Physicians for Social Responsibility - Los Angeles
Military Tour of Southern California
June 10, 2006

- Meet at UCLA | Pasadena
- Rocketdyne ~ Santa Susana Field Lab
- Jet Propulsion Lab ~ Pasadena
- North American Aviation ~ Downey
- Lunch
- Seal Beach Naval Weapons Station
- Los Angeles Air Force Base

Southern California is among the nation’s most active military regions. In fact, the US aircraft industry started in Compton, on Dominguez Mesa, on January 10-20, 1910 when the "First in America: Aviation Meet" was held. The exhibition inspired Wilhelm Boeing to start his aircraft company.

Yet few Angelenos realize the military’s considerable impact on the environment and public health. In an effort to better understand the military’s impact, the military tour will visit select sites in the LA region. We will visit Rocketdyne Lab in the Santa Susana foothills, then continue eastbound to tour Jet Propulsion Laboratory. Traveling south on the San Gabriel River Freeway, the tour will stop at the former North American Aviation plant in Downey, then onto the Seal Beach Naval Weapons Station. The tour will then turn west to visit the massive military-industrial complex south at LAX.

The Military is the #1 Polluter
The US Department of Defense is the largest polluter in the world, producing more hazardous waste than the five largest US chemical companies combined. In the US there are 27,000 toxic hot spots on 8,500 military properties. Nor does this figure take into account the notorious legacy of radioactive pollution by the Department of Energy, nor the thousands of military contractors.

One out of every ten Americans lives within ten miles of a military site that has been listed as a US EPA Superfund priority cleanup site. In the Los Angeles area, there are sixteen major military-related Superfund sites. The eastern half of the San Fernando Valley is a Superfund site, as is the entire San Gabriel Valley, as are the following sites: Edwards Air Force Base, Jet Propulsion Laboratory, El Toro Marine Corps Air Station, March Air Force Base, Barstow Marine Corps Logistics Base, George Air Force Base, Norton Air Force Base, and Camp Pendleton Marine Corps Base.

Many of LA’s military-caused contaminated sites have not been declared a Superfund due to political pressure.

Los Angeles and Nuclear Weapons
On a clear January morning in 1965, scientists at the Nevada Test Site deliberately melted down a Kiwi nuclear rocket during a Santa Ana wind condition. The wind blew a radioactive cloud three hundred miles into the LA basin until the cloud finally died over the Pacific Ocean. A few days later, increased radioactivity in routine air samples was observed in Barstow, San Bernardino, Los Angeles, and San Diego.

Between 1951 and 1992, the US and Britain conducted a minimum of 925 nuclear tests at Nevada Test Site – one hundred of which were aboveground. A small but significant number of these nuclear tests took place during Santa Ana wind conditions, blowing deadly radiation into Southern California. In a 2001 study, the Centers for Disease Control estimates “that about 11,000 extra deaths from all cancers, including leukemia, would occur at any time during the years 1951-2000 as a result of external exposure to fallout. (The predicted number of incident cases [including non-fatal cases] would be about double the number of deaths or about 22,000).” Physicians for Social Responsibility believes the number of fatal cancers from nuclear fallout to be much greater than the US government conceives.

Nuclear Weapons Deployed in Los Angeles
Most of the United States’ strategic missiles are deployed deep in America’s heartland – in Missouri and South Dakota – in order to buy time against a crippling first strike. Nevertheless, the US Army deployed nuclear-tipped air-defense rockets around Los Angeles. The Nike Missile Air Defense System was built and deployed to shoot down incoming Soviet bombers.

The Nike missiles were deployed at sites in a circular pattern around key American industrial and military locations. The first Los Angeles area Nike-Ajax battery was placed in the mountains...
above Malibu in 1954. By 1958, there were 16 Nike-Ajax launch sites around the greater Los Angeles area.

The newer, more powerful nuclear-tipped Nike-Hercules missiles replaced the Nike-Ajax from 1958–1963. The Hercules was completely powered by solid fuels, eliminating the troublesome and dangerous liquid fueling procedure of the Nike-Ajax. The Nike Hercules were installed at 9 of the original 16 sites in the LA area.

One of the problems with detonating nuclear bombs over the ocean is that the fallout would blow directly into the LA area. With the advent of ICBMs, the Nike system became obsolete. And in 1974, the Army ordered the closure of Nike batteries. In Los Angeles, remnants of the Nike sites can be found off Mulholland Highway at San Vicente Mountain Park in the Encino hills, in Newhall, and in San Pedro at Fort MacArthur.

The University of California and the Bomb

The University of California was present at the creation of nuclear weapons, sending its best scientists to head up the project, including professors J. Robert Oppenheimer, Phil Morrison, Glenn Seaborg, Robert Serber, and Owen Chamberlain.

And ever since, the University of California has managed the design and development of nearly every nuclear weapon. Operating under a contract with the Department of Energy, the University oversees two of the nation’s three bomb-building laboratories – at Los Alamos and Livermore. Again, nearly every nuclear weapon in the US arsenal was designed by a University of California employee!

From the 1940s to 1970s, UCLA operated a Laboratory of Nuclear Medicine and Radiobiology for the Atomic Energy Commission (AEC). Dr. Stafford L. Warren, the founding dean of the UCLA School of Medicine, was an AEC commissioner and was also chief of the medical section of the Manhattan Project.

Dr. Warren was a complicated man. On the one hand, Warren was acutely aware of radiation’s terrible health effects. In conjunction with the West Los Angeles Veterans Hospital, the UCLA laboratory had injected thousands of patients with radioactive material that had no medical benefit whatsoever. According to an exceptional article published in LA City Beat, "in 1967, a university experiment had 16 children shot up with radioidine to see the differences in retention between healthy and ill kids. The healthy children ranged in age from 6 months to 12 years."

Warren had also directed the establishment of survivor studies in Hiroshima, and oversaw the medical teams during the Navy’s 1946 Pacific tests. He wanted to publish studies indicating human health problems associated with radiation. Unfortunately, when the government refused to allow the publication, Dr. Warren remained obediently silent.

Environmental reporter Michael Collins also recently revealed the burial of UCLA’s extensive radiological tests in a Brentwood park.

RAND Corporation

Founded in 1946 by aviation pioneer Donald Douglas in conjunction with Army Air Force Major General Curtis LeMay, Project RAND, a contraction of the term “research and development,” was created to develop military plans and scenarios for those newfangled weapons, nuclear weapons. Originally housed at Douglas Aircraft Company in Santa Monica (at Clover Field on Ocean Park Blvd.), the company moved to downtown Santa Monica and became independent within a few years.

