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2005

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NAVAL POSTGRADUATE SCHOOL

NPS Computing: 50 Years Golden and Growing

Story by Barbara Honegger

As the Naval Postgraduate School celebrates 50 years on the forefront of academic computing, Aug. 27, it's fitting that Superintendent Rear Admiral Patrick Dunne is a graduate of the Department of Mathematics, for NPS's move from Annapolis five decades ago not only coincided with the birth of the Information Age, its first computer was the proud property of the Department of Mathematics.

In 1953, only months after the move, when five-foot slide rules were still being used as instructional aids, the father of NPS computing, Mathematics Dept. Chairman and former naval officer Warren Randolph Church (right; Vice Adm. Aubrey Fitch, at left) installed the first electronic automatic digital computer -- a National Cash Register 102A (below) -- in the Mathematics Department in Root Hall, hoisted by crane through a second story window.

Seven years later, in 1960, it was replaced by the world's first all-solid-state computer -- Control Data Corporation's CDC1604 Model 1, Serial No. 1 (top p.5) -- designed, built and personally certified in the lobby of Spanagel Hall by the legendary Seymour Cray. Cray's "first born" was the first of ten such machines, ordered by the Navy's Bureau of Ships for its Operational Control Centers world wide.

"I was there when Cray sat at the 1604 console and, like a master pianist, ran through the test programs," said Edward Ward, a mathematician and the first computer technician hired by Church. "I watched and listened. When it's raining knowledge, you just hold out your hand."

"This was the supercomputer of the day," said former Professor of Mathematics Douglas Williams, Director of the NPS Computer Center from its founding in 1961 to 1994, "yet it was only being used by a very small number of faculty, submitting machine language programs on paper tape. There was no operating system and no assemblers, compilers or utilities." Williams first came to NPS on sabbatical leave from the University of Glasgow, Scotland with an extensive background in computing and an entrepreneurial spirit. Within a year of his arrival, computing had spread across campus -- in faculty research, student thesis research, and many classes.

"It not surprising NPS's Information Technology (IT) infrastructure emerged from the Math Department," said current department chairman Clyde Scandrette. "It was a seminal time when the mathematical underpinnings of algorithms met the dawning of the Information Age, and mathematical researchers could appreciate and act on this potential."

"That first transition from the NCR to Cray's CDC was the biggest jump in computing power NPS has ever had -- a factor of 300," Williams noted. "By comparison, the IBM 360/67, which replaced the 1604 in 1967, was only 25 times faster than the CDC; the IBM 3033AP, which we installed in 1981, was just a tenfold gain over the 360/67; and the AMDAHL 5995-700A, received in 1990, an increase of just another factor of ten."

Despite the leap in computing power, Cray's 1604, in use at NPS from 1960 to 1967, could serve only one user at a time, and initially had no software or operating system.

"It wasn't long before Cray wrote an assembly routine and complete FORTRAN compiler, which is really what jump-started computing at NPS," Ward recalled. "It was now a lot easier for faculty and students to program for complex scientific problems."

"I began teaching classes on how to use Cray's FORTRAN compiler to standing-room-only audiences of faculty and students," Williams recalled. "Everyone knew how revolutionary this was, and wanted to get in on the ground floor."

Seymour Cray's CDC1604 was also the computational seed of the Navy's Fleet Numerical Meteorological and Oceanographic Center (FNMOC). In the early 1960s, the Naval Numerical Weather Prediction (NANWEP) Project was given time on the machine for a feasibility study. Its success led to the installation of a second 1604, back to back with the first, in Spanagel 101A. NANWEP soon got its own supercomputers and moved to another on-campus location. Later renamed FNMOC, it is still synergistically co-located with NPS in Monterey, about a mile away.

The 1960s saw a number of other firsts at NPS. The Navy's corporate university was among the first to move from

single-user machines to multi-access timesharing. In 1963, Williams designed and started a computer-oriented masters degree program in management data processing. In 1964, an IBM 1401 character-oriented business computer was added, with a card reader, card punch, and printer. Students' punched cards were written to magnetic tape, the tape carried to the mainframe where it was run in batch-processing mode, and the results, also on tape, printed out on the 1401.

The mid 1960s saw the installation of two CDC160A 'mini' computers, one next to the 1604, and the other in Electrical Engineering, which also acquired a custom-built graphic display with a track ball, joystick and other features common in today's units. "The 160A was the computer that gave people the idea that there might be a justification for one-user machines after all -- the forerunner of today's Personal Computers, or PCs," recalled David Norman, former Director of Academic Computing. "Back then, though, a 'mini' didn't fit on a desk. It was the size of a desk, or a refrigerator."

Following the lead of Electrical Engineering's dedicated mini computer, special-purpose computing systems were installed in all NPS science and engineering departments, complementing the general-purpose computing services offered on the Computer Center's IBM-compatible mainframes.

