Leading the Best

Carl Haussmann helped to revolutionize nuclear warhead design, build Livermore's renowned laser program, and create an environment conducive to world-class research.

SCIENTIST, manager, and self-proclaimed "meddler," Carl Haussmann made an indelible impression on generations of Livermore employees. In an age of increasing specialization and narrowing focus, Haussmann made lasting and creative contributions to a variety of programs, including weapons, lasers, and site planning. In times of constrained funding when it was difficult to see beyond the next fiscal year, Haussmann could seemingly see decades ahead. Indeed, some say his most important gift was his visionary leadership. It was with fond remembrance that Laboratory employees honored Carl Haussmann's passing last year and his 45 years of service to the nation and the institution he loved.

U.S. Army Captain Carl Haussmann arrived in 1953 as the Laboratory's second military research associate with the standard assignment to acquire in-depth exposure to nuclear weapons and other defense-related programs. Haussmann already possessed

and the Brightest

exceptional skills and experience—a solid academic background in physics; experience as a nuclear weapons supervisor at Sandia Base, New Mexico, and Killeen Base, Texas; and member of the team that helped Princeton University's John Wheeler calculate the explosive power of the first hydrogen bomb. Not surprisingly, Haussmann was assigned to the Livermore thermonuclear test program, where he quickly became, in the words of former Livermore Director Roger Batzel, "a major spark plug for the entire weapons program" (Figure 1).

By 1956, Haussmann was already in management, and Livermore had proven itself with several nuclear explosives designs successfully tested in Nevada and the Pacific (Figure 2). Subsequently, the breakthrough designs for the Polaris warhead for the first submarine-launched ballistic missile brought the Laboratory the special attention of the top managers of the Department of Defense and the Atomic Energy Commission (AEC).

The Polaris story began in 1956 at a much-publicized meeting held at Woods Hole, Massachusetts. U.S. Navy representatives told Los Alamos and Livermore weapons experts that their planned ballistic missile–launching submarines required a much smaller and lighter warhead than was currently available. Edward Teller, who represented Livermore, boldly projected that Livermore could develop small thermonuclear warheads to be carried by a solid-fueled missile.

Haussmann's group was assigned the task of fulfilling Teller's pledge to the Navy, pursuing what some had deemed impossible. Haussmann was characteristically unintimidated by the challenge. "Polaris gave us a goal and a high-priority one at that," he recalled later.

"Carl had great respect for his brilliant cohorts at the Lab," says longtime colleague Lyle Cox, "yet he believed he could add to their strengths as a leader, and he took pride in leading them" (Figure 3). Indeed, during the Polaris development effort, Haussmann demonstrated an ability to recognize and act on the big picture, says former Livermore Director John Nuckolls. Nuckolls also notes that Haussmann was a wonderful complement to top Livermore creative theoreticians because "he could turn great ideas into reality."

Livermore's teams of extraordinary thermonuclear and fission weapons experts tapped the nation's growing computer resources (see the box on p. 8) to successfully reduce the size of strategic warheads while maintaining the required explosive power. In a note to Laboratory Director Bruce Tarter, Haussmann discussed the high-profile project: "We worked our way toward Edward Teller's technical and time-scale goals, utilizing

Figure 1. Carl Haussmann quickly established himself as one of the most respected leaders in Livermore's weapons program.

Figure 2. Haussmann traveled to the Pacific for key Livermore tests. Pictured are Haussmann (fourth from the right) with visiting University of California Regents and key Livermore managers such as E. O. Lawrence (to the left of Haussmann) and Herb York (second from right), at the time Livermore's Director.

several successive FBM [Fleet Ballistic Missile] payload iterations, ever introducing better materials. The introduction of the (conceptually) penultimate design . . . did not receive instantaneous approval. I remember Harold Brown saying 'It takes more than a French curve and a compass to design a warhead.'"

The innovative Livermore design for Polaris was first validated in 1958 during Operation Hardtack in the Pacific, only a few months before nuclear testing was halted by an international moratorium. Nuckolls notes that the final design even surpassed Teller's bold promise to the Navy.

In 1960, the first Polaris submarine armed with warheads designed at Livermore took to sea, ahead of the most optimistic schedule. "Polaris was critically important to the stability of the nuclear deterrent," says Nuckolls. "Submarines could not be destroyed by a first strike; Polaris provided a secure second-strike force." The design improvements reflected in the Polaris warhead were adopted in most subsequent U.S. strategic nuclear weapons (Figure 4).

From 1962 to 1968, Haussmann served as associate director of the Laboratory's new Military Applications Program, the interface between Livermore's design and engineering divisions and the military services. "In this role, Haussmann was also extremely successful," Nuckolls says.