In the stable of brilliant RAND scientists were notable the military theorists Albert Wohlstetter, Herman Kahn, Samuel Cohen, and Bernard Brodie.

Among the most influential theorists of the post-war era, Bernard Brodie defined the strategy of nuclear deterrence. Instinctually humanitarian, Brodie believed the atomic bomb was at heart an unusable weapon, but he argued that nuclear weapons may pose a useful threat. Brodie famously said “Thus far the chief purpose of our military establishment has been to win wars. From now on its chief purpose must be to avert them. It can have almost no other useful purpose.”

Physicist Sam Cohen promoted the notion of a “clean” nuclear weapon in the 1950s, arguing that the Eisenhower Administration may safely continue testing in the atmosphere. Later, during the Vietnam War, Cohen argued that using small neutron bombs – his invention – would end the war quickly and save American lives.

Albert Wohlstetter famously revamped the Strategic Air Command, moving strategic bombers away from immediate attack. Wohlstetter also criticized nuclear arms treaties in principle as he believed treaties constrained US technological creativity. It is no surprise that Wohlstetter’s protégés include Richard Perle, Paul Wolfowitz and Condoleezza Rice (who served on RAND’s board for years).

Herman Kahn, a model for Dr. Strangelove in the movie of the same name, argued in favor of “thinking the unthinkable,” using nuclear weapons in war. Kahn argued that hundreds of millions may die or the US may “merely” lose a few cities, but life would in fact go on, as it had after the “Black Death” of the 14th century.

Defense establishment heavyweights – including Donald Rumsfeld, Frank Carlucci, Scooter Libby, Harold Brown and Zalmay Khalilzad – have held leadership positions at RAND. RAND currently maintains a mix of military and social science research. Of special note, the City of Santa Monica commissioned a mushroom cloud sculpture by Paul Conrad, “Chain Reaction,” which faces RAND Corporation headquarters.

Systems Development Corporation (SDC), an offshoot of RAND, was arguably the world’s first computer software company.
Atomic Filmmakers

Located at the top of Laurel Canyon, Lookout Mountain Air Force Station was a secret film studio producing films from 1947 to 1969 for all branches of the armed services, as well as for the Atomic Energy Commission. Although it was the principal production facility for filming atmospheric nuclear tests, only a few dozen of the thousands of films made here have been declassified.

The Santa Susana Field Laboratory

In 1945, when North American Aviation (NAA) bid on the Army Air Force's contract for surface-to-surface missiles, the Rocketdyne division was born. Working out of a small building at Mines Field, soon to become LAX, NAA poured their extensive resources into modifying the recently captured German V-2 engine.

Detonating extremely toxic and highly flammable rocket fuels at LAX became dangerous business, so in 1947 NAA hired Dieter Huzel, a German engineer trained under Wernher von Braun, to design a testing facility, as Huzel had previously designed the Pennemunde rocket testing facility for the Nazis a few short years before. A remote mountaintop in the Simi Hills was chosen. At the time the Santa Susana Field Lab overlooked orange groves and ranches and little else.

Another key facility in NAA's Los Angeles aeronautics program is the Rocketdyne De Soto plant, a plutonium-manufacturing facility devoted to producing nuclear fuel elements that has been nestled in amongst modest single-family dwellings. This site is operating today, as a piece of the Rocketdyne operations that Pratt-Whitney just recently purchased from Boeing. It is little known to the regulators, and information about its operations and history is extremely hard to obtain.

Radioactive Water

The City of Los Angeles receives 30% of its water from the Colorado River. Santa Monica receives 80%. Beverly Hills garners an even higher percentage of Colorado water. However few realize that deadly radiation – the detritus from making nuclear weapons – can be found in LA's drinking water. Three miles northwest of the city of Moab, Utah, lies the former Atlas uranium-ore processing facility. Upwards of 16 million tons of uranium tailings were stored in unlined ditches leading into the Colorado River. Over the past fifty years, thousands of curies of radiation have leached into the river, ending up in our schoolyard drinking fountains. The Bush Administration had originally sought to simply cover the mill tailings with concrete. After considerable public pressure, the Department of Energy is engaged in a decades-long plan to haul the radioactive dirt fifteen miles away. In the meantime, radiation continues to leach into the river.

Among the few nuclear tests performed near California, Operation WIGWAM was a deep underwater nuclear test in May 1955 in the Pacific Ocean approximately 300 miles west of San Diego. A single, 30-kiloton nuclear device was suspended by cable to a depth of 2,000 feet. Radioactive waste from AEC laboratories was located at Cloverfield and Colorado Blvds. in Santa Monica – now a large commercial center called Colorado Place. The company changed its name (to Paramax) and its location. It is currently owned by Lockheed Martin.

The SRE leaked hundreds of times more radiation into the environment than Three Mile Island, and the nuclear contamination in the ground and water at the site remains so dangerous that the US EPA has issued warnings against the cleanup currently being done by the Department of Energy. The City of Los Angeles, the Natural Resources Defense Council and Committee to Bridge the Gap are currently suing the Department of Energy over their lax cleanup standards for the site and the hazards the contamination poses for future generations.

The SSFL, however, was where the “exotic” fuel and nuclear work went on. In addition to becoming the testing site for all of NAA's rocket programs (which supported America's early satellite programs, the Mercury and Apollo missions, ICBM propulsion systems, the Space Shuttle Main Engine program and, currently, the Mars Mission and Delta Rocket Series), the SSFL was home to North America Aviation's Atomics International and their nuclear research and development facility, the Energy Technology and Engineering Center (ETEC).

Like RAND, SDC was a non-profit organization providing expertise for the United States military in the design, integration, and testing of large, complex, computer-controlled systems – such as the systems for NORAD and nuclear-safety protocols. SDC was located at Cloverfield and Colorado Blvds. in Santa Monica – now a large commercial center called Colorado Place. The company changed its name (to Paramax) and its location. It is currently owned by Lockheed Martin.
During its six decades of operation, the SSFL has been home to activities related to the development of lasers (which involves high levels of radiation), 'decladding' operations (recycling spent fuel from other nuclear facilities), various nuclear and combustion power experiments, and over 30,000 open-air rocket tests that vented tons of exhaust from these dangerous fuels, with no regard for the impacts on the growing communities surrounding the laboratory.

