The Link

BULLETIN OF THE NATIONAL CRYPTOLOGIC MUSEUM FOUNDATION, INC.

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CHANGE OF COMMAND AT THE MUSEUM

INGRAM STEPS DOWN; WEADON NEW CURATOR

More than any one individual, Jack Ingram shaped the National Cryptologic Museum of today. He personified it in the media and in countless lectures. The vision and direction of David W. Gaddy, who was tasked by NSA Director William O. Studeman to establish the then-parent Center for Cryptologic History in 1989 and who proposed that use of a nearby former motel, and the perseverance and creative talent of Earl J. "Jerry" Coates, the first curator, who—with Jack's assistance—brought it into being in 1993, were rewarded by a succession of supportive Directors of the National Security Agency, and Jack "assumed the con" in 1994. In a rare coupling of vocation and avocation, Jack's talent and training in graphics art, his career experience in the field of Communications Security (in which he was a singularly effective teacher and lecturer), his love of military history, and his strong sense of patriotism led to eleven years of dedication to the Museum. His "fingerprints" are (in some cases, literally) on all of the exhibits. By year's end, and over four decades with the Agency, Jack was ready to turn over his "baby" to a new parent and announced his plans for retirement.

Retirement Flag flew over the NSA

Jack's own account of this period has received wide publicity within the Agency and the Intelligence Community. An intelligence and security museum—especially one in the tightly controlled field of government and military communications security and intelligence—was a new entry into the public domain, when Director Studeman (then VADM, USN) enthusiastically endorsed the concept. Aimed at increasing public understanding of the role of the "super secret" National Security Agency, while serving as inspiration and building esprit de corps among the professionals, the Museum was opened. There was (and is) no entry fee. What was displayed and interpreted had been purchased through public taxation--and the expenditure of lives of American citizens and their colleagues at home and abroad. The National Security Agency took pride in sharing and reflecting on this legacy.

Jack was profiled in The Link, Vol. 1, No. 4, Winter 1998/99, and his tribute to a colleague, Art Green, appeared in The Link, Vol. 7, No. 3, Fall 2004. His personal narrative of his tenure as Curator has appeared in an internal NSA publication, CIA's "Studies in Intelligence," and in

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OVERVIEW

The President's announcement of his selection of NSA Director Hayden as the first Principal Deputy to the newly established post of Director of National Intelligence in February 2005, and his concurrent promotion to General "elevated" a close friend and ardent supporter of the Museum and our Foundation. We wish him well in his new and vitally important role and await a new leader we hope will be equally supportive of our principal focus.

Although in retrospect the signs were there, it still came as a shock when we learned that Jack Ingram, Curator of the National Cryptologic Museum since the Foundation came into existence, was retiring at the end of December 2004. Upon his recommendation, Patrick Weadon, an Agency historian and doctoral candidate—already known to Museum visitors through several monographs—takes the helm. We bid an affectionate farewell to Jack, with the very best wishes on his retirement, and we look forward to a continuing, close relationship with Patrick.

The Marines are "out front" as usual, moving right along with their National Museum of the Marine Corps at Quantico, with its towering, sloping design recalling the flag-raising on Iwo-Jima in World War II. The Army is likewise moving with their National Museum of the U.S. Army, to take shape at Fort Belvoir, also in Northern Virginia. A project of the Army Historical Foundation, Inc. (chartered in Virginia in 1983), an enabling sponsorship program has been launched with Gen. Tommy Franks, USA (Ret.), seeking to raise $200 million. A curator has been hired and staff is already at work. Recently we have learned (via "The History Channel Magazine") that the U.S. Navy Civil Engineer Corps (CEC)/Seabee Historical Foundation, a private non-profit organization in Gulfport, MS, is mounting a $12 million drive to build a new 35,000 sq. ft., facility in Port Hueneme, CA, replacing a smaller 1947 Seabee Museum there, honoring the 750,000 people who served in WW II and since, according to retired Navy Captain William C. Hilderbrand, foundation president. We also have the Cold War Museum, among others, and the commercial Spy Museum in downtown Washington, DC. I draw two conclusions from these events: we must move more aggressively with our own efforts to build a new National Cryptologic Museum facility, realizing that there is competition for fund-raising from similar enterprises and a tighter economic climate. And to do this successfully, we must convey the sense that this is not just for the present-day National Security Agency, but a truly national museum, honoring and memorializing the service of hundreds of thousands of men and women—military and civilian-- who have participated in and built America's cryptologic accomplishments, not just in World War II, but throughout our existence as a nation.