The early contributions of Haussmann and others at Livermore set a solid course for future Livermore weapon designs. Over the next decades, until the end of the Cold War, Livermore scientists and engineers worked to assure the nation's stockpile with increasingly sophisticated tests at the Nevada Test Site, new generations of diagnostic instruments, and computer codes running on ever-more powerful supercomputers.

Shining a Light on Lasers

Haussmann's notable tenure as a weapons program manager was matched by his enormous contributions as associate director for Laser Programs (1971 to 1975). During this period, he built up the program and provided it with strong direction (Figure 5) and top managers.

It is no exaggeration that Haussmann created the milieu within which two far-reaching decisions were made in the

Figure 3. Haussmann took great pride in managing and leading Livermore physicists, including some of the best theoretical minds. From the left are physicists Dick Adelman, Haussmann, Jim Frank, and Mel Harrison.

Figure 4. The first test of the Navy's Polaris submarine-launched missile in 1960. Livermore's breakthrough design for the Polaris warhead is largely credited with helping to discourage a Soviet first strike.

1970s: the choice of solid-state lasers for Livermore's laser fusion program and the atomic vapor method for laser separation of isotopes, particularly uranium, for use in weapons and nuclear power plants. These two options proved in the long run to be by far the most effective, both technically and economically.

Almost since the first laser flashed in 1960, Livermore had been exploring the potential of lasers, looking primarily at their application to weapons and other military uses. By the late 1960s and early 1970s, scientists in the burgeoning laser field were studying different types of lasers for producing energy from laser fusion.

In 1971, Laboratory Director Michael May asked Haussmann to take charge of the Laboratory's fragmented laser efforts. With that request, May played to Haussmann's strong suit as a visionary and "big-picture guy" who enjoyed making things happen quickly and effectively.

Haussmann moved swiftly to focus Livermore's laser work. With a few phone calls and visits to the head of the AEC's Division of Military Application, he committed Livermore to building Shiva, the first large laser fusion facility in the country. Haussmann sought out James Schlesinger, head of the powerful AEC, who agreed to support the development of lasers. Lasers were still experimental, but the scientific community and a few well-informed national leaders recognized the role that lasers could play in research germane to nuclear weapons.

Committing to a huge project such as Shiva was only part of the big picture. Livermore needed to expand its staff of laser experts if it was going to deliver on Shiva. After an audit of laser expertise around the country, Haussmann brought in John Emmett and Bill Krupke to define and run the new program. Both had already been responsible for advanced laser research, at the Naval Research Laboratory and Hughes Aircraft, respectively.

Says Nuckolls, "I'm sure Haussmann thought that one of the most important things he did was bringing in John Emmett to lead the laser program." With Haussmann's assistance, a diverse group of highly qualified newcomers was recruited, so that by 1974, some 260 personnel were working in Livermore's laser program.

According to Bill Krupke, "From the beginning, Haussmann was committed to creating an entire program, not just to building a laser. He wanted Livermore's laser effort to be all-encompassing, to include theorists, computational modelers, facility designers, testing engineers, as well as diagnostics experts. He felt that the end users of the facility should be involved in Shiva's development so that all parties would share a common commitment to its success."

Nuckolls recalls that Haussmann equated that success with achieving extremely difficult fusion goals. Haussmann brought together in one place experts from throughout the Laboratory to complement new hires for the design, development, and construction of the new laser. Having diverse disciplines "live together," a method inspired by E. O. Lawrence's multidisciplinary team approach to the management of big science projects, proved effective for getting the laser program up and running quickly and onto a very successful track.

Focusing on Shorter Wavelengths. Various types of lasers were being studied by the early 1970s for inertial confinement fusion: carbon dioxide, neodymium glass, hydrogen fluoride, and atomic iodine lasers. Basic considerations of plasma physics, coupled with Livermore computer calculations, indicated to Laboratory scientists that delivering the laser energy to the target at shorter wavelengths was extremely important.

Figure 5. Haussmann shown in the mid-1970s with a disk laser, one of the technologies for the Cyclops laser.

With this requirement in mind, in 1972 Livermore selected the neodymium-doped glass (Nd:glass) laser for its inertial confinement fusion program. The Nd:glass laser had the shortest wavelength at 1,050 nanometers (nm), the potential for frequency doubling to produce even shorter wavelengths, and by far the greatest ability to produce high peak power.