And those were just the legal activities.

In 1995, an explosion occurred at the SSFL that killed two scientists and maimed a third; investigation by the FBI disclosed that the explosion resulted from the illegal burning of chemical and nuclear waste, and Rocketdyne was given the largest fine for environmental crime in California history.

Currently Boeing is under a Grand Jury investigation for its chronic, historic violations of its NPDES Wastewater Permit, which it violates at a rate fifty times that of the average facility, and the company has just settled a huge class-action lawsuit focusing on radiation damage to surrounding populations.

Boeing purchased Rockwell International in 1996 and became the owners and operators of the various Rocketdyne (former North American Aviation) facilities.

The Santa Susana Field Laboratory is one of the most polluted places in California; the list of toxins runs into the hundreds, and includes some of the worst poisons known to man: TCDD dioxins, PCBs, perchlorate, hydrazines and benzenes, chromium, Cesium-137, trichloroethylene, and many, many more.

One of the toxins of greatest concern is TCE, or trichloroethylene. Favoring as a solvent, TCE is highly volatile and becomes gaseous very rapidly. Early concerns about TCE's toxicity were bolstered recently when the EPA noted that TCE in gaseous form is up to 65 times more toxic than previously thought. Over 500,000 gallons are estimated to have seeped into the soil at the SSFL, and regulators doubt the possibility of a full cleanup.

In the fall of 2005, a huge wildfire swept through the site, burning vegetation that had 'drawn up' contamination from the soil and groundwater into its fibers, liberating potential chemical and nuclear contamination. No government agency took any air sampling during the fire – only Boeing has the equipment necessary to detect their toxins – and no information has been given about the ten buildings that were reported by Boeing as having burned. Once again the public was put at huge risk, and the only information available is held closely by Boeing itself.

This incident points out one of the greatest worries about this site, which is the state of the data regarding the contamination on- and offsite.

Due to regulatory laws, Boeing is responsible for collecting its own samples and submitting them for tests. It has been known for years that Boeing filters all of its groundwater samples prior to testing for radiation and metals; filtering removes all sediment and the contamination that adheres to it. The USEPA has testified about the inadequacy of these tests for comprehensive assessments of contamination levels, yet Boeing continues this procedure today and the entire body of data on the site's groundwater is under question.

This questionable data is in keeping with Rocketdyne/Boeing's historic behavior regarding this site. The mind-boggling dangers to the surrounding communities created by their activities at the site occurred because of Rocketdyne's secrecy surrounding the site.

It took three decades – and probing by a UCLA student – for the news of the 1959 meltdown to become public, and twenty years of effort by the community and elected officials to conduct a public regulatory investigation and cleanup of the site. In 1989 the Interagency Workgroup – composed of the USEPA, the Department of Health Services, the Department of Toxic Substances Control, the Regional Water Quality Control Board, and community representatives including Physicians for Social Responsibility – was created to supervise the investigation and cleanup of the SSFL.

The site characterization is far from complete, and what information is available is sparse and highly questionable. In 1991, the Department of Toxic Substances Control issued a report for their Resources Conservation and Recovery Act (RCRA) Site Investigation. The report's Summary notes that 48 boxes of old Rocketdyne data could not be used because they did not properly title the facilities; of 49 "Areas of Concern," only ten were visited, and these were mere visual inspections. Leachfields from radioactive sites had been long forgotten and paved over; solid waste impoundments were dropped from inventory and memory; decades of "burns" of spent fuels and other wastes occurred, yet logs were kept for only a few years out of sixty.

Not only was the work done in secrecy – or at least marked by atrocious record-keeping – but concerns are high because the polluting agency (the Department of Energy, who ordered these nuclear tests) is in charge of its own cleanup. A glaring hole in the documentation of the site is the fact that the Department of Energy had decontaminated and decommissioned nearly all of its nuclear buildings prior to the USEPA getting involved in 1989. No satisfactory records have been provided to show radiation levels, nor that the radioactive waste was disposed of properly; in fact, Rocketdyne has been fined for disposing of low-level radioactive waste in local municipal landfills, and even "donated" radioactive trailers to local elementary schools.

Cal Tech and Jet Propulsion Laboratory

Although Cal Tech professor Richard Feynman played a notable role in the Manhattan Project – and Cal Tech professors and alumni have played major roles in developing nuclear weapons – Cal Tech's military contributions were chiefly in the area of aeronautics and rocketry.
In 1921, University of Chicago physicist Robert Millikan arrived at Pasadena’s sleepy Throop College of Technology and, with help from LA politicians, quickly transformed the school into the California Institute of Technology. Millikan served as “chairman of the executive council” from 1921 to 1945. His influence was such that the Institute was referred to as “Millikan’s School.”

In 1926 Millikan recruited the best airplane designer in the world, Austrian engineer Theodore von Kármán, who had designed the Red Baron’s fighter planes. Over the next three decades, Von Kármán trained thousands of aeronautical engineers who would later design aircraft for local manufacturers including Douglas Aircraft in Santa Monica and Long Beach; Northrop Aircraft in Glendale, Burbank, and El Segundo; Hughes Aircraft in Culver City; North American Aviation in Inglewood and Downey; and Lockheed Aircraft in Burbank. Indeed, Cal Tech served as a major economic engine for Southern California. In 1958, JPL was transferred to NASA, where its current mission of unmanned planetary exploration began.

In 1936 Jet Propulsion Lab first served as a field lab for Cal Tech engineers. Precocious graduate students and professor von Kármán began running rocket-propulsion experiments in the Arroyo Seco. The crew of graduate students, known as the “suicide squad” – including Frank Malina, Jack Parsons and Ed Forman – went on to formally found JPL to exclusively work on “black” (i.e., secret) projects. The Skunk Works began to remove perchlorate, which affects endocrine production.

In 1997, the California Institute of Technology received a ten-year multimillion-dollar contract from the Department of Energy (DOE) to perform computational modeling of nuclear explosions. Cal Tech collaborates with the nuclear laboratories to develop computer models for “virtual testing.”

Aerojet
Parsons’ success in batching perchlorate into rocket fuel offered great economic opportunity. The quartet of von Kármán, Parsons, Forman and Malina founded the Aerojet Corporation in Azusa in March 1942. They built the JATO units sold to both the Army Air Corps and Navy. Aerojet helped produce ICBMs, including the Titan and Minuteman missiles. They also delivered propulsion systems for the submarine-launched nuclear-tipped Polaris missile. In the late 1950s most of the fuel-making and rocket construction moved to Rancho Cordova in Sacramento County. Not coincidentally, the major Superfund cleanup sites in California – in Sacramento and the San Gabriel Valley – have Aerojet as a chief responsible party.