At the urging of Board Member Gen. Linc Faurer at our 24 December Board meeting, that we refine our concept of operations, Dr. Hermann moved that a task group be established for that purpose and more, and that Gen. Faurer head it, as chairman of a New Museum Study Group. General Faurer graciously accepted that position and immediately set to work. We look forward to hearing from him in a future issue of The Link, which will also carry a report from a joint Foundation-NSA visit to the Marine Museum project at Quantico.

It is with great delight (and relief) that I welcome to our ranks Mr. John S. Garcia, who has volunteered to serve as Foundation Secretary, a cornerstone of our "headquarters" staff, and a vacancy since the departure of John Callahan. John Garcia brings with him a record of over thirty years' experience in program management, task analysis, and system migration, acquired and applied in the intelligence and intelligence-related activities of the Department of Defense and the Intelligence Community. To his degree in political science and history (Brown University), John added master's degrees from Central Michigan (MBA) and Georgetown University (MPM) and completed the course of instruction at the Program Manager Institute. His (Navy) field experience in Great Britain, Japan, and Scotland ranged from direct support to management of costly and complex advanced systems. Since 1992, his experience has been in the Defense-related public sector. Currently John is Program Manager for Strategic Programs within the Hewlett-Packard Advanced Program Group. Already his energy and drive have become evident to all of us.

John E. Morrison
President

CHANGE OF COMMAND AT THE MUSEUM

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Receiving NSA's Highest Award The Director's Distinguished Service Medal for Exceptional Service

a separately distributed NSA monograph, "The First Ten Years: A Personal Story." After an all-too-short break, Jack has returned to work with a company where his graphics art talent and experience are being brought to the fore-front.

At a mid-day reception and retirement ceremony held in the Canine Suite at NSA on 1 February 2005, Jack was honored by Director Hayden in the presence of family and friends. Gen. Hayden presented the Director's Distinguished Service Medal (DDSM), a flag that had flown over the Agency, and other tokens and remembrances, followed by appreciative remarks by colleagues and officials. Ingram's heartfelt response was echoed in a personal letter he subsequently addressed to Gen. Morrison and the Foundation.

Jack Ingram, NCM Curator, 1994-2005

Director Hayden, Jack, wife Rosemary Ingram, mother Vivian L. Ingram, daughters Cathy and Angela and her husband, Brad Myers

I retired on 31 December 2004, after an NSA career spanning almost forty two years. For the last eleven years of my career I was privileged to serve as the Curator of the National Cryptologic Museum (NCM). I thought it appropriate that I pen a few parting remarks expressing my thanks and sincere appreciation for the support I received from all the members of the National Cryptologic Museum Foundation (NCMF).

Major General John E. Morrison, Jr., USAF, Ret.

First of all, I want to take this opportunity to thank you, General Morrison, for your vision to create a museum foundation to begin with, your leadership of the NCMF, unerring support of the NCM and for your ongoing quest to build a state of the art new NCM. However, just as important to me personally is the friendship you have demonstrated to me in so many ways and which has enriched my career and life in more ways than I have room to recount here. General Morrison, I have always thought of you as the "Godfather" of US Intelligence and I would like to add that in some ways I feel you have been like a Godfather to me too. During my retirement luncheon you gave some poignant remarks on my behalf. At the conclusion of your remarks, when you turned and saluted me, I almost lost it; it is a moment in time I will treasure always. Thank you for everything "my dear friend".

National Cryptologic Museum Foundation Board of Directors and Staff

It was an honor and humbling experience for me to be associated with and to be befriended by so many past and present members of the NCMF Board and Committees, some of you already legends in our field of endeavor. Many of you helped to create, form and lead NSA during the Cold War and to make it the best intelligence organization in the world. You are now freely giving of your time to help ensure our cryptologic legacy survives for future generations. While serving as curator, I would often reflect on how fortunate I was to be associated with you and how personally enriched I felt in knowing that you valued my opinions and ideas. I want to thank each of you for accepting, supporting, and encouraging me as well as for your advice and guidance while I served as curator. I want to add my special thanks for those of you that attended my retirement luncheon. Your presence truly touched me.

