The NTDS 30-bit shipboard unit types are green boxes below the 490 series. The yellow boxes evolving from the Athena launch computer are aerospace or airborne units. Then orange boxes are the St. Paul file computers, the Blue Bell UNIVAC I, 1004, and 9200, plus Rowayton CT's 409, U60, and U120 processor types. The green boxes across the bottom are the 18-bit shipboard unit types. {Editor's Note: If you are viewing with a .pdf reader, use the enlarge view function to see details.}



2. The then classified Atlas I is immediately below the 1950 of the timelines.