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Gerald E. Miller

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DEPARTMENT OF DEFENSE TECHNOLOGY TRANSFER
CIVILIAN USES OF MILITARY KNOW HOW

Gerald E. Miller

President Nixon, in his March 16, 1972 Message to Congress, challenged the nation to harness science and technology to strengthen our economy and improve the quality of life in the U. S. A portion of his statement addressed the issue of using federal R & D laboratories to assist in solving local and state problems.

In June of the same year, over 200 leaders from all levels of government, industry and academia met in Harrisburg, Pennsylvania for the National Conference on Inter-governmental Science and Technology Policy. The goal of the Conference was to identify actions essential for effective use of public and private science and technological resources to aid harried state and local officials in providing services at an acceptable level of cost. One of the principal resolutions passed by the Conference called for the use of federal laboratories to solve local problems. This Conference was the forerunner of numerous subsequent studies by such agencies as OMB and NSF, plus numerous articles, all calling for the application of federal technology toward the solution of civilian problems.

In March of 1977, President Carter wrote a memorandum to all Cabinet Heads asking that they place special interests on involving state and local government inputs in their departments' operation. Reflecting the administration's concern, several high level governmental committees have recently been formed to see how science and technology can be used to solve local problems.

But an organized, although informal, attempt to provide federal technological assistance to cities and states had started long before Carter's memorandum, or even Nixon's message. In July of 1971, eleven Department of Defense (DOD) labs joined together in an informal consortium to do that very thing. Each lab appointed a technology transfer representative and pledged its cooperation with the others in seeking civilian uses of the technology originally created for military purposes. There was no DOD policy, congressional mandate or executive order which directed that this occur. Rather a handful of dedicated and far-sighted federal scientists, believing in the concept, and willing to accept the collateral duties of

technology representative, provided the impetus for the Consortium.

From its original eleven members the DOD group expanded to almost 40 labs by 1974 at which time membership was opened to all the federal agencies. Today the more than 100-member Federal Laboratory Consortium for Technology Transfer includes R & D centers from such federal agencies as Commerce, Transportation, Justice, Interior, Energy, Agriculture, NASA and Defense.

The Consortium is still an informal organization, bound together only by the common belief in the concept of technology sharing from the feds to local government and private industry. This report describes some examples of how the DOD labs of this Consortium have converted their military know how to civilian uses.

ELECTRO-OPTICAL EQUIPMENT

Locating enemy soldiers and equipment at night was a difficult problem for the American soldier until the U. S. Army Night Vision Laboratory was established and charged with the development of electro optical night vision devices for ground use, vehicles, missiles, armor and aircraft. Their R & D programs involve research in the fields of near infrared, image intensification, thermal imaging, new light sources, and lasers. But this highly important military technology has found numerous civilian uses as well including:

- assisting the Treasury Department in conducting narcotic raids on the Arizona-Mexico border resulting in the seizure of \$19,000,000 worth of narcotics in one year alone;
- restoring the vision of patients suffering in the early stages of night blindness (retinitis pigmentosa);
- detecting loose and dangerous rock before it collapses in a mineral mine, a problem which currently kills 200 miners a year;
- providing night vision goggles to state and federal forestry helicopter pilots

so that forest fire fighters can now receive airborne assistance day and night;

- providing night vision devices to zoologists and fish and wildlife researchers on projects such as alligator poaching prevention in Florida, the study of gorilla and chimpanzee behavior in Africa, deer migration in Pennsylvania and fish poaching in Ohio;
- utilizing a 30 kw searchlight, so powerful that it illuminates a square mile eight times brighter than moonlight, to light the scene of rescue operations at a high rise apartment building collapse in Virginia;
- assisting the San Diego, California police department in detecting illegal aliens who enter the U. S. to rob, rape and murder other aliens.

BODY ARMOR

Recent developments in soft body armor now make it attractive for daily use by police officers. As a result, literally thousands of law enforcement personnel around the U. S. wear the armor throughout their work shift, considering it now as just another piece of their uniform. And it works, with at least 35 policemen alive today who would not be had it not been for the protection their armor provided.