National Cryptologic Museum Foundation Members

I would also like to express my thanks and appreciation to the general membership of the NCMF for your support of the NCM. During my eleven year tenure as curator I met many of you as you visited the NCM or attended the Annual General Membership meetings or other venues. Your support and interest in the NCM and cryptologic history in general were always a comfort to me. It was personally rewarding for me to meet many of you and see your pride in the NCM and our cryptologic history as you brought guests to visit the museum. I hope each of you will continue to support the NCM as members of the NCMF and that you will encourage your friends to join as well. Without your interest and your continued support there would be no NCMF! I'm now a member myself and I am looking forward to seeing many of you at upcoming NCMF events.

Serving as curator was a challenging, fulfilling and rewarding experience. It was often a step into uncharted waters and I enjoyed the trip immensely! Thank you all for helping me along the way.

Sincerely yours,
Jack E. Ingram
NCM Curator, Retired

RAYTHEON PRESENTATION TO NCMF

On 14 January 2005, officials from Raytheon Corporation presented to the Foundation a check for $10,000, designated for the "a.k.a. Smart" program, teaching mathematics and cryptography to school children over the Internet. In the accompanying photograph, Arthur Green (Raytheon Vice-President, Intelligence, Space, and Geo-Spatial Programs) presents the check to Gen. Morrison, as Linda Taylor (Raytheon) participates. Gen. Morrison expressed appreciation on behalf of the Foundation and thanked Raytheon for recognizing in a tangible way the promise for the future represented by "a.k.a. Smart."

NCMF
General Membership Meeting

26 October 2005

AT&T PRESENTATION TO NCMF

In a special ceremony at the Museum on 21 January 2005, representatives of AT&T demonstrated their company's support with the presentation of a $15,000 check earmarked for the Foundation's New Museum Building Fund. Shown here presenting the check to an obviously delighted Gen. Morrison is RADM Ike Cole (USN Ret), Vice President, AT&T National Information Systems-Government Solutions, Inc., flanked by Joseph Bellomo, Director, Special Projects, and Michael Green, Director, Intelligence Community—both of AT&T-Government Solutions, Inc.—and NCMF Vice President Gene Becker.

ANNUAL DECEMBER PROGRAM

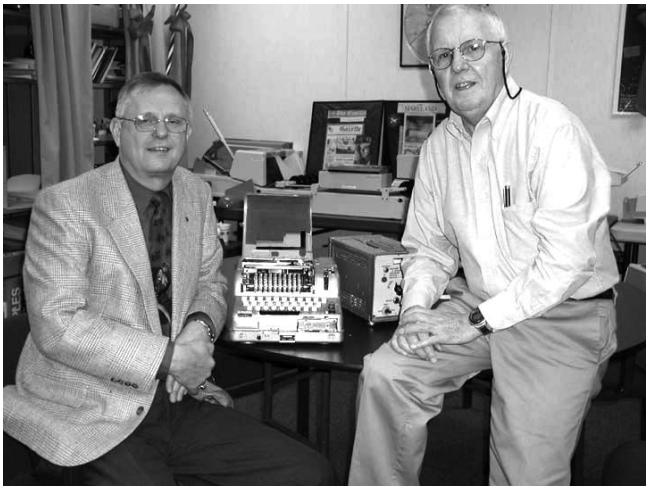
The Foundation's annual "Remember Pearl Harbor"program took place on 1 December 2004, featuring NCMF member Bill Price, who worked at NSA in the early years and preserves a continuing interest in history. His presentation dealt with MAGIC during World War II, as derived from exploitation of the Japanese PURPLE cryptomachine, and he emphasized the value of reporting by Japan's ambassadors to Berlin and Moscow. Bill's characterization of the cabled reports (encrypted in PURPLE) was enhanced during the question-and-answer session by the presence of four retired flag officers in the audience.

THE RUSSIAN M-125 FIALKA

David Hamer - NCMF Vice-Chairman Acquisitions

In December 2004, through the auspices of the NCM Foundation, the National Cryptologic Museum acquired an example of the rare, Russian-built, M-125 cipher machine used by the USSR and Warsaw Pact countries during the Cold War. M-125 was codenamed FIALKA [Violet] by the Soviets. Earlier in the year word was circulating amongst the community of cipher machine researchers and collectors that exists throughout the world that five of these machines had surfaced in the former East Germany, via Poland. When this news reached my ears I forthwith began an inquiry to determine their then current disposition and locations. One, I found, had been purchased by a British collector and was on loan to the cryptologic museum at Bletchley Park (BP) in the UK. Three were in the hands of a US collector, while the location of the fifth was, and still is, unknown to me.

After some discussion with NCM Curator Jack Ingram, I began negotiations with the aforementioned US-based collector and, to cut a long story short, after some time was successful in arranging a trade in which ownership of an M-125-MN FIALKA was transferred to NCM. The machine was delivered to the museum on 2 December 2004.