Aerojet’s field lab in the Chino Hills has been undergoing remediation for the past ten years. Depleted uranium, perchlorate and unexploded ordnance are still being removed.

It bears mentioning that two of Aerojet’s founders were purged from the organization. Jack Parsons was a very strange occultist and satanist, who became an embarrassment. He later died in a mysterious explosion. Frank Malina’s socialist ties were considered a liability during the Cold War. He died in exile in the 1980s.

Another JPL founder, Chinese-born Qian Xue-sen, with full security clearance and the rank of colonel, interrogated Nazi rocketeer Wernher von Braun in 1945 on behalf of the US military. In 1950, as McCarthyism swept the country, Xue-sen’s security clearance was revoked for no reason. He then sought to return to China but was instead placed under informal house arrest for five years. During negotiations in 1955 on the return of American prisoners of war from Korea, the Chinese made the release of Xue-sen an explicit condition. President Dwight Eisenhower personally agreed. In subsequent years, Xue-sen became the father of the Chinese missile program.

Lockheed & Skunk Works
Skunk Works is Lockheed Martin’s Advanced Development Programs for “black” (i.e., secret) projects. The Skunk Works began during World War II at Burbank Airport. The first project was the P-38 “Lightning,” the fastest fighter of WW II. In 1955 the CIA contracted with Skunk Works to build the U-2 spy plane. During the cold war the company built various manned and unmanned aircraft for the purpose of spying. The division notably built the F-117 Nighthawk, the first stealth fighter. In 1989 Lockheed relocated the Skunk Works to Air Force Plant 42 in Lancaster.

The name “Skunk Works” derives from the Al Capp comic strip Li’l Abner, which featured a backwoods still operated by Big Barnsmell, “inside man at the Skunk Works.”

While the world’s fastest aircraft, Lockheed’s SR-71, the Blackbird, is not among the many aircraft that were built at Lockheed Burbank, the rather slow-moving P-3 Orion – a plane that had the most fascinating mission during the Cold War – was. Soviet submarines would patrol off the coast of California – as well as other parts of the world. The P-3 Orion, a submarine hunter, would fly quietly above the subs waiting for an order to drop a nuclear payload and start World War III.

For decades, Lockheed built planes in Burbank, bending and degreasing metal with highly toxic solvents. This activity badly polluted the aquifers beneath the San Fernando Valley. In 1991 Lockheed Martin – and other responsible parties – were held liable for the largest share of $60 million for past and future remediation at the site.
The X-15 rocket plane that shattered the sound barrier. Mustard fighter and B-25 Mitchell bomber. NAA also produced the company made essential World War II aircraft – the P-51 Mustang fighter and B-25 Mitchell bomber. NAA also produced the P-51 Mustang fighter and B-25 Mitchell bomber. The company became known as Convair and moved to San Diego. In March 1953, Convair was acquired by General Dynamics, becoming the Convair Division of the merged company. In 1996, the Convair Division was awarded a $1.2 million contract by the government to study the possibility of the long-range missile weapon. The study was identified as Project MX-774, and it was to explore two types: a subsonic jet-engined cruise missile – essentially an unmanned airplane – and a rocket-powered supersonic ballistic missile. The three test missiles begun with the MX-774 project were later completed with some extensions of funding, but their flight attempts fizzled. The ballistic missile effort prevailed, though, and in 1951 was renamed the Atlas project. Ultimately the Atlas became the first US intercontinental ballistic missile and the workhorse of the early American space launches. In 1941 Vultee Aircraft merged with Consolidated Aircraft Corp. In 1943 the company became known as Convair and moved to San Diego. In March 1953, Convair was acquired by General Dynamics, becoming the Convair Division of the merged company. The Aerospace Corporation, headquartered in El Segundo, is the nonprofit engineering and science arm of the Los Angeles Air Force Base. Its mission, when created in 1960, was to "aid the United States Air Force in applying the full resources of modern science and technology to the problem of achieving advances in ballistic missiles and military space systems." Its status as a nonprofit - specifically as a Federally Funded Research & Development Center – allows Aerospace to act as a trusted agent of the US Government. In 1973, The Aerospace Corporation initiated and developed the Global Positioning System (GPS). Counter to popular belief, GPS was not primarily developed to guide ships across the sea or guide geographically challenged BMW drivers, but was designed to guide ballistic missiles to their targets with great accuracy. To this day Aerospace Corporation assists in numerous support functions for Air Force space and missile activities. Wyle Laboratories, though headquartered in El Segundo, is of late best known for the frightful environmental conditions at the company's field laboratory located in the City of Norco (Riverside County). Founded in 1949, Wyle engineers have worked closely with the aerospace industry, military, and other government agencies. Wyle has worked on such projects as defense systems, the Space Shuttle, nuclear power plants, communications satellites, and launch vehicles. The Hughes Aircraft Corporation bought an orange grove in northwestern Fullerton in the late 1950s and soon became the city's largest employer, building torpedoes and other submarine warfare products, and even, for a time, setting up a radiation laboratory. Hughes began winding down much of the Fullerton operation when it merged with Raytheon in the late 1990s. Raytheon sold most of the property to real estate developers, promising to clean up any toxic waste their predecessor may have left. The developer, LSF – shell corporations variously headquartered in Bermuda, Texas and Delaware – with shameful haste put in 1,250 homes and forty acres of retail shopping. Unfortunately, Hughes had made extensive use of 1,1,1 trichloroethane, a toxic solvent and industrial degreaser used in plating which degrades into the still toxic 1,1,1 dichloroethene (1,1 DCE) even when deposited into the ground. These volatile organic compounds (VOCs) are known carcinogens that, in the short term, cause liver damage and, in the long term, can cause kidney, nerve, and immune system damage and impair heart function. 1,1 DCE proves toxic to developing fetuses and, in many cases, leads to cancer.
Deep below this Raytheon property lies a giant aquifer that provides drinking water for much of Orange County. Raytheon assured city and state officials that the 1,1 DCE would never reach the aquifer. They were wrong. In the fall of 2005, the California Environmental Protection Agency found levels exceeding federal standards by as much as 750 times in monitoring wells that reach the aquifer.