Livermore's earliest lasers for nuclear fusion experimentation, developed under Haussmann's leadership, were Janus, Cyclops, and Argus, each producing higher and higher peak power and output energy. All of these lasers operated at a 1,050-nm wavelength. But experimentation with the more powerful Shiva laser indicated that even a 1,050-nm wavelength was not short enough to produce effective implosions. So researchers at the University of Rochester developed the way to efficiently convert 1,050-nm

The Bet on Supercomputing that Paid Off

From his earliest days at Livermore, Carl Haussmann was instrumental in obtaining and applying ever-more powerful computers for nuclear weapon design efforts. Former colleagues say the source of Haussmann's confidence in computers as an essential tool was almost certainly his work with physicist John Wheeler at Princeton University. As part of Operation Matterhorn, Haussmann did thermonuclear calculations on the precommercial version of the Univac, a machine designed by famed physicist John Van Neumann.

Not surprisingly, Livermore weapons managers first assigned Haussmann to work on thermonuclear explosion calculations for early Livermore warhead designs, using the Laboratory's two card-programmed calculators. Group leader Chuck Leith found Haussmann a "quick learner and very energetic." Shortly after his arrival, Lawrence Livermore's first supercomputer, the Univac-1, was delivered, and Haussmann performed calculations using that machine as well (see figure below).

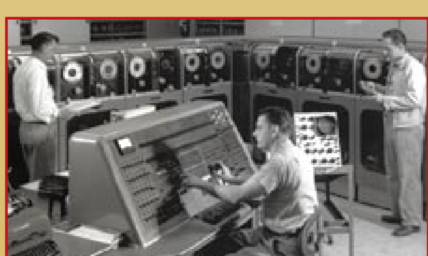
Haussmann helped to develop codes as well as use them to verify new weapon designs. Judged by today's standards, the early codes were crude, in part because they were one dimensional; Haussmann often found it necessary to extrapolate computer data with both intuition and hand calculations.

Former Laboratory Director John Nuckolls says, "Carl was a great champion of the supercomputer. We became known as the 'computer lab' in the early days." Much of that reputation can be attributed to Haussmann's conviction that the capabilities of the early machines would grow rapidly and serve as increasingly important tools for weapons designers.

"Working on the thermonuclear weapons program for the first decade, I had a need and an opportunity to vigorously support both a good stable of supercomputers and numerical modeling," Haussmann later said. "I always made sure we had the money to get the maximum quantity and quality of those computers in that era. Betting on supercomputers and supercomputer utilization has never let me down."

During the first decades, Livermore helped advance the nation's fledgling computer industry by contracting for and purchasing the most advanced machines. The computers supplied by manufacturers were often acquired early in their development and had little support software. As a result, Livermore became expert in software development, from numerical approximation algorithms to operating systems.

Even after Haussmann left the weapons program in the late 1960s, he had a strong influence on the supercomputer industry. He helped lead the development of the S-1 supercomputer for the Navy in the 1980s, a machine that incorporated several advances. An outgrowth of the program was SCALD (Structured Computer-Aided Logic Design), a graphics-based program to drastically reduce the time to design computers. The program has been used successfully by several Silicon Valley computer firms.



The Laboratory's first supercomputer, the Univac-1, arrived in 1953 and was immediately put to use performing thermonuclear explosion calculations.

output to 532- and 355-nm wavelengths, a technology adopted for Livermore's Nova laser in 1984 (Figure 6).

At about the same time that Livermore made its solid-state laser decision, the scientific community was exploring ideas for separating isotopes with lasers. Livermore focused its attention primarily on uranium and plutonium because of the relatively high cost of these isotopes and their relevance to Laboratory missions. Livermore researchers ultimately selected the atomic vapor method using a dye laser pumped by a copper vapor laser to selectively excite, photoionize, and separate isotopes of choice.

John Emmett, who succeeded Haussmann as associate director of Laser Programs in 1975, recalls, "Carl was willing to let go, but he was always there when I needed him. He was a unique person at Livermore. He was committed to creating the future and made it possible for younger people to carry the organization forward. What finer mentor could a person expect to have?"

Meddling with a License

After leaving the laser program, Haussmann was named as one of two associate directors at large, a position he likened later to having "a license to meddle." His zeal for landscaping, which made him famous as Livermore's Father of the Trees, was part of a larger vision of changing the former military base into a campuslike environment more amenable to research excellence.

According to Chuck Meier, a Livermore retiree who worked closely with Haussmann, "He said that an improved site would provide a more efficient working environment as well as give it a more aesthetic quality that would be more conducive to attracting and retaining top employees." With Director May's approval, Haussmann commissioned the landscape architecture firm of Royston, Hanamoto, Beck & Abey to develop a long-range site master plan, later known as the Royston Plan.