Mr. Ingram, FIALKA, Dr. Hamer

Very little information about this interesting machine is publicly available but an initial close examination reveals some basic details about its systems and capabilities. Of great help has been a German language manual located by British collector John Alexander, who has produced a good quality facsimile of this most useful, 112-page document, publication of which is ascribed to the Nationale Volksarmee der Deutschen Demokratischen Republik and dated 1978. (A copy of this manual was subsequently purchased by the Foundation and donated to NCM as a companion-piece.).

FIALKA is generally similar in its design principle to the German Enigma cipher machine of WW II and derivatives such as the Swiss NEMA [NEu MAschine] already in the Museum. However, it has ten wired wheels or rotors, each with 30 contacts, instead of the three (or four) wheels, each with 26 contacts, found in Enigma: many other differences are apparent.

Rather than illuminating light bulbs [Enigma's Glühlampen] to display the cipher text resulting from the input of plain text via the keyboard, FIALKA prints its output in readable form on paper tape, simultaneously punching holes in a five-bit telegraph tape of the Baudot type if required. FIALKA also includes a paper tape reader that may be used for the rapid enciphering and deciphering of messages received by teleprinter – obviating the need to re-enter this material manually via the keyboard. The machine can also be connected directly by cable to either a teleprinter or radio receiver/transmitter for input and output respectively.

FIALKAS's keyboard is interesting and raises questions to those of us unfamiliar with the Cyrillic alphabet. Unlike the Western keyboards that we know and love, the keyboard of the Russian machine has 30 characters…and the first question that came to mind was why? The standard Russian alphabet has 33 characters. A quick check with a Russian specialist disclosed that 30 characters are quite adequate for communications: substitutions may be used for two of the three 'missing' characters while the third, though grammatically a component of the present-day

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THE RUSSIAN M-125 FIALKA

David Hamer - NCMF Vice-Chairman Acquisitions

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alphabet, is no longer in common use.

Another interesting observation concerning the keyboard is that each key, in addition to its Cyrillic character, carries a Western character or numeral. The layout, as I came to discover, is basically that of a standard Russian typewriter or computer keyboard and is quite similar, apart from the additional keys, to that used by Enigma. The four extra keys bear the numerals 2, 5, 7, and 8 and some characters, namely L, P and Q, are relocated. Otherwise the familiar QWERTZUIO… used in the Enigma keyboard is retained.

FIALKA is normally operated from a separate power supply that provides DC output from a range of input voltages and frequencies - selectable on the power unit. Manual operation of the mechanical components is possible through a hand crank, with which the machine is provided.

In use, a major characteristic of this machine is that each of the ten wired wheels moves in the opposite sense to its neighbor. In other words five wheels move 'away' from, while the other five move 'towards,' the operator. This movement is achieved by a simple but effective arrangement of stepping levers mounted beneath each of the ten wheels.

FIALKA has no plugboard comparable to Enigma's Steckerbrett. Instead, an electronic reader is located on the left side of the machine, which allows the use of punched cards to set internal cipher parameters in addition to those resulting from the internal wiring and movement of the wheels.

Others who are studying FIALKA have shared their observations with me. In addition to John Alexander's work on the machine displayed at BP, here in the US Professor Tom Perera is currently examining another of these interesting machines. I am indebted to the Curator of the NCM and the museum staff, who kindly allow me to have access to what is now 'their' M-125-MN.

[Editor's note: The designation M125 recalls the M111 cipher machine, identified as having been introduced in late 1977/early 1978 in the North Vietnamese Armed Public Security Forces, later the Border Guard Troops. (See "Essential Matters: A History of the Cryptographic Branch of the People's Army of Viet Name, 1945-1975, with a Supplement…1959-1989." National Security Agency, Center for Cryptologic History, Special Series, No. 5, 1994.) Perhaps the M-series designated cryptoequipment designed or modified for export to Soviet bloc components or allies.]

MEMORIAL REGISTRY

The Foundation's "In Memorium" registry was initiated in 2002 (The Link, Vol. 4, Nos. 1 and 2, and Vol. 5, No. 4) to provide for member recognition of departed colleagues, admired and beloved supervisors, and others, whose "silent service" deserved special recognition. The Memorial Book records the name of the individual so honored and the sponsor(s). Entry of that information is based upon receipt of a donation of $100 or more to the NCMF. Multiple sponsorships are also listed, in the order received or alphabetically. (Of the 29 names listed in the first report in The Link, Winter 2002, the first 24 are in alphabetical order.) Donations of lesser amounts than $100 are gratefully accepted, and acknowledged in a letter of recognition and appreciation to the donor.