But it hasn't always been this way, for the research and development required to produce a lightweight, comfortable and effective body armor is relatively new. In 1972 the Law Enforcement Assistance Administration (LEAA) decided to institute an R & D program with the eventual goal of developing body armor which would stop bullets fired by most handguns, be resistive to knife attacks, be inconspicuous when worn and yet be comfortable enough so it could be worn for a full eight hours. This was a quantum leap beyond the armor available at that time and required extensive knowledge of ballistic materials; user needs in terms of wear, maintenance and comfort; testing methodologies and, of course, the specialized equipment necessary for such an R & D effort.

LEAA found all of these at the U. S. Army's Edgewood Arsenal in Edgewood, Maryland and the U. S. Army's Natick Development Center at Natick, Massachusetts. Edgewood's role was principally in the selection and testing of the various ballistic materials, while Natick concentrated on defining the manufacturing and comfort requirements. From these two labs evolved body armor made from a commercially available aramid fiber called Kevlar 29. Based on the

Army's recommendations, LEAA acquired 3,000 sets of this armor and distributed them to 16 municipal police departments in the U. S. for evaluation. During this test period, at least three officers avoided serious injury or death when they were shot or knifed while wearing the armor.

There is now a viable soft body armor industry in the U. S. and many law enforcement agencies are purchasing armor for all their personnel. And once again, the U. S. Army is assisting. As an example, San Diego, California police department recently purchased 850 armor vests for its men and women patrol officers. The specifications for purchase were prepared with the assistance of the Edgewood lab. Natick is actually writing complete specifications for police departments who do not have the expertise to do so themselves. As an additional assistance, the labs joined in preparing a document entitled "Lightweight Body Armor for Law Enforcement Officers" which is available to any law enforcement agency.

Thus, because of their past experience and expertise in armor research for the military, two Army labs were able to answer a pressing need of the civilian law enforcement community. But beyond the initial solution, these labs are, to this very day, continuing to offer advice and technical assistance to police departments all over the U. S. who are seeking to acquire the best armor at an economical price.

WEATHER MODIFICATION

In January 1976 the Oregon Legislature opened its biennium session, faced with an obvious winter drought which eventually lasted all year. Early in the session, several bills were introduced in the House of Representatives to permit the state to launch an immediate weather modification (i.e. cloud seeding) program. Two of the legislators pushing this action contacted the State's Technology Transfer Office with an initially simple request. Who in the U. S. could they talk to about the pros and cons of cloud seeding. But then some added dimensions were included. They would prefer to talk with someone not in the commercial cloud seeding business (thus preventing any bias in the advice they might receive which could come from a party who would benefit from such a project), and two, they wanted someone who had actual seeding experience.

All of these requirements were embodied in two scientists working for the Naval Weapons Center (NWC) at China Lake,

California. For over 17 years these men had been involved in cloud seeding research and operations for military purposes. One call to NWC's Technology Transfer Office and the two men, and their cloud seeding equipped aircraft were winging their way to Oregon. The scientists met with numerous House and Senate members, sat on the House floor during debates to answer technical questions and flew two seeding demonstration flights for the press and legislators. As a result, the House passed the bill and sent it to the Senate for vote, where it was defeated. The issue was subsequently raised again this fall but the return of what appeared to be a normal wet winter dampened enthusiasm for the program and it died in committee.

Now, this example could be interpreted as a failure since the military know how failed to positively effect a civilian problem. But I would contend that this is not the case. Rather it highlights a lesson that those in the DOD labs must learn. The ultimate use of any DOD furnished technological assistance at the local level usually depends on a blend of administrative, social, economic and political factors. In this case political infighting prevented the cloud seeding program from becoming a reality. But at least the decision makers had the best technical knowledge at their disposal so the bill was not defeated because of lack of technical information.

EYE TEST

Determining visual deficiencies in humans has always been a tedious process dependent upon a judgment and some sort of response from the person being tested. But this is no longer necessary because of an important breakthrough in optometrics at the Naval Ocean Systems Center in San Diego, California.