The orange grove is gone. Raytheon is reduced to a small parcel of their original campus. 1,250 homes and a shopping center are there. So is 1,1 DCE in abundance.

**Boeing - Anaheim**

Boeing-Anaheim designed, developed, and produced the guidance and control systems for three generations of Minuteman ICBMs, as well as the Peacekeeper ICBMs. Today, Boeing continues to provide engineering support to deployed ICBMs. This Boeing plant also has developed the navigation systems for virtually all submarines in the modern American fleet.

Boeing-Anaheim is also a major contractor of the new Star Wars missile defense program. Boeing is working on the ground-based interceptor – a system that has consistently failed tests, but on which billions in development is spent each year.

The plant was founded in 1959 by North American Aviation in Downey. From that time on, the site grew rapidly, with employment exceeding 30,000 in peak years of production. As the plant is currently operating, pollution information remains unknown.

**Boeing - Seal Beach**

Boeing purchased Rockwell International in 1996, obtaining its Space and Communications Headquarters in Seal Beach. The site has 2,000 employees. Boeing is working on a $1 billion contract to design and build a new generation of spy satellites. Boeing-Seal Beach also oversees command and control of military GPS satellites in orbit through 2012. As the plant is currently operating, pollution information remains unknown.

**Northrop Capistrano**

Recently purchased from TRW, the Capistrano test laboratory resides directly downwind of the San Onofre Nuclear Generation Station. The laboratory is conducting basic research on a high-energy chemical laser to supposedly be used in shooting down enemy missiles from either a specially equipped 747 or a satellite. As the plant is currently operating, pollution information remains unknown.

**Military Bases**

**Seal Beach Naval Weapons Station**

Naval Weapons Station at Seal Beach began in 1944, at the height of World War II, as a Naval Ammunition and Net Depot. The base at that time had two primary missions: storage and loading of ammunition onto Pacific Fleet ships bound for the war, and servicing the anti-submarine nets used to protect fleet bases and anchorages around the world. Seal Beach was considered an ideal site due to its proximity to Navy fleets in Long Beach and San Diego.

The base is today the primary west coast ordnance storage, loading and maintenance installation. This is the only port on the west coast where cruisers, destroyers, frigates and amphibious assault ships are loaded with missiles, torpedoes, bombs, shells and bullets at the facility’s 1,000-foot-long wharf. Naval Weapons Station personnel also perform maintenance on some types of torpedoes and missiles. (Aircraft carriers, jets and submarines are loaded with weapons at other west coast locations.)

About 100 ships are loaded and unloaded here every year, either at the wharf on the edge of the base, or at sea, with weapons transported by barge and helicopter. The 5,000-acre base contains 127 earthen munitions storage magazines, all of which are in use. The base "will not confirm nor deny" the presence of nuclear and/or chemical weapons in its stockpile.

Besides the weapons depot and transfer service, the Seal Beach site now also houses facilities for doing research and testing on weapons and other lethal products. This is the Naval Surface Warfare Center – Indian Head Division. The warfare center advertises its services to potential customers on its own web site. In case you want to have some weapons tested, this is the place.

Like the Los Angeles Air Force Base, the Seal Beach Naval Weapons Station is a magnet for industries manufacturing military products of all kinds. Seal Beach is surrounded by military- and space-related activities, from private companies to federal facilities. Most of the adjacent private weapons, satellite, and aerospace facilities are owned by Boeing, which acquired the McDonnell Douglas plant when it bought that company, and another major Boeing facility. The Los Alamitos base is the only other active military site remaining in Orange County.

Seal Beach is poised at Anaheim Bay – one of the finest estuaries in California. Therefore, a fifth of the naval base has been designated a refuge. The Seal Beach National Wildlife Refuge is an approximately 920-acre salt marsh and upland habitat located entirely within the boundaries of Naval Weapons Station Seal Beach.

A document prepared by the Navy in 2002 identified over fifty toxic cleanup sites on the grounds of the Seal Beach weapons facility. Some sites had been cleaned up. However, for over a dozen sites, no cleanup had been initiated. Naval Weapons Station released gasoline and diesel fuel into a shallow unconfined aquifer. Preliminary analyses revealed that the presence of so many different compounds made biological degradation of VOCs less effective or impossible.
Los Angeles Air Force Base

Los Angeles Air Force Base, a centrally important Cold War military facility, is located near LAX. It is the only air force base to not have an air strip. Founded in 1954, the base houses the Space and Missile Systems Center (SMC). The original mission was to develop Intercontinental Ballistic Missiles (ICBMs). These included the Atlas, Thor, and Titan rockets of the 1950s, and the Minuteman series of the 1960s-2000s, which included the famous MX “Peacekeeper” missile. Other death-related technology includes early warning systems and meteorological, navigation and communications satellites to serve combat forces.

Space and Missile Systems Center is responsible for research, development, acquisition, on-orbit testing and sustaining of military space and missile systems. In addition to managing Air Force space and missile programs, SMC participates in space programs conducted by other US military services, government agencies and NATO allies. SMC is the hub of the Strategic Defense Initiative. It monitors more than 70 Space Defense Initiative (“Star Wars”) efforts and has direct management responsibility for more than half of these projects.

The LA Air Force Base was on a list of military installations scheduled to be closed early in the 21st century, until a unanimous coalition of local governments, business and state officials persuaded the federal government to keep it around.

Since manufacturing is the primary mission of the LA Air Force Base, it is closely connected with the surrounding military industries. These include Northrop Grumman, Lockheed Martin, Pratt Whitney, Boeing and The Aerospace Corporation. The base used to closely collaborate with TRW – an early designer of ICBM systems – until TRW sold off its military business to Northrop.

Edwards Air Force Base

Edwards Air Force Base is located in Kern, Los Angeles, and San Bernardino Counties, occupying approximately 800 square miles in the western portion of the Mojave Desert. The base has been in operation since 1933. It had historically served as a gunnery range, ICBM launch site and rocket-testing facility, but its primary mission today is to conduct research and development on new aircraft. This is where Chuck Yeager broke the sound barrier and wild stealth aircraft depart at night for flights over Nevada’s Area 51.

The Air Force has identified twenty-one contaminated areas at the facility. Large amounts of fuel have been spilled in the South Base area, at the western edge of Rogers Dry Lake. Organic solvents have leached into the ground. An abandoned landfill containing pesticides and heavy metals and the industrial waste pond also blight the base.

The base’s 13,800 employees obtain drinking water from wells within three miles of the contaminated South Base area.