In addition to the book, a memorial tablet or plaque records the names of individuals in whose memory a donation of $10,000 (or more) is received. Both the book and the tablet are displayed at the entrance to the Museum. Donor-sponsors are reminded that their donations contribute directly to the work of the Foundation in support of the Museum, and that the amounts are entirely tax-deductible under the provisions of the Internal Revenue Service, which recognizes the NCMF as a not-for-profit 501 c (3) organization.

The following names have been added to the Memorial Book:

#56 Honoree:	James Richard "Dick" Chiles
Sponsors:	Susan D. and Benjamin N. Hoover
#57 Honoree:	Earl David Clark Jr.,
Sponsors:	K. Janet Clark (wife), and (children) Terri Lynn Murphy & Diane Clark
#58 Honoree:	Captain Norman Klar, USN (Ret.)
Sponsor:	Harry G. Rosenbluh
#59 Honoree:	Joseph Richard
Sponsors:	Mr. & Mrs. David Hendershot
#60 Honoree:	Colonel Charles H. Hiser, USA (Ret.)
Sponsors:	Mr. & Mrs. Charles Girhard
#61 Honoree:	Colonel Paul E. Neff, USA (Ret.)
Sponsors:	Mr. and Mrs. Charles Girhard

FOR THE BOOKSHELF

(Guest reviewer and NCMF Member Ray Schmidt recalls the late Grace Hopper in the following essay. –ed.)

SAVING GRACE

Raymond P. Schmidt, CAPT, USNR (Ret.)

Lost to History?

Grace Brewster Murray was widely known by her married name, Grace Hopper. She was once better known in the Pentagon as the oldest US Navy admiral on active duty— when Admiral Hyman G. Rickover ("Father of the nuclear submarine") retired in 1983. Her retirement at the age of 80 for a second time three years later marked the passing of an era because she was the last of the World War II WAVES to leave active service.

Almost forgotten now, however, is that Grace Hopper as a newly commissioned officer was the first programmer for the historic Mark I Calculator at Harvard beginning in June 1944. Mark I computations supported vital Navy ordnance research 24 hours a day until the end of the war. Only a few people today remember the many ways she qualified as a bona fide civilian pioneer in the new and expanding post-war field of automated data processing. Seldom remembered by anyone is that she earned professional recognition for developing the first compiler for a computer programming language. Or that she went on to transform computer programming when recalled by the Navy in 1967, and then quickly resumed work as a civilian information technology consultant the day after she retired from the Navy in 1986.

These accomplishments and her association with cryptologists have all but disappeared from the public consciousness. Indeed, even knowledgeable librarians have never heard about this "Grand Old Lady of Software" who was sometimes affectionately—but somewhat misleadingly—called "Grandma COBOL."

Keeping the Memory Alive

Historian Kathleen Broome Williams of the City University of New York has helped ensure the preservation of Hopper's vital role in the critical early years of US Navy information technology—a task for which she is ably qualified. Williams' short biography, Grace Hopper: Admiral of the Cyber Sea, was published by the Naval Institute Press of Annapolis in late 2004 as the latest volume in The Library of Naval Biography. Books in this series are intended for the general reader, accounting for a text under 200 pages and an abbreviated index. For the specialist, on the other hand, 24 pages of "Notes," nine pages listing the extensive "Bibliography," and a four-page essay suggesting "Further Reading" all lead to popular as well as hard-to-find sources on World War II, computer development, issues on science and government, and the role of women—especially scientists and mathematicians—in society and war, among other topics. These writings can sometimes be tedious; not so the life of Grace Hopper.

A Small Giant in Fields Dominated by Men

Born on 9 December 1906 into a relatively prosperous New York City family, this short (five feet, six inches tall) and slight (never weighing over 106 pounds) mature professor (well over age at 37 when finally accepted for Navy service) was appointed a rank above her classmates as a Lieutenant Junior Grade in June 1944 because she had earned a PhD. (Characteristically for that time, the commissioning certificate read: "I do hereby appoint him . . . "!)