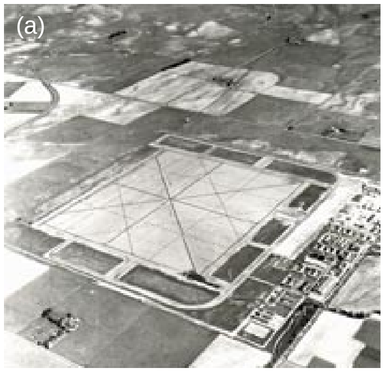
The Royston Plan provided the basis for an orderly development of the site. The plan demonstrated an understanding of Livermore's needs and wants by posing, among other questions, this rhetorical one: "Should a great laboratory continue to be controlled by a road system and flying field adapted for training aviators in World War II?"

Before the founding of the Laboratory in 1952, the site had been a ranch, then a naval air station, and then the proposed location of the Atomic Energy Commission's Materials Testing Accelerator (MTA). In the early years, groups of employees were housed close together in existing barracks and other facilities, to promote communication and unity of mission. As the Laboratory grew, new facilities were built in north–south, east–west blocks adjacent to previously developed areas. The result: dense overdevelopment along the southwest perimeter of the site and a grid design with poor traffic flow and dead-end streets, all compounded by security area barriers.

The Royston Plan replaced the grid system with a curvilinear design based on a loop road system (Figure 7). The loop roads partitioned the site into large parcels of land that were shaped differently enough to allow flexibility for future development. The roads also eliminated many intersections and provided better access to buildings while reducing driving distances.

The plan also advocated using plants and trees for aesthetics; to define spaces, such as pedestrian and bicycle paths, parking lots, and groups of buildings; and to provide shade, dust control, and protection against wind and glare. Haussmann was passionate about increasing the number of trees on site. He brought in some from his own yard, and one year, he got the California Conservation Corps to plant some three hundred trees throughout the site.

Figure 6. Carl Haussmann's dynamic leadership of Livermore's laser program gave rise to an organization that has produced a series of ever larger and more powerful lasers. (a) The one-beam Cyclops laser was built in 1975. (b) The two-beam Argus laser was completed in 1976. (c) The 20-beam Shiva laser was completed in 1977. (d) In 1984, the 10-beam Nova laser, which is 10 times more powerful than Shiva, became the world's largest and most powerful laser. Early in the next century, Nova will be replaced by the 192-beam National Ignition Facility, currently under construction.



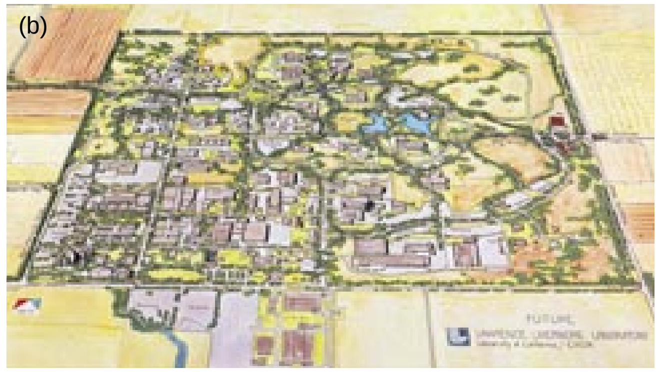


Figure 7. (a) The grid plan of the early Laboratory was a holdover from the site's days as a naval air station. (b) The Royston Plan provided flexible, basic guidelines for development. (c) This recent aerial photograph of the Laboratory reveals how the Royston Plan's curvilinear layout has produced a campuslike setting.

Former colleagues recall how Haussmann urged resource managers to "fence off" landscaping money within project budgets, because he knew that once project managers started running low on funds, the first thing they would defer would be trees. "Take that money away before they get their hands on it," he'd tell them. Today, thanks to Haussmann and the Royston Plan, employees enjoy a tree-studded, campuslike environment throughout most of the Laboratory (Figure 8).

Using Land, Buying More

The construction of the Shiva–Nova laser complex in the north-central portion of the site was consistent with the Royston Plan's recommendation of siting new facilities away from the crowded southwest corner of the Laboratory. Perhaps that move spurred other improvements as well. The new complex had carpeting on its office floors, a first for the Laboratory. Even more radical was the space planning notion successfully advocated by Haussmann and other associate directors. They wanted space designed in a way that would cause people to bump into each other; the impromptu encounters would promote communication and idea-sharing.

