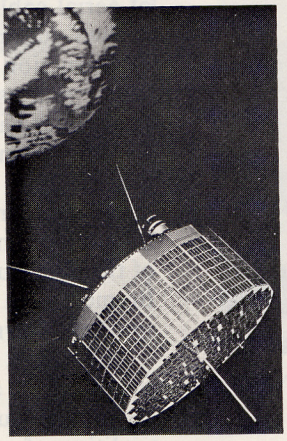
Spinoffs

Prepared by the U.S. Army Electronics Command Public Affairs Office

Military C-E achievements by the Electronics Command (ECOM) have resulted in many civilian "spinoffs." This **thermal viewer** *(top), which can "see" in absolute darkness, now helps discover rock faults during mine excavations, detect thermal pollution in water, and rescue victims of nighttime sea disasters.* **Night vision goggles** *(far right) are now important to law enforcement officers and to persons suffering from an eye disease. The* **Tiros I satellite** *(near right) sent back the first sharp pictures of the earth's shifting cloud patterns, important to weather studies.*



The research and development effort of the Army Electronics Command (ECOM) has given the U.S. military the finest communications-electronics equipment ever fielded. It has also had tremendous beneficial impact on modern life, worth billions to the civilian economy.

The benefits range from greater mine safety to computer-aided design and manufacturing, from better radios to new jewel stones, from greater air safety to instant aid for heart attack victims, from aid to nearly blind persons to simple processing of color photographs.

These are just a few of the hundreds of the "spinoff" results of the military R&D of the ECOM laboratories and their predecessors. ECOM itself, located at Fort Monmouth, NJ, is only a dozen years old. But its scientific and engineering achievements reach back to the birth of the Army Signal Corps more than a century ago.

NIGHT VISION DEVICES

One of the greatest areas of progress in recent years is night vision, which has had spectacular civilian benefit.

ECOM's latest night vision goggles, developed for "hands-off" sight in night tactical situations, have been successfully used to aid victims of retinitis pigmentosa to see in dim light.

Sufferers from the disease cannot see well enough to move about in anything less than full daylight. With the goggles they can see in twilight or even moonlight.

Another device, the thermoviewer, about the size and weight of a pair of binoculars, can "see" in absolute darkness.

The thermoviewer recreates images by sensing minute temperature differences between the target (or object sought) and its background. It was designed to find enemy troops and vehicles at night.

Already it has been put to more civilian uses than military. It has proven invaluable in coal mining and other mining projects, where it is sensitive enough to discover potentially hazardous rock faults behind apparently solid mine walls. Air in a fault or around loose rock has a slightly different temperature than solid rock, and a thermoviewer can detect that difference.

The U.S. Bureau of Mines, considering the thermoviewer an indispensable safety device, is funding especially-made thermoviewers for use by its inspectors.

The thermoviewer also has been used successfully in aircraft to detect thermal pollution in bodies of water and in geophysical studies of conditions affecting the earth's surface temperature. It also can be useful in nighttime sea rescue, where it can quickly spot a swimmer because his temperature is not the same as seawater.

Other night vision devices—including the goggles—used extensively in combat areas depend on the principle of light intensification. The slightest light—moonlight, starlight, or even the glow of decaying vegetation—provides enough illumination to give the user almost daylight vision. It has been widely adopted by police departments fighting night crime, by scientists studying the behavior of vampire bats, by naturalists studying the habits of nocturnal creatures, and by many others seeking to turn darkness into daylight.

LASERS

Another binocular-sized device developed by the ECOM laboratories is a new lightweight laser rangefinder that can provide a readout of distance—from 200 to 6,000 meters—within a second after the target is located in the rangefinder's cross hairs.

Weighing less than 5 pounds with batteries, the device can be of inestimable value to surveyors and others needing a quick, accurate reading of distance to any object within range.

The laser rangefinder would have been impossible without a new laser material, Nd: YAG (Neodymium doped Yttrium Aluminum Garnet) developed under ECOM sponsorship. The new material is already in use for laser machining, drilling, and spot welding of metals and other materials.

The team which developed the rangefinder is now exploring techniques for converting the Nd: YAG wavelength into an eye-safe region. Other ECOM scientists are developing materials (such as erbium and holmium-doped yttrium lithium fluoride) which "lase" in eye-safe regions. Much wider use of lasers in the civilian domain will be made possible by these efforts.