Williams's biography relates that, during her long and active life, the remarkable Grace Murray Hopper:

- graduated from Vassar with honors and as a Phi Beta Kappa in 1928, majoring in mathematics and physics;
- taught mathematics and physics at Vassar from 1931 to 1943, initially as an assistant professor and then accepting a promotion to associate professor;
- received a fellowship enabling her to complete an MA in 1930 and a PhD in 1934 —the only woman earning the higher degree—in both those disciplines at Yale, writing her thesis in absentia, and received two prestigious Sterling Scholarships;
- won election while at Yale to Sigma Xi, the international honor society of research scientists and engineers;
- married Vincent Hopper in 1930 and helped

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him with his PhD dissertation at Columbia on medieval number symbolism—they divorced in 1945;
- typically undaunted after being turned, down pursued her quest to serve in the Navy from early 1942 until finally accepted into the WAVES in December 1943;
- wrote programs as a newly-commissioned Lieutenant Junior Grade for the IBM Automatic Sequence Controlled Calculator or Mark I—arguably the first real computer in the United States—for its demanding designer, Howard K. Aiken, at the Harvard Computation Lab during WWII;
- remained at Harvard after the war in a civilian capacity as Aiken's deputy for three years under a navy contract, and stayed in the Navy Reserve after being promoted to Lieutenant in 1946, retiring as a Commander in 1966;
- designed software for the first commercially-produced computer, the Universal Automatic Computer (UNIVAC), for the Eckert-Mauchly Computer Corporation, and continued working for Remington Rand, Sperry Rand, and UNISYS through successive corporate acquisitions from 1949 to 1967, retiring from the company at the mandatory age of 65 in 1971;
- served 19 years on active duty in the US Navy––all after the normal retirement age, starting in 1967, and was promoted twice during those two decades;
- retired as a one-star admiral after 43 of years total service, and claimed that her highest award was "the privilege and responsibility of serving very proudly in the United States Navy and of programming and operating the Mark I."
- then immediately hired on as a full-time senior consultant with Digital Equipment Corporation, a company with no mandatory retirement age, from 1986 until she died on 1 January 1992.

Williams takes care to note that these many successes never caused Grace Hopper to ask for favored treatment or moved her to support the women's liberation movement. She quotes a San Diego newspaper article that captures the essence of Grace's views: "Hopper is more worried about the computer mystique than she is the feminine mystique." Perhaps her early dedication to learning and her popularity as a professor led her instead to a lifelong commitment to youth and mentoring. Her brother observed that she had devoted her life to teaching, saying "once a teacher always a teacher." Williams agrees, saying that her lasting legacy was her students: Grace Hopper "thought her greatest accomplishment was all the young people she had taught over the years."

Concentration on Learning Languages
Opened Doors to the Future

Whatever inspired Grace Hopper, she relentlessly pursued her dream of seeing computers accepted for use in a wide variety of applications. Machine technology advanced rapidly in little over a decade after the war from using electromechanical relays to vacuum tubes to silicon chips in a bewildering array of equipments, many of them dedicated to addressing a single function, such as accounting or shipboard fire control. As author Williams makes clear, Grace Hopper was a mathematician and not an electrical engineer. Her interests remained focused on simplifying the task of programmers and standardizing software quickly wherever possible.

Perhaps part of the motivation derived from her family heritage—her great-grandfather Russell was an admiral whose name was often invoked to propel Grace and her siblings to excel. Another source may have been her curiosity at an early age to understand how things worked, even taking apart all seven alarm clocks in the house literally to see what made them tick. But most certainly one major influence was her affinity for languages:

- As a teenager, she studied Latin for one year at the Partridge private school for women in Plainfield, New Jersey in order to gain admittance in 1924 to Vassar College in Poughkeepsie, New York. She graduated four years later with majors in mathematics and physics and was elected to Phi Beta Kappa.
- This budding scientist then taught herself

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German while a master-of-arts candidate at Yale in 1928-1930 by studying both English and German versions of the same mathematics textbook.

- As a Vassar assistant professor of mathematics beginning in 1931, she sat in on two courses each semester at the Poughkeepsie women's college. Grace acknowledged that these courses provided her an understanding of the basics of subjects such as architecture, astronomy, statistical astronomy, bacteriology, biology, geology, philosophy, plant horticulture, and zoology. They also gave her the insight that each discipline has its own language and symbols, so essential to her later contributions in software development.
- Later as a teacher, she would write in German on a chalkboard with her left hand until the line reached her face, then continue writing that line in French with the chalk in her right hand, a feat somewhat replicated in 1955 when she demonstrated capabilities of the first minicompiler with instructions written in English, French, and German.
- When she joined the Eckert-Mauchly Computer Corporation in Philadelphia in 1949, her job required her to learn to program in the octal numerical system (base 8) for the BINAC (binary automatic computer). Although she mastered this new and allegedly "more efficient" means of coding, it caused her problems when she unconsciously carried the conversion over to balancing her checkbook. The resulting frustration convinced her that computers would simply have to learn the decimal system, and eventually led her to the conclusion that writing software instructions in English would be even better.
- In 1952, this meticulous mathematician wrote every instruction herself for the first "compiler," called the A-0 for initial Algebraic, thus creating what she considered "a series of specifications" that would allow a computer to arrange subroutines to form a program.