Several years ago, two experimental psychologists were working on pattern recognition studies of Navy flyers as a basis for designing new cockpit displays for Navy aircraft. While seeking an objective method of measuring what the pilots saw, they discovered that the brain creates electrical impulses in response to visual stimuli. In other words, when you see an object, an electrical signal is produced by the brain. Further, the signals intensity and shape is directly correlated to how well you see that object. By tapping that signal through non-invasive electrodes attached to the scalp, and processing the signals with a computer, the psychologists could exactly determine: 1) whether a person

was near or far sighted, and 2) the relative strength of the various parts of the visual system. This was a phenomenal discovery for now a complete eye examination could be given, even to prescribing eyeglasses, and the only thing the examinee had to do was keep his eyes open. Now, for the first time, infants, mental retardards and those not familiar with the letters on the eye charts, as well as the general population, could get a thorough and quick visual examination.

This technique was patented by the Navy scientists and widely written up in professional journals. As a result, it is now used in eye clinics and doctors offices all over the world. In San Diego, the Navy has joined forces with the Children's Hospital and the local medical school to equip and operate a visual and auditory testing lab in the hospital. This testing facility is both an operational and a research lab where daily testing and new research is combined to seek even more knowledge about how we see and hear.

HYDRAULIC FLUIDS AND OILS

The City of Little Rock, Arkansas receives about 50 inches of rain a year, most of it during the summer season when the parks and golf courses require maximum maintenance. The grass mowing machines used by the parks department possessed mowing reels that were driven by the ground wheels of the mowers. While this type of drive requires a minimum of maintenance, extreme difficulty was being experienced in mowing operations during wet weather because the wheels slipped on the wet grass. The solution appeared to be the construction of a mower whose reels were powered by hydraulic motors but the parks personnel were concerned about the effectiveness and maintainability of the hydraulic units.

The city's Science Advisor turned to other cities for assistance but also contacted the DOD labs since he was a retired military officer. The Lubricants and Tribology Laboratory at the Wright-Patterson Air Force Base in Ohio was able to provide considerable assistance on problems associated with the selection of the hydraulic fluids best suited for the operating environment of Arkansas. In addition suggestions were provided on specific design issues such as the mounting location of the hydraulic reservoirs.

In a separate case this same laboratory offered their expertise in identifying the type of commercial oil used in a

a suspected arson case involving the burning of commercial trucks in eastern Oregon. Here the technology needed was the ability to separate one oil from another and then identify what brand of oil was contained in some burnt residue obtained from one of the vehicles. In both cases the technology existed within the military at DOD expenses, but could be shared at no cost to the local governments because of Wright-Patterson's participation in the Federal Laboratory Consortium.

THERMOGRAPHY

Last year the Naval Air Development Center in Warminster, Pennsylvania received a request from the Mayor's Science Advisor in Philadelphia to assist the city in conducting an aerial infrared scan of some of the city buildings and row houses to obtain an indication of the comparative heat losses of these buildings. A Navy developed and owned IR scanner was mounted in a NASA C-54 aircraft from Wallops Island, Virginia and a swath 10 miles long was flown over the city which included downtown buildings as well as row houses on the outer edge of the city. This demonstration flight clearly showed the technical feasibility of using IR photos to detect sources of heat losses from both types of structures. Subsequently, the Pennsylvania League of Cities has requested that similar flights be conducted over smaller cities in the state where the local utilities could use the photos to show individual home owners which houses should add additional insulation.

To this point, one cannot point to any modification of homes or buildings as a result of this technological assistance and so it can be only hoped that concrete action will be forthcoming by cities and home owners. But a serendipitous discovery made during this Philadelphia fly-over has had immediate payoff to the fire department.

The city has suffered through two recent refinery and tank farm fires, one which claimed seven lives. One major obstacle faced by the fire department during these fires was to accurately establish how much fuel these tanks contained. In one case the fire personnel ended up shooting holes in the tank until they found the fluid level. While viewing the IR pictures taken by the NASA/NAVY fly-over project it was found that the liquid in the tanks was clearly and accurately discernable. The Philadelphia Fire Department already possessed some hand held IR sensors (which, by the way, were a commercial version of an original military piece of hardware) but had never

considered that they could be used to establish liquid levels in the oil and gas tanks. Demonstrations were subsequently held with the hand operated IR units in the tank farms and it was verified that they would clearly show the liquid level. As a result, the Philadelphia Fire Department now has a new and powerful tool to assist them in any future refinery or tank farm fire.