There are three main groundwater plumes under the occupied North Base. Contaminants consist of benzene and VOCs, as well as perchlorate. A groundwater extraction system uses ion-exchange technology on a perchlorate plume. Influent perchlorate concentrations averaged 450 ppb. The state standard is (soon to be) 6 ppb.

March Air Reserve Base

March Air Force Base covers 7,123 acres next to the cities of Riverside, Moreno Valley, and Perris. Established in 1918 as the Alessandro Aviation Field, MAFB has served as a training base and refueling operations base. Famously during the Cold War, March AFB served as Strategic Air Command Base, providing refueling for B-52 bombers carrying nuclear weapons to distant targets.

In 1993, March AFB was designated for realignment by Congress and all active duty units left by April 15, 1996. The Air Force Reserve took over a portion of the Base which is now called March Air Reserve Base (ARB).

March is a Superfund site. Industrial operations (including aircraft maintenance and repair) involved use of solvents and disposal of solvent wastes that caused soil and groundwater contamination. There are a total of 44 cleanup sites on the base. Wells have been shuttered. Yet groundwater contamination has migrated to wells off base. Approximately 11,600 people obtain drinking water from municipal wells within three miles of the site.

Barstow Marine Corps Logistics Base

The Barstow Marine Corps Logistics Base site covers 5,687 acres east of Barstow, California. The site consists of three areas: the Nebo area, the Yermo area and the Rifle Range. The base was established at the Nebo location in 1942, when the US Navy transferred command to the US Marine Corps. In 1946, the Yermo area was annexed by the Marines from the US Army. The Rifle Range was acquired in 1955 and was developed as a facility for the Marines to improve their marksmanship.

The Barstow base has two major functions: providing equipment maintenance, repair, overhaul and rebuilding; and receiving, storing, maintaining, issuing and shipping materials. Consequently, the majority of wastes historically generated by the base have been vehicle-related and war surplus. Vehicle-related wastes include waste oil, grease, hydraulic fluids, fuels, battery acids, bilge waters, and antifreeze. Industrial wastes are generated by the Repair Division while maintaining, rebuilding or preserving the vehicles. These include painting, degreasing, metal parts cleaning, and preservation wastes. Some hazardous or suspected hazardous wastes were contained in war surplus materials received at the base including ammunition, various sources of low-level radiation (luminescent dials, watches, and scopes) and chemicals such as pesticides, herbicides and raw materials.

Investigations by the Marine Corps have found 38 areas of contamination on the base. Approximately 29,000 people live in the City of Barstow. About 1,300 people use on-site groundwater as a drinking water source. Groundwater is the only source for domestic, commercial and industrial water supply, as well as crop irrigation. The base is located in the central Mojave Desert.

Groundwater contains volatile organic compounds (VOCs) such as trichloroethylene (TCE) and perchloroethylene (PCE). Soil is contaminated with VOCs, pesticides, polynuclear aromatic hydrocarbons (PAHs), heavy metals, and polychlorinated biphenyls (PCBs).
Chocolate Mountains Aerial Gunnery Range

The Chocolate Mountain Aerial Gunnery Range is a 456,000-acre (about 60-square-mile) restricted area on the east side of the Salton Sea administered by the Yuma Marine Corps Air Station. It is used by the Navy and Marine Corps for aerial gunnery and bombing practice, and by the US Navy, Marines, National Guard, visiting NATO wings and various helicopter fighters. The RAF (yes, the British) is a frequent flyer, and Navy SEALs practice desert warfare tactics on the range.

On any given day the surrounding territory is subject to the din of 500- to 2000-pound bombs detonating or just dropping to the ground. A scavenger who roams the range for its high-quality salvage metal estimated that five to twenty per cent of the ordnance does not detonate, littering the landscape with live explosives. One specialty is the “900-pound, 92-inch-long (room height) cluster bomb (designed for ‘multiple kills’ and ‘soft target lethality,’ as the military puts it) … [that releases] hundreds of soda-can or hockey-puck-sized submunitions blasting outward at the speed of bullets” (Michael DiGregorio, Los Angeles Times Magazine, Dec 11, 2005). In other words, thousands of tons of live ammunition, spilled fuels, toxic metals and other poisonous materials are scattered about the 60 square miles comprising the practice range.

A sizable portion of the military range is part of the habitat for the endangered desert tortoise and many other at-risk desert species. The US Bureau of Land Management sought restrictions on vehicle access to this critical area. The Navy also indicates that groundwater as far as 100 feet below the surface may be poisoned.

Clean-up: When?

A 2003 GAO report on the clean-up of FORMER military sites – including sites that had been developed for years with shopping centers, housing subdivisions, schools, and so forth, as well as sites that were scheduled to be decommissioned from military use – found that the Department of Defense had, basically, no organized plan to deal with leftover toxics on sites DOD was abandoning.

According to the report, at an annual funding level of approximately $106 million per year, cleanup at the remaining munitions sites in DOD’s current inventory could take from 75 to 330 years to complete. Delays in the availability of anticipated funding from hazardous, toxic, and radioactive waste sites could greatly impair DOD’s ability to clean up its sites.

The report goes on to note that one reason the military services are having a hard time cleaning up after themselves is that they do not know where all their trash is. The Air Force, for instance, had no inventory of its abandoned munitions.

UXO Means Unexploded Ordnance

It’s interesting to consider how the military thinks about cleaning up its mess. Let’s take unexploded ordnance for one example.

The army favors a one-pass sweep with metal detectors, followed by excavation to a depth of one, two or four feet. By contrast, California officials mandate incremental passes with metal detectors followed by removal and sifting of all soil to a depth of four feet.

A 2005 study estimated the cost to clean up a single 7,000-acre site as follows:

- Army preferred method: $35 million
- State preferred method: $1.1 billion (billion with a "b")

That billion-dollar figure really stands out when you consider that the total budget available in 2004 to clean up all contaminated Army sites was $57 million.

Old military sites are being discovered all the time. Months ago, a gunnery range – 1,800 acres – was found in the heart of Orange, near the communities of Rancho Santa Margarita and O’Neill Regional Park. From 1944-1956, the Marines ran hundreds of sorties over the area, dropping tens of thousands of practice bombs. Today signs warn: “Possible unexploded ordnance (UXO) or practice bombs may be present in this area. DO NOT TOUCH!!!”