Almost Assigned to Cryptology

Graduate student Hopper studied mathematics at Yale with the distinguished professor Howard T. Engstrom, and maintained contact with him the rest of their lives. As war loomed, Vassar assistant professor Hopper eagerly studied the course in cryptanalysis the Navy had sent to college math departments. Some time in 1944, officer candidate Hopper arranged upon commissioning to work for Engstrom at Navy's OP-20-G in DC.

There—although she had no way of knowing this at the time—Commander Engstrom directed the research section that developed the "high speed" Bombe in an attempt to process messages encrypted by German M4 Enigma machines. Thus, what seemed a logical and welcome assignment for Hopper could have sent her on to a career in cryptology—the other major Navy use of computers. But her previous success at Vassar may have been the reason those anticipated orders were changed.

While an assistant professor at Vassar in 1931, Hopper taught a tough course in finite differences, learning the subject one lesson ahead of her students. During school year 1941 as an associate professor, Hopper won a Vassar faculty scholarship that allowed her to spend half her time studying the calculus of variations and differential geometry with the highly respected mathematician Richard Courant at New York University. Years later, Hopper learned that one course on finite differences and solutions to partial differential equations (PDEs) showed up in her Navy job classification record.

[A mathematician advised me that PDEs have historically been used in military applications. For example, Napoleon's scientific advisor Joseph Fourier performed such calculations which are iterative in nature to aid in cooling big guns without cracking the barrels—but you need no mathematics to understand the book or Hopper's career!]

These qualifications clearly were important to the Harvard Computation Lab. Williams concludes that they probably led to the change in Hopper's orders which sent her to work with Howard Aiken rather than Howard Engstrom.

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Amazing Grace

Williams' biography tells a story of the interaction between technology and bureaucracy but from the informed view of people involved. The diminutive former professor helped lead her companies, the Navy, and other clients and military Services into a wartime operational environment and peacetime business world no one could have predicted. Williams had prepared for this task by her two recent publications. Secret Weapon: U.S. High-frequency Direction Finding in the Battle of the Atlantic demonstrates how HFDF played a critical part in ending the U-boat threat during World War II. Improbable Warriors: Women Scientists and the U.S. Navy in World War II recounts the lives of four women with PhDs who served vital roles at the Woods Hole Oceanographic Institute, on an Applied Mathematics Panel of the National Defense Research Council, in Navy weather service organizations, and with the Harvard Computation Lab; they modestly attributed their unheralded successes to a desire simply to "do what needed to be done." To help readers understand these scientific contributions, the author describes briefly the work they did and explained what difference it made. She carried this clarity into the Grace Hopper book.

The last chapter recapitulates many contributions by the "Grand Old Lady of Software" and the recognition that followed. Williams concluded that Hopper made three "real contributions to programming languages and information processing:" She developed the first minicompiler (to operate in three languages), created FLOW-MATIC to translate English sentences into a computer-coded program, and grasped and exploited the value of the Mark I concept which separated data from procedures. Hopper became a champion of developing higher-level software languages, serving on the committee that developed COBOL or Common Business Oriented Language in 1960. "Grandma COBOL" did not invent it herself, but her name has become forever associated with the software.

Throughout the book Williams refers to Hopper's sense of humor, a gentle wit that added to her management prowess and endeared her to audiences around the Navy and the world. Some of this came out as self-deprecating thoughts that disarmed potential critics. When the Navy re-titled the Commodore rank to Rear Admiral, she called friends in Philadelphia. Keep an eye on great-grandfather Russell's grave, she cautioned. The thought of a female admiral might cause him to rise from the dead!