An unexpected double dividend is the gemlike quality of Nd: YAG. It makes beautiful stones, and can be made in sizes far larger than normal garnet crystals for costume jewelry.

Additionally, ECOM scientists have discovered that the wavelength of erbium coincides with the absorption region of methane, one of the most persistent air polluters produced by internal combustion engines. Thus, sensing systems for methane in the atmosphere may be based on erbium lasers that may be used in congested areas where both the methane concentrations and the potential danger of other lasers are greatest.

AIR SAFETY, WEATHER

Another area in which ECOM has always pioneered is air safety. Most recent important work in air safety is a new instrument landing system for the steep angle of approach of helicopters or STOL (Short Takeoff and Landing) aircraft, and a lightweight collision avoidance system for Army aircraft that can easily be adapted for civilian use.

Conducting some of their basic flight work at the Federal Aviation Administration's National Aviation Facilities Experimental Center at Atlantic City, NJ, ECOM engineers are using their successful "A-SCAN" system for steep angle approaches of aircraft as a research tool in support of the National Plan for Development of a Microwave Landing System.

The Army's work is of particular interest to the FAA because many of the characteristics of helicopters in landing and takeoff are similar to STOL aircraft designed for short haul air transport.

Of great interest to the FAA is the development of collision warning and avoidance systems that can be used not only by large airliners but also by some 200,000 small, privately-owned aircraft in the United States. Here again ECOM's work adapts itself to the FAA's purposes.

The ECOM collision warning system, feasible for both helicopters and fixed wing aircraft, calls for in-aircraft installations of only 8 pounds. Previous systems that worked as well required units that weighed 150 pounds in each plane, a serious load addition in any light aircraft.

The widely used ground control approach (GCA) for fixed wing aircraft also owes much to Fort Monmouth's ECOM laboratories. The vital element in GCA radars is the magnetron tube, pioneered in these laboratories.

The weather, of course, is of vital interest to everyone and is tied directly into air safety. Always in the forefront of meteorological research and development, the ECOM laboratories have recently developed and have in production a completely self-contained portable weather observing station.

These stations can be set up to make frequent weather observations at specific locations. In the military version the complete system weighs 30 pounds; the civilian model is 10 pounds lighter.

ECOM's predecessor organizations were responsible for most of the weather observation equipment now used by the U.S. Weather Bureau and all the Armed Forces. Included are balloon and rocket-borne radiosondes—light weather stations that send back weather conditions at all altitudes—as well as the ground radio equipment that tracks the radiosondes and records their data.

Weather radar, now in use throughout the world, was developed in the same laboratories, as were specific weather radars that can pinpoint tornado-producing conditions as far away as 200 miles.

COMMUNICATIONS SYSTEMS

None of the data produced by weather stations, rangefinders, night vision devices or any other equipment is much good if it cannot be communicated, and communications have always been the prime business of ECOM and its predecessor organizations.

One recent development of great interest, and high potential in civilian communications, is an ECOM-developed small, rugged laser communications system. The capacity of the visual and near-visual wavelengths has long attracted communicators, particularly in today's computer environment requiring transmission of vast amounts of data.

The portable ECOM laser communications system can carry twice as much data as normal military coaxial cable when operating through the atmosphere. When the small laser terminals are connected by low-loss fiberoptics, the capacity increases by several orders of magnitude.

Radio communications, of course, are commonplace, but recent ECOM developments in producing handheld transceivers using integrated circuit components can have as much impact as the first backpack and handheld radios pioneered years ago by the Army Signal Corps at Fort Monmouth.

The small radios carried by individuals such as police and firemen throughout the world are all outgrowths of the first "Handie-Talkie" developed for and in Fort Monmouth's laboratories.

Microwave communications, now used by all common carriers of electronic communications and responsible for the dish-bearing towers spread across the earth's continents, was first used by Fort Monmouth engineers in Africa during World War II.

NEW DESIGN METHODS

All equipment must first be designed, and as it grows more complicated—and smaller—the number of calculations necessary in the design mounts astronomically. Computers have long been used to assist in design, but now an ECOM scientist has devised an operation called "DEMON" (Diminishing Error Method for Optimization of Networks) that permits rapid solution of complex equations involving as many as 30 variables.

Used in conjunction with the design of miniature microwave transistor amplifiers, DEMON has allowed engineers to design, fabricate, and test an amplifier in 7 days. Similar operations in the past took 3 to 6 months.

