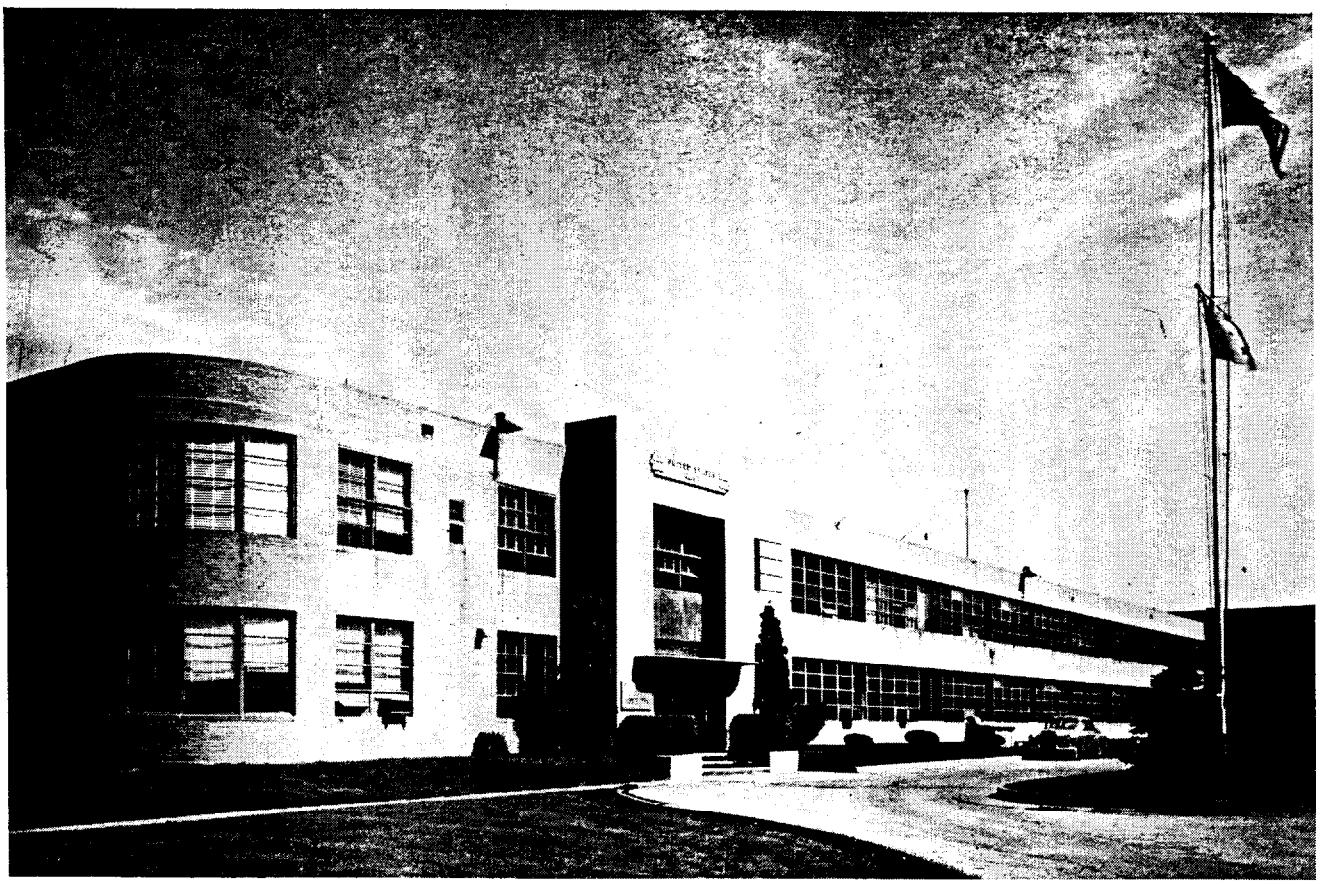


RESEARCH TO REALITY

EVERY time a pilot straps on an airplane preparatory to defying the laws of gravity, every time a crewman dons a parachute and survival gear, every time the ground technicians use a piece of equipment to test or repair aircraft, it is a safe bet that they are doing their job better, and that their equipment is safer, more efficient or more comfortable because of the existence of the Naval Air Development and Material Center.