Lead Pollution

Lead is a common, naturally occurring element that has been used for thousands of years. Its density and malleability made it an ideal material for the two technological innovations that supported European domination of the globe for several hundred years: moveable type and bullets. In the latter manifestation lead is ubiquitous on military facilities.

The Department of Defense reported in its 2001 toxics report that it “relies heavily on lead for use in munitions” and that it disposes of extra armament by burning it!
At Point San Vicente, part of a former federal installation was turned over to the California National Guard after WW II. The guard disassembled the target range at the edge of the cliff by bulldozing the earthen berm. In 1999-2000 preparations for a native plant garden and nature center became stalled when toxic amounts of lead were discovered; the primary danger was run-off from the garden into the ocean. The building of the interpretive center was delayed for six years as federal, state and city authorities negotiated who was responsible for cleanup. Eventually, lead was removed from soil to be used in the garden and pathways; the remainder of the contaminated area was built on or paved over.

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**Mines – Our Own Business**

In November, Human Rights Watch posted a report on US production of anti-personnel mines:

The United States has not banned or placed a moratorium on the production of antipersonnel mines. The stockpile cap announced on January 17, 1997 does not preclude the production of new antipersonnel mines to replace those used in future combat operations.

In April 2000, Human Rights Watch wrote to twenty-seven companies who were past producers of antipersonnel landmines. These companies had refused to join nineteen other US companies who were past producers of antipersonnel landmines in renouncing future involvement in mine production.

El Toro Marine Corps Air Station

The El Toro Marine Corps Air Station covers approximately 4,700 acres. Commissioned in 1943, it supported the Fleet Marine Forces in the Pacific Ocean, serving as the major west coast jet fighter facility. The Station was decommissioned as an active base in 1999 under the Base Realignment and Closure Act. In early 2005, the Department of the Navy sold the land at the Marine Base, which covered six square miles, through an auction process. The winning bidder for the entire property was nationally respected land developer, Lennar. Later in 2005, Lennar signed a development agreement with the City of Irvine that transferred 1,316 acres of land back to public ownership for a park.

The City of Irvine has announced the building of the “Great Park.” In January 2006, Ken Smith Landscape Architecture of New York was chosen to design the park. A canyon will join the Agua Chinon with a lake and an amphitheater that faces east across this lake. The design will retain the old runway with fighter planes stationed along its entire length as a monument to the base’s military history.

Twenty-five potentially contaminated areas were identified on the Air Station, including four landfill sites suspected of containing both hazardous and solid waste, and other areas where polychlorinated biphenyls (PCBs), battery acids, leaded fuels, and other hazardous substances could have been dumped or spilled. A Remedial Investigation conducted by El Toro identified volatile organic compounds (VOCs), primarily trichloroethene (TCE), in groundwater that migrated more than three miles off base. Recent evidence shows that the TCE plumes may be nearer to the surface, and thus more dangerous than previously supposed.

Surface water flows into the Upper Newport Bay Ecological Reserve, eight miles from the base, and the reserve is potentially threatened.

San Clemente Island

On a clear day, looking south from the Laguna Hills, you can see San Clemente Island, the southernmost of the Channel Islands, seventy miles off the coast.

US Navy Station San Clemente has been owned and operated by the Navy since 1934. More than a dozen range and operational areas are clustered within a 60 mile radius of the island.

The island has 58.5 miles of coastline. There are piers, roads, structures, and military activities (including the use of ordnance and an airfield), all of which contribute to the discharges into the water quality protection area, which is also the drainage for 100 natural gullies and ephemeral streams. There are 23 direct discharges into the protection area, including industrial storm drains, runoff from roads, and pier and marine landing facilities. A large area in the southern part of the island is used for military operations including explosion of ordnance, which causes erosion and resulting sedimentation into the coastal portion.

Point Mugu and Port Hueneme Naval Bases

The Construction Battalion Center at Port Hueneme was first built as a temporary depot in the early days of World War II. The base was originally established to train, stage, and supply the newly created Seabees - the construction arm of the Navy. The Port Hueneme base was officially established and began operating May 18, 1942 as the Advance Base Depot. In 1945 the Advance Base Depot was renamed the Naval Construction Battalion Center. For example, in the Korean and Vietnam wars, almost all of the Navy construction equipment and supplies for the wars were routed through the base.

Best known as the place President Reagan touched down when visiting the western White House, Point Mugu began in 1941 as...
a training area for the Seabees. In 1946 the site was converted to a test center for Navy missiles. In the 1970s and 1980s errant cruise missiles would crash in the neighboring Santa Barbara Mountains.

In 1998, the two bases began to be reorganized into one, with a change in mission. In 1998 the early-warning planes, E-2C Hawkeyes, were transferred to the base. Naval reserve operates Hercules transport aircraft from the base as well.

More than seventy military commands are located at the Ventura bases. These missions include combat and weapon systems testing on the 36,000-square-mile Sea Range off the coast of Point Mugu. Four Seabee battalions, Underwater Construction Team TWO of the Third Naval Construction Brigade, and Naval Construction Training Center (Seabee College) are homeported at Port Hueneme. The Navy’s combat skilled construction force serves around the world in support of military construction requirements.

A large diorama outside Pt. Mugu’s gates displays the nuclear-tipped Polaris missile.

The place names are Native American in origin. Hueneme comes from the Chumash word for “resting place” as Huene- me is the closest spit of mainland to the Channel Islands. The Chumash would row their canoes between this area and the islands. Mugu is the Chumash word for beach - and the beaches are magnificent. Little is known about the two base’s environmental performance.

**Plant 42**

United States Air Force Plant 42 is a federally-owned military aerospace facility in Palmdale, California where aerospace contractors share a common runway complex. The plant is over-seen by Air Force personnel out of Edwards AFB – a short 37 miles away. Most of the United States’ most advanced aircraft have been built.

Lockheed-Martin’s “Skunk Works” is a tenant. Here, Northrop Grumman assembles the B-2 Stealth bomber. Boeing has buildings on site. Plant 42 currently has an employment level of around 6,400 and has a combined annual payroll of over $320 million.

Plant 42’s two runways may one day be home to the Palmdale International Airport as envisioned by LA planners. In 1989, Los Angeles World Airports (LAWA), a department of the City of Los Angeles, and the U. S. Air Force came to an agreement concerning use of the Plant 42 complex’s facilities and land for commercial use. The agreement allows a maximum of 400 flights per day. This civilian terminal is unused today.