In a typical design problem, 6 million repetitive calculations are performed in 6 seconds as the computer seeks the best solution.

DEMON has been made available to 15 other government laboratories and at least 6 private enterprise industrial firms.

A further step now under experiment at ECOM not only designs equipment, but also designs the manufacturing process as well.

HELPING UNCLE SAM

In work not precisely in the civilian domain, but extending to other government agencies, ECOM scientists have developed thin lens coatings exhibiting the highest reflectance achieved yet in the ultraviolet wavelength region.

These coatings were used on the ultraviolet camera planted on the moon in the Apollo 16 mission and allowed NASA scientists to receive high resolution photographs requiring much shorter exposure times than photos taken with cameras with ordinary coatings.

The photos showing the interaction of solar high-energy particles and the earth's atmosphere are highly important to the study of atmospheric phenomena affecting all electrically transmitted communications.

Another government agency drawing on the Electronics Command's expertise is the Environmental Protection Agency, which employs the ECOM-developed Multipurpose Infrared System (MIRS) to detect and track oil slicks on water. Images are formed not by temperature contrast, but by the characteristic differences of oil and water emissivity and reflectivity.

And U.S. Customs authorities are using ECOM forward-looking infrared systems in aircraft to apprehend airborne drug smugglers along the U.S.-Mexican border.

Spurred by recent aircraft hijackings, ECOM scientists have developed a radiographic system used in at least one U.S. airport to inspect baggage as it is conveyed to the cargo holds of commercial aircraft. Other command researchers are working on a concealed weapon detector-

Ecom engineers, conducting some of their basic flight work at the Federal Aviation Administration's National Aviation Facilities Experimental Center at Atlantic City, used their already-successful scanning system for steep angle approaches for helicopters. The system was used as a research tool in support of the National Plan for Development of a Microwave Landing System.

imaging device operating in the millimeter and submillimeter range.

SATELLITE R&D

While ECOM is now only peripherally connected with the space effort, all space operations owe much to early space age work done at Fort Monmouth by men still connected with ECOM and other agencies there.

Tiros I, the world's first successful weather satellite, was developed under the technical supervision of the Fort Monmouth laboratories, following closely on the heels of Vanguard II, the first attempt to record and transmit pictures of cloud cover and other weather conditions from an orbiting satellite.

The various National Aeronautics and Space Administration meteorological satellites that followed Tiros I have largely grown out of the techniques worked out here.

Vanguard II and Tiros I were but two of the many artificial earth satellites which challenged the interest and ingenuity of Fort Monmouth's scientists and engineers.

Today, communication satellites and their ground stations provide worldwide message and photographic communication facilities undreamed of a few years ago.

The first two communication satellites were products of Fort Monmouth research and development. The first was SCORE, which in December 1958 proved the feasibility of communications from an orbiting vehicle by relaying President Eisenhower's goodwill message to the world. Then came Courier, the first high-capacity communications satellite.

OTHER SPINOFFS

Developing and printing of color photographs can be made much faster and cheaper through a process worked out by two ECOM chemists.

The process is faster (for film, four steps instead of nine, 11 minutes compared to the conventional processing time of 53 minutes); simpler (it uses fewer different solutions); cheaper (because of time and material saved); and nonpolluting (it eliminates the use of ferrocyanide bleach).

In an entirely different area, ECOM scientists worked with Army medical officers to develop a new and revolutionary coronary care unit—a combination pacemaker and defibrillator—that can be implanted in the patient or attached to the patient's arm.

Designed to perform the function of portable coronary care units found in hospitals, it detects the start of heart fibrillation (wild and discordant tremors of the heart's muscle fibers).

Instantly, the device stops the heartbeat. Then, if the heart does not start normally by itself, the device restarts it at its regular beat. The entire operation takes between 10 and 15 seconds.

Other currently available heart pacers can also restart the heart following heart stoppage, but cannot cope with the problem of a too rapid or uneven pace.

Of direct benefit to the civilian economy is a method, patented by two ECOM engineers, which permits the automated production of millions of printed circuit dip-solder boards used in the great majority of radios and television sets produced today.

Because electronics affects so greatly all apsects of civilian life, it is possible that this field offers more potential for benficial spinoffs from military research and development than any other scientific discipline. The Army Electronics Command continues to seek the greatest possible benefits to all from its numerous R&D efforts. (POC: ECOM Public Affairs Office, AUTOVON 992-1510)