Slightly over one year old, the NADMC is located at Johnsville, Pennsylvania. Its first commander is RAdm. Selden B. Spangler, USN. Technically in command of the aviation research and development activities in the Fourth Naval District, Adm. Spangler in fact directs a vast complex of laboratories, facilities, and stations that have their fingers in practically every minute detail of aircraft, airborne equipment and guided missiles that are or will be in use in the U.S. Fleet.

Frequently the part played by this scientific complex is well concealed either because of the classified nature of much of the work that goes on there or because the credit for the development is assigned to the manufacturer. But a little research will reveal that almost every piece of aeronautical equipment put into service in the fleet has had the NADMC touch somewhere along the line.

Included in this intricate command structure are four principal subordinate commands: Naval Air Development Center at Johnsville, Naval Air Material Center at Mustin Field, Philadelphia, Naval Air Turbine Test Station at Trenton, N. J., and the Naval Air Publication Facility at Naval Supply Depot, Philadelphia.

Adm. Spangler's background as a Naval Aviator and aeronautical engineer fits him well to direct the Development and Material Center. As a Naval Aviator, he qualified aboard the Navy's first aircraft carrier *Langley*. He was then as-

signed to the first ship built as a carrier, the *Saratoga*, and rode through the first carrier landing aboard her. On the engineering side he did his post-graduate work at MIT and served two tours in BuAer: one as Director of the Power Plants Division and one as Director of the Maintenance Division. At one time he directed the Navy's largest overhaul activity at Alameda and was once top man in what is now one of his most important subordinate commands-NADC.

The scope of activity within the NADMC Oranges through the full spectrum of aeronautical problems from dreamy-eyed excursions into the future of space ships and earth satellites to the practicality of nuts and bolts that make up the hardware of the offensive and defensive weapons.

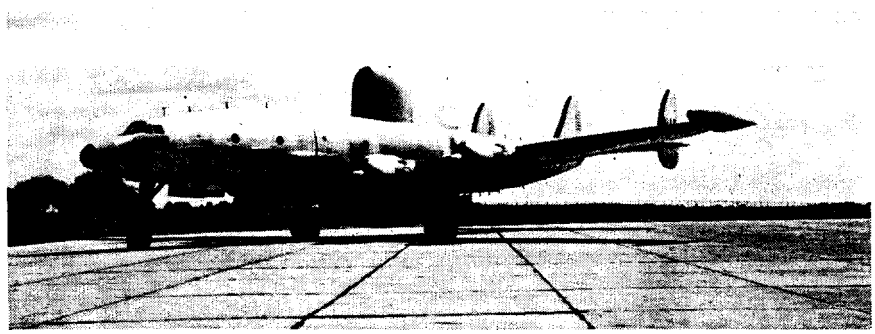
Naval Air Development Center

ONE OF the most frequently asked questions is, "What do you actually do at a development center?" The answer could run into volumes. In its eleven-year history, the Development Center has itself done a good deal of developing. In 1944, the Navy took over the properties of the Brewster Aircraft Corporation and began to operate the Naval Aircraft Modification Unit as a branch of the Naval Air Material Center. The tasks assigned to the new-born NAMU were threefold: development of guided missiles and target drones and the prototype and production line modification and conversion of service aircraft.

At the end of WW II, the need for a modification unit vanished and the NAMU became the Naval Air Development Station. It was an independent facility dedicated to research and development in aeronautical fields.

By 1949, the NADS had greatly expanded. Many research activities were moved from other parts of the country to Johnsville. In August 1949, the activity was given its present name and its scope and responsibility were enlarged with a corresponding expansion of space and personnel force. Three general fields of aeronautics were encompassed in the original Naval Air Development Center: electronics, armament and pilotless aircraft.

Since 1949, other R&D functions have been assigned to NADC until today it comprises eight areas of scientific study and application. These scientific projects are carried on in eight separate laboratories or departments housed in more than a million square feet of modern building floor space. The entire center, now under the command of Capt. J. A. Haley, occupies more than 751 acres of Bucks County real estate and includes an airfield, three hangars and the office and laboratory buildings. Over 2300 military and civilian personnel carry on the work of the center that is so vital to our National Defense. The results of their studies and practical applications of scientific principles are available to BuAer, the fleet and Navy contractors.