The Blackbird Airpark displays some locally built planes including the Lockheed SR-71A Blackbird. The park is open Friday through Sunday. Admission is free.

**Norton Air Force Base**

The 2,165-acre now-shuttered Norton Air Force Base site outside Redlands began operations in 1942 and served as a major overhaul center for jet engines and the general repair of aircraft. The site had the responsibility of providing maintenance and logistics for nuclear-tipped ICBMs. For a short period, Norton also administered ICBM development, and housed DOD’s massive collection of film and photography archives.

Located adjacent to the Santa Ana River – source of drinking water for millions of people in Orange County – Norton AFB remains badly polluted. The Air Force had dumped directly in the soil or buried drums of oils, solvents, polychlorinated biphenyls (PCBs), acids, and paint residues into landfills and unlined pits and ponds. Toxic contaminants had leaked out of underground tanks. The areas of contamination on the base include two landfills, six discharge areas, four chemical pits, a fire training area, a fuel spill area, a PCB spill area, a chemical spill area, two waste storage areas, and an underground storage tank area.

The base is undergoing a lengthy cleanup and San Bernardino officials hope to convert the site to private use.

**Raytheon Space and Airborne Systems**

In 1997 Raytheon purchased Hughes Aircraft. Headquartered in El Segundo, Raytheon’s Space and Airborne Systems has 9,300 employees.

Raytheon is the nation’s major contractor in missile defense. Specifically, they are working on ground-based interceptors, the Exoatmospheric Kill Vehicle, Space Based Infrared System (SBIRS) Low, the Airborne Laser’s Track Illuminator Laser, the Ground-Based Radar Prototype, X-Band Radar, Upgraded Early Warning Radar and the PAVE PAWS Early Warning Radar for the Ground-based Midcourse Defense Segment. The company also supports Sea-based Midcourse and Terminal Defense, provides the Ground-Based Radar element for the Theater High-altitude Area Defense program, and its Patriot systems continue to be mainstays for theater ballistic missile defense. Raytheon is the prime contractor and integrator for the PAC-3 system and continues to provide the Patriot Air and Missile Defense System for many U.S. and Allied forces. As the El Segundo facilities are still in-service there has been comprehensive characterization of pollution at the site.

**Northrop Grumman**

Northrop Grumman Corporation is one of two Fortune 100 companies (67th on the list) with headquarters in Los Angeles County; the other is the Walt Disney Company. (Northrop’s corporate address is 1840 Century Park East in Century City). The company has more than 125,000 employees and operates in all 50 states and 25 countries.

Jack Northrop started locally working for Lockheed and Douglas. After a failed attempt at starting an aircraft company with his brother Donald Douglas, in 1937, Northrop returned to the South Bay in 1939 to found “The Northrop Corporation,” which lasted until 1994 – when the company merged with Grumman Aircraft.

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Northrop bought the San Pedro-based company Logicon in 1997. Founded in 1961, the company’s name is a derivation of two words, logic and controls, and represented their plan to apply computer technology to weapon systems. The company won its first competitive contract award in 1963, capturing the ICBM Advanced Targeting Study for the Air Force. In the 1980s, Logicon wrote software for President Reagan’s Star Wars program, software for testing nuclear weapons, and the guidance system software for the MX and other ICBMs.

In 2000, Northrop sold off the Hawthorne airport manufacturing facility to Vought Aircraft, which builds parts for 747s. The sale represented the company’s last manufacturing facility and was promptly followed by layoffs of several years. Cal/EPA entered into complex negotiations so that Lowe Enterprises Real Estate Group could develop parts of the El Segundo site.

Over the decades Northrop has specialized in jet fighters and trainers. At Plant 42 in Palmdale, Northrop builds the B-2 Stealth bomber. It is currently working on a program called “Cyber Warfare Integration Network,” the aims of which are unclear.

Northrop Grumman currently retains two major divisions headquartered in Los Angeles: Northrop Grumman Integrated Systems in El Segundo and Northrop Grumman Space Technology (the latter purchased from TRW in 2002 for $7.8 billion).

Space Systems works on the missile defense projects such as the space laser and airborne laser (tested at the Capistrano Test Site), as well as satellites connected to NORAD’s warning system. These satellites use infrared detectors to detect heat surging from the tails of ballistic missiles and then report the information to NORAD. The satellites can also detect nuclear bomb detonations.

This guide has been prepared by Daniel Brown, Elizabeth Crawford, Helen Jaskoski, Gilbert Kim, Jonathan Parfrey, Robin Podolsky, and Sharmeen Premjee. Map illustration by Morgan Amanda Parfrey. Design: Jon Hofferman/Carissimi Publications

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The gifted writer Robin Podolsky spent years “on the line” at Lockheed’s manufacturing plant in Burbank. She eloquently describes the environment among Lockheed’s workers in these two essays.

SPIDER
by Robin Podolsky

We called him Spider because he was all bumpy arms and legs. A tall stringy man, he worked his lean muscles into knots.

Spider was a full machinist at the company and still in his thirties. That marked him as an unusual guy. Hardy anybody made machinist that young. To get there you had to start as a trainee; then become a B Operator, A Operator and Machinist all in one particular specialty--lathes, mills or drills--and then you could be promoted to General Machinist if somebody quit, got fired or died, making a place for you. The alternative was to serve a four year apprenticeship at trainee wages.

Spider had built his seniority the hard way. He’d hired in as a teenager and worked his way up. He could retire with full benefits before he was fifty.

And Spider was a black Machinist. That was his most striking distinction. Few black men made machinist at the company; I never met a black woman who did. The affirmative action generation was too new to have climbed that high. In Spider’s youth, trainee jobs in the machine shop were white property.

It seemed to take long for black men to get promoted too. One of the long-term black employees in the machine shop was a B Operator for six years before he got his A. Most people made A in a year. The company said that he didn’t have experience on enough machines to be promoted. They didn’t move him around to different machines either. They kept him on the “drip mill,” the dirtiest, heaviest, simplest machine of all. He was good at it, they said. A workhorse.

One day, our leadman brought Spider over to my machine and told me to teach him the job I was running. That was odd.

The girl’s job. Operators, not Machinists like Spider. But then, I wasn’t an Aeither, only a lowly B. What the job had actually become--being a ceaseless repetition of excruciatingly detailed operations that had to be performed just right--was ‘the girl’s job.’

I looked forward to teaching Spider my job, because I thought I’d have someone on the machine to hang out with for a while. It had taken me a week and a half to learn that