In 1967, the School's CDC1604 was replaced by an IBM 360/67 mainframe computer (above, center), the first to have special addressing hardware features for implementing virtual storage. Two years later the entire system was moved to the first on-campus space specifically designed for computer operations, in Ingersoll Hall, where the new W.R. Church Computer Center (bottom, p.5) was dedicated in 1969. Typewriter terminal clusters were soon installed in academic buildings across campus, connected by point-to-point four-pair cabling. "There were no dedicated underground cable facilities," Norman explained. "We used whatever cable route we could find - steam tunnels, underground telephone cable paths. For the major part of the 1970's we ran cable through the trees from Ingersoll to Root, Bullard and Spanagel Halls."

In the 1970s, NPS Computer Science Professor Gary Kildall (left) wrote the world's first high-level programming language for Intel's microprocessor, as well as the first microprocessor operating system, soon run on nine out of ten PCs. He and his wife founded Intergalactic Digital Research, in Pacific Grove, later shortened to just Digital Research. About the same time, a young Bill Gates was approached by IBM to provide an operating system for their proposed PC, and referred the company to Kildall. IBM returned to Gates when the approach didn't work out, and, as they say, the rest is history. One of Kildall's Navy officer students, submariner Lt. Gordon Eubanks, went on to become chief executive officer of Symantec, and then president and CEO of Oblix.

As computer use increased, graphics displays popped up all over campus, and NPS enlisted computer science specialists, primarily from the Mathematics and Electrical Engineering Departments, to assist faculty and students. The School established its first Computer Science Group in 1973, and, within five years, five Math professors -- over half the department's faculty at the time -- joined the newly established Department of Computer Science. In 1975, NPS was one of the first California nodes to connect to the ARPANET, along with Top Ten-ranked Stanford University (Neil Harvey, user services programmer, 1970s, right).

The '70s also saw the addition of an SDS9300 and multiple DEC PDP8s and PDP11s in many of the science and engineering departments at the Navy's university. In the following decade, many of these were replaced with DEC VAX computers running the UNIX operating system, in turn superceded by a variety of high-performance UNIX-based workstations in laboratories and faculty offices. Applications ranged from data acquisition to scientific visualization and virtual reality simulations. Many of these systems outgrew their parent departments and now have an independent existence in NPS centers of technological excellence, like the world renowned NPS Institute for Modeling, Virtual Environments and Simulation (MOVES).

In the 1980s, the Navy's university purchased an IBM 3033AP mainframe computer (left), marking a major shift from punched cards to on-line terminals. Williams and his Information Technology (IT) team set up Learning Centers across campus with PCs, Macs, and UNIX-based workstations. Instant messaging to other logged-in users and an IBM 3851 mass storage system boasting tapes capable of holding 50 megabytes of data made their advent. The School installed a 250-page-per-minute IBM 3800 laser printer, and the Computer Center set up a library of over 5,000 IBM manuals documenting the new mainframe system, and for general reference. Micro-networked word processing labs were soon added, with Xerox graphics workstations providing the first graphical user interface with "What you see is what you get" displays.

The 1990s saw the implementation of a five-year computer infrastructure master plan, "Support of Graduate Education in the 1990s". The program funded acquisition of an AMDAHL 5995-700A (right), and Cray X/MP (E98) supercomputer; SUN servers for the campus network; 150 SUN Sparc10 workstations in faculty offices and clusters across campus; Storage Tek mass storage silos accessible via the campus network; Learning Resource Centers in the academic buildings; creation of a Scientific Visualization Laboratory, and War Lab for secure classified thesis production; the first Web browser; and the infrastructure for a campus-wide backbone. Glasgow Hall was the first building to be wired for high-speed networking from the ground up, and, in 1999, fiber optic cable was installed between campus buildings. By the end of the decade, the speed of the School's network had increased tenfold, from 10 to 100 megabits per second.

"When Professor Jim Emory first became Associate Provost for Information Technology, in 1994 just after Doug

Williams retired, one of the first things he did was to come into my office and ask, what would make the most difference for NPS in IT?" Dave Norman recalled. "In about one second, I told him, 'Put in a single, centrally managed campus-wide network.' Jim said yes, and in about a week, I came up with a projected cost of $4.2 million. Four years later, the project came in at exactly $4.2 million. This wasn't so much because I was a great project manager, as that we had a truly fine contractor."

In 1997, the AMDAHL was replaced by an IBM 9672 mainframe, followed in 1998 by a move to PC standardization (top, p.9) under then Superintendent Rear Adm. Robert Chaplin's implementation of the Navy's "Information Technology for the 21st Century" (IT21) Strategic Plan.

Computing at NPS Unique

According to Williams and Norman (above, center), research and instructional computing at NPS is unique because it is free to the user and student-centered.

"Throughout my 33-year tenure ending in 1994, I thought it very important, considering the special nature of NPS, to make these powerful resources available free to students and faculty for class work and research -- a practice rare in universities," said Williams (right). "At most graduate institutions, computing time went to the users with the most money, usually physics and engineering researchers. Our free access policy resulted in a much higher computer literacy rate here at NPS than at most universities."