Nevertheless, her awards came heavy and fast: She received some thirty honorary degrees. The Data Processing Management Association selected Hopper as its first "man-of-the-year" in 1969. In 1973 Hopper was tapped as the only American to be made Distinguished Fellow of the British Computer Society and her escort to the award was the legendary Lord Louis Mountbatten. One year before her retirement, the Navy broke ground for the Grace Murray Hopper Service Center data processing facility in San Diego. Upon her retirement, the Secretary of the Navy awarded her the Defense Distinguished Service Medal. Finally, in 1991, the President presented her with the National Medal of Technology. Then, four years after she died, the Navy launched USS Hopper, an Arleigh Burke-class destroyer. Williams was correct to title her last chapter "Amazing Grace"!

A Final Note

Grace Hopper's retirement ceremony for the oldest serving admiral was held on board the oldest commissioned Navy ship, USS Constitution, in Boston. Secretary of the Navy John Lehman, who had promoted her in 1983, delivered the farewell remarks. He concluded with this humorous reference to what Grace Hopper meant to the Navy: "I am reminded of that famous story about P.T. Barnum. About the turn of the century, his principal attraction, the human cannonball, came to his showman boss and said, 'Mr. Barnum, I just can't take it any longer. Two performances a day and four on weekends are just too much. I'm quitting.' To which Barnum replied: 'You can't possibly quit! Where will I find someone else of your caliber?'"

STAMPS, ANYONE?

What does philately—the collection and study of stamps, "covers" (envelopes), post marks, and related aspects-- have to do with cryptology? Foundation member Mark Sommer, a political scientist and professor at Stevens' Institute of Technology in Hoboken, NJ, has a very special interest in that subject and wonders to what extent others in the NCMF may share that interest.

Prof. Sommer, himself a philatelist and postal historian, offers a partial answer to the rhetorical question: he is an Academic Member of the Association of Former Intelligence Officers (AFIO), the National Military Intelligence Association (NMIA), the Security Affairs Support Association (SASA), the Military Intelligence Corps Association, and the Bletchley Park Trust in England, as well as our Foundation. Given his avocation and the span of interests represented by that membership, he has become fascinated with the postal reflections of intelligence and security, world wide. One example that might be cited (as it was in the Fall 2004 issue of The Link) is the Polish commemorative stamp recalling the exploits of the three Polish cryptomathematicians who achieved the Enigma breakthrough so critical to victory in World War II. Neatly framed, one hangs on the wall of the National Cryptologic Museum. But with his keen eye, Prof. Sommer has drawn attention to other cases in which postal items be of interest to some of our readers. One example he cites is that commemorating the "The Bridge of Spies," prominent during the Cold War and the literature of that period. He writes:

On January 27, 1998, Germany issued a set of stamps picturing bridges, under the motto "Bridges Bring People Together." One of these was the Glienicke Bridge in divided Berlin.

The Glienicke Bridge was also called "The Bridge of Spies." At the northern (West Berlin) end of the bridge a sign warned "You are leaving the American sector." Under the four-power agreements dividing up Berlin, it was reserved for Soviet and Allied military traffic.

In 1962 downed U-2 pilot Francis Gary Powers walked past Soviet spy Rudolf Abe while Powers walked north across the bridge in a famous spy exchange. In 1985, 25 Western agents were traded on the bridge for four Eastern Bloc spies imprisoned in the United States.

But the most famous crossings of the bridge were dramatized in the movies. The exchanges were always conducted at night, with glowing shadows and the infamous shapes of Soviet personnel. It seemed to take forever for the Western individual to come home from the cold as the Eastern individual went south, back behind the Iron Curtain.

The fact remains that the "walks" always took several suspenseful minutes, even though these changes were almost always arranged ahead of time and were usually done in the daylight.

The original wooden bridge was part of the link between Potsdam and Berlin that Frederick William II developed into a weather resistant road in Prussia in 1795. Growing traffic made it necessary in 1834 to build a broader and more solid stone bridge. The bridge became something of a bottleneck at the beginning of the 20th Century, and it was replaced by a broader and higher structure made of steel. Officially the Bridge of Spies was supposed to be called the Kaiser Frederick Bridge, but most still call it the Glienicke Bridge.

The bridge was destroyed at the end of WW II. In 1949, as a gesture toward German unity, it was rebuilt by Brandenburg (then in East Germany) which extended halfway across the river, and it was called The Bridge of Unity. Before the Berlin Wall was constructed, the East Germans closed the bridge on May 26, 1952, with an exception for vehicles of the four occupying powers. The day after the Berlin Wall fell, the checkpoints at both ends were taken away, and thus the bridge did become a bridge of unity.

If you wish to correspond with Prof. Somer, he may be reached at:

Prof. Mark Sommer
1266 Teaneck Road
Apt. 10A
Teaneck, NJ 07666

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