As the Laboratory grew, Haussmann recognized that the town around it was growing as well. In response to projections made by Livermore city planners, he realized that Laboratory capabilities and security could be compromised by new housing developments, so he urged the purchase of buffer land. He was instrumental in working with the Department of Energy and Congress to secure funds to purchase the hundreds of acres needed for a buffer zone adjoining both Lawrence Livermore and the neighboring Sandia National Laboratories. He also persuaded Laboratory management to fund landscaping of the buffer zone on the Laboratory's west side to match that of the housing development across the street.

Fostering Talent and Programs

One of Haussmann's final accomplishments was mentoring the young scientists in the Laboratory's fabled O Program, a group dedicated to advanced defense research and development. In time, this "merry band," as he referred to them, built a program funded with tens of millions of dollars a year. Haussmann's presence was felt throughout O Program, yet it was never dominating.

Edward English, who was a part of this program in the late 1970s,

Figure 8. Haussmann's love of trees led to a site shaded by approximately ten thousand trees of over 50 species.

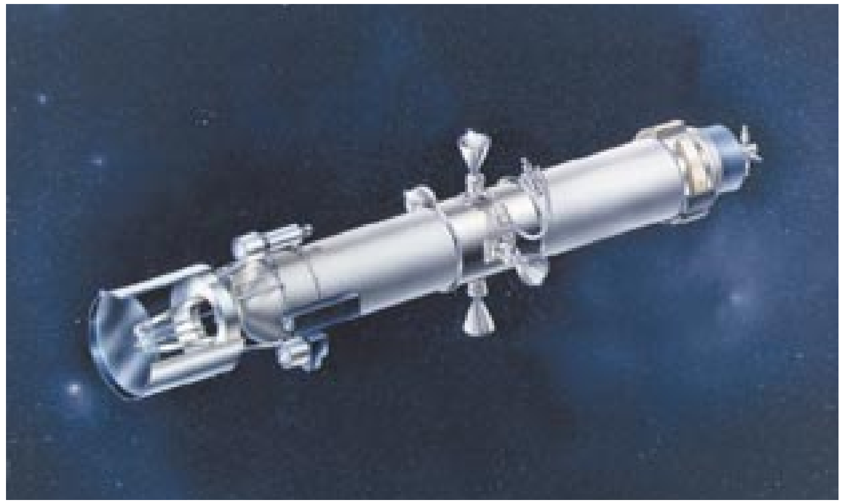


Figure 9. The "brain" of a Brilliant Pebble spacecraft was to be a high-performance computer system, its "eyes" a collection of target-tracking video cameras, and its "legs" an agile propulsion system for intercepting a ballistic missile or other target.

remembers how Haussmann saw to it that everyone was well prepared for making presentations. English says, "You were schooled in 'Viewgraph 101,' and then he would open the doors and let you walk through to make all your points to the senior military officers."

Haussmann worked with O Program researchers to develop technologies for the Defense Advanced Research Projects Agency. The results were advanced computer chips, the S-1 supercomputer for the Navy, and the beginning of projects for the fledgling Strategic Defense Initiative (SDI) organization. Haussmann also communicated with senior military officers and members of Congress to provide information needed to help build the consensus for the Brilliant Pebbles program of nonnuclear defense spacecraft (Figure 9). English remembers how Haussmann would release his nervous energy during many long meetings by tearing Styrofoam coffee cups into creative designs, even as he was helping to focus attention on important points.

After Haussmann's retirement in 1988, the spacecraft aspect of Brilliant Pebbles continued, changing course to become a major new research program. The work generated considerable national recognition for the Clementine spacecraft and continues today, with the creation of microsatellites for space exploration and defense. English says that the microsatellites are "just like Carl—compact, energetic, functional, and bound to capture the imagination."

It is easy to forget today the early role and large part Carl Haussmann played in so many Livermore programs. His contributions can still be seen, however, in the Laboratory's continuing technical successes and its commitment to the expression, encouragement, and development of new ideas in science and technology to serve the national interest.

—Arnie Heller, with Katie Walter and Gloria Wilt

Key Words: Argus laser, atomic vapor laser isotope separation (AVLIS), copper vapor lasers, Cyclops laser, diode-pumped solid-state laser, inertial confinement fusion (ICF), Janus laser, loop road system, Materials Testing Accelerator (MTA), Military Research Associates, Nd:glass (neodymium-doped glass) laser, Nevada Test Site, Nova laser, O Program, Operation Hardtack, Operation Matterhorn, Polaris, Royston Plan, S-1 supercomputer, SCALD (Structured Computer-Aided Logic Design), Shiva laser, site planning, solid-state lasers, Strategic Defense Initiative (SDI), Woods Hole, Univac.

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