In the preceding pages I have identified an informal, but organized, attempt by federal R & D labs to transfer their federally funded and directed research results to solve problems facing local and state governments. Within the framework of the Federal Laboratory Consortium, the DOD R & D Centers, for six years now, have been actively seeking secondary uses of their military technology, and specific examples of this transfer have been provided. Literally hundreds more could be provided, with the range and type of assistance provided spanning the spectrum of military R & D capability including:

- termite resistant fabric paper sandbags for flood control in Mississippi
- inexpensive sickle cell screening device for use in San Diego
- cheaper method of snow and ice removal for cities in New England
- a computerized asset management system for the New York Police Department
- a method for calculating pressures on steel culverts buried under deep road fills in California
- equipment for determining optimum procedures for removing asbestos fibers from Lake Superior for Duluth, Minnesota
- providing technical advice for selection of burglar alarms for tribal buildings on Indian reservation in Oregon.

But for many of the Consortium members, and especially the DOD labs, this technology transfer effort has been marked by many obstacles and frustrations. For in spite of all the rhetoric and promises, in spite of all the positive support provided by the OMB and outside evaluations and in spite of all the pleas from local officials, the federal laboratory technology transfer effort is still a voluntary, do it if, how and when we can kind of program. There is still no national policy directing the federal agencies to participate. And within the DOD there are no committed funds, manpower or positive reinforcement provided to any lab for assisting local government.

Nevertheless, I am completely convinced that the DOD technology transfer program is strong, and will continue to expand in the future, principally through the insistence of the user communities. There is a rapidly growing awareness by state and local officials of the potential for assistance from federal laboratories. This is due to several factors.

1. Several DOD labs have held technology transfer field days in which local officials are invited to visit the lab to see what that, and other DOD labs, can offer. Such workshops have been held in New England, Florida, California, and Pennsylvania. And in May of 1977, the Federal Laboratory Consortium held its spring meeting in Portland, Oregon, where over 400 representatives from city, county, state, university and private companies in the three-state northwest region met with the federal scientists to see how federal technology could help their organizations.
2. There is a growing proliferation of science advisory positions being created at city and state levels throughout the U. S. Individually and collectively, cities and states are creating specific positions for scientific or technically oriented individuals whose full time job is to look for new technologies to solve local problems. Many of these "advisors" are being drawn from DOD R & D labs and thus bring with them the knowledge of the potential assistance available from the military technology.
3. The National Science Foundation, principal funder of all local and state government science and technology programs, has taken a strong lead in supporting and pushing the Federal Laboratory Consortium as a source of technical assistance for local and state governments. As an example, in the new nationwide program for assistance to small cities (less than 50,000 population), seven DOD scientists will be "loaned" to NSF and each assigned to assist four of these cities on a roving advisor basis. This kind of exposure will definitely increase the requests for help to the DOD labs. In addition, a scientist from the Federal Lab Consortium is assigned full time to NSF and is continually contacting potential users in the U. S. to make them aware of the assistance available from the DOD labs.

4. There is a continuing, albeit slow, buildup of interest within the federal agencies for a more formal, funded and recognized technology transfer program, which could result in a national policy effecting all federal agencies including DOD. Pressure for such a policy is now coming from public interest groups who do have a voice at the national level.

If, and when, such a policy and support effort is reached, then you will see a stronger technology utilization effort being made by DOD laboratories. But even today, the contributions being made by DOD labs toward improving the quality of civilian life via the utilization of military know how is significant. As a user of that technology I know personally the contribution the DOD labs are making to help local and state government in Oregon. Those of you here today may not have that same personal knowledge but I can confidently say that your life has been positively effected to some degree by military-created technology finding its way into the civilian market.