"From the earliest days, what made NPS computing support unique and, frankly, a lot of fun was that it has always been student-centered, as opposed to administration-or faculty-centered," recalled Norman. "Where else could you find a computer services staff member at one or even three o'clock in the morning working with a student to get a modeling or analysis program right, or to get his or her thesis out? Some of my fondest memories are of those early morning hours, desks piled high with memory dumps, manuals, and program listings, the office floor awash with empty soda cans."

The New Millennium: Best of Both Domains

In 2000, Google was installed as the NPS home page search engine, the PYTHON student-data management system was developed and implemented through a series of student masters theses, and the School completed system-wide precautionary measures for Y2K, including the first combined campus-wide inventory of both administrative and academic computing systems. "Netcentricity" became a watchword, as Web forms and database interfaces became integrated, and user interfaces for application software increasingly took advantage of the Worldwide Web.

In 2001, the Navy's corporate university installed a wireless network. The following year, Dr. Christine Cermak was brought on board as Executive Director, Information Resources and Chief Information Officer, establishing an Information Technology Task Force as the IT advisory body at NPS. Under her direction, IT quickly privatized all NPS telephone support, making communications services an integral part of computer and networking support; consolidated e-mail services; and instituted remote management for anti-virus updates.

2003 was a year of remarkable productivity at the Navy’s corporate university. Even while the organization was being redefined as a result of a Functionality Assessment study, NPS joined Internet2, a vision for a joint DoDNet was developed for the Monterey Peninsula, and ITACS upgraded network core and edge network devices to Foundry GIG-E to improve both reliability and speed. Cermak's team completed and published the School's IT Strategic Plan, "The Information Revolution: Planning for Institutional Change" (above). Planning for the Navy-Marine Corps Intranet (NMCI) was initiated, Network Attached Storage debuted, and campus backup capabilities were expanded with multi-level storage and increased capacity on an automated virtual tape system.

An increased focus on security resulted in the appointment, in 2003, of a full-time NPS Information Systems Security Manager within ITACS, the introduction of "smart cards", and the implementation of Public Key Infrastructure (PKI). Classified computing labs were moved to new facilities with improved networking and bandwidth, and the Classroom Technology Plan won Naval Education Training Command support. Automated computer account creation and deletion, along with definition of a standard image for administrative and academic desktop computers, made system administration tasks more efficient. One of the central tenets of the Functionality Assessment study -- a recommendation to establish a new customer support unit -- was implemented in the new Technology Assistance Center.

A major initiative of the Information Technology Task Force Advisory Committee has been to ensure that NPS computer users have the best of both Internet domains -- .mil and .edu. As of April 2004, faculty, students, and staff now have access to both Internet worlds, ensuring the rich, high-speed network access of the world's top-ranked civilian universities via .edu, as part of the cooperative Education and Research Network (ERN), while continuing to meet robust military security standards for classified research and communications via .mil. This year also will see the transition to the Navy-Marine Corps Intranet (NMCI) in the .mil domain. (IT-21 standard PC, right)
"Our IT infrastructure has always been oriented to do this," said Professor Peter Denning, Chairman of the NPS Department of Computer Science. "What we've now done is to formalize it, by declaring ourselves a member of the .edu arena. This guarantees an infrastructure capable of supporting rapidly evolving graduate education and research programs, as well as access to the fastest networking, most cutting edge technology and software, and widest range

of colleagues and collaborators from other institutions. Formally entering the .edu domain also enables us to cooperate with those colleagues and collaborators to evolve Internet2, which will be of even higher bandwidth, greater functionality, higher reliability, and greater security." Denning is also Director of the NPS Cebrowski Institute's Battlespace Communications Architecture Project, whose focus is converging the Navy's ForceNet infrastructure into the larger DoD Global Information Grid (GIG). A true Internet pioneer, in 1981 Denning catalyzed the revolution of DoD's closed ARPANET into the open Internet, via the bridge of an unclassified ARPANET clone, CS Net.

The Next 50 Years

On Aug. 27, 2004, NPS will hold a day-long celebration of its Golden Anniversary in research and academic computing.

"Information Technology was born in the academic enterprise -- it was invented and established for education and research," said Cermak. "Over the past 50 years, that role has only increased and been made stronger, with IT becoming a strategic resource for universities as a change facilitator and multiplier. On August 27, we will be celebrating 50 years of NPS leadership in the development and use of Information Technology in academic research computing. We take that leadership role as a world-class graduate university very seriously, and honor it by carrying it boldly into the future."

And what does the Naval Postgraduate School IT future look like?

"NPS's Information Technology infrastructure ranks with the world's top research universities, and will continue to do so into the future," said Denning. "The growth in computing power at NPS has followed the exponential curve of the larger IT community, and this will also continue. Via shrinking silicon chips and other technological advances, the environment in which we will do research on Network Centric Warfare and ForceNET will continue to see Moore's Law holding to at least 2050, and probably 2100. So we can count on communications power and computing power continuing to double every 18 months. But so can our enemies. It's therefore vital that we continue to hold and exploit the incremental IT advantage, which is our superior ability to innovate. To ensure that future, we must proactively promote a paradigm shift to a culture of innovation. With its world class IT infrastructure, NPS will be on the cutting edge of that paradigm shift and emerging culture."