NADC SCIENTISTS, ENGINEERS HELPED DEVELOP "EYES" OF EARLY WARNING CONNIES

EDSD The Engineering and Development Services Department, directed by Cdr. G. S. Parrett, is the pioneer organization of the Naval Air Development Center. Its primary function is to perform research and development studies, and design, engineering and prototype work in the field of target drones, special aircraft and guided missile systems and related equipment. It is further responsible for providing engineering and fabrication services for other laboratories of the Naval Air Development Center. Many a scientific fact has been known for many years, but it is up to EDSD to put those facts to work in the evolution of brand new concepts or the improvement of the existing methods of flying and fighting. It also conducts testing programs to determine the performance and reliability of equipment.

The EDSD is equipped with a complete fabrication shop manned by experts who can manufacture anything from a complete guided missile or aircraft down to the finest part of the most delicate instrument. The extensive engineering and mechanical force in the shop form a group that changes the incomprehensible formulae of the scientist into usable hardware. They

change theory into practice. In short, they make science go to work.

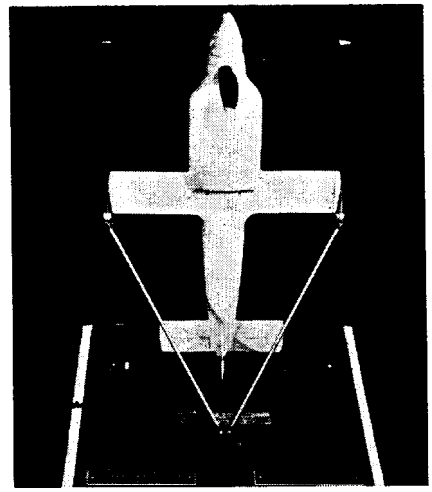
Significant among the successful projects of the EDSD was the development of the F6F pilotless aircraft that were used, loaded with thousand-pound bombs and guided by television, to attack Red lines of communication in the Korean action. These obsolete ***Hellcats*** actually functioned as guided missiles. A great deal of effort has been devoted to the successful development of techniques for the underwater launching of guided missiles.

Another contribution of this laboratory was the development of the mockup and of the small scale flying demonstration model of the first vertical take off fighter. The feasibility of the VTO idea was originally explored at NADC, and it was NADC's design proposal which ultimately provided the basis for development contracts for Convair's XFY *Pogo* and Lockheed's XFV.

These are but a few of the projects that occupy the time of the scientists and engineers. They work, mostly under a veil of secrecy, on the aircraft and the weapons of the future.

AEEL

When a Lockheed WV-2 keeps her lonely vigil off the shores of the continental United States, or ranges far ahead of the fleet, she is an electronic, multi-eyed sentinel that gives to our defenses those few precious hours warning of imminent enemy attack. Credit for her protracted "vision" goes to the scientists and the engineers of another of the laboratories of the Naval Air Development Center, the Aeronautical Electronic and Electrical Laboratory.



NADC HELPED DEVELOP THE POGO AND XFV

The AEEL was established as a component of the NADC in 1947. Its physical growth started immediately, for it absorbed the Aeronautical Radio and Radar Lab, Naval Air Magnetic Lab, the Aviation Electrical Test Group of the Naval Research Lab, and the Naval Research Field Station at Boston, Massachusetts.

The primary mission of the AEEL is to assist BuAer and industry in providing naval aircraft with modern electronic and electrical equipment. The laboratory is a necessity for the continued preliminary study, investigation and engineering of electronics. So fast has been the development, so broad the scope of this relatively new science that it would be impossible to dictate requirements to the industry without first determining what surprising new capability can be proved feasible. The seemingly endless applications of electronics makes it mandatory that the AEEL be staffed by scientists who are not afraid to dream a little and engineers who make those dreams come true. Men of vision, electronic "vision", literally.

The scope of the lab, with Capt. Grayson Merrill as director, is broad. Interest is divided under the sea, on the sea and over it. Radar, radio, electrical, missile control and guidance, undersea warfare are some of the areas in which it helps to solve the Navy's problems.

Among many other fields in which the AEEL has pioneered is the field of piezoelectric ceramics. This is the science of taking certain ceramic or pottery-like materials and, by shaping them and exposing them to high voltage, rendering them capable of emitting electrical impulses when disturbed by pressure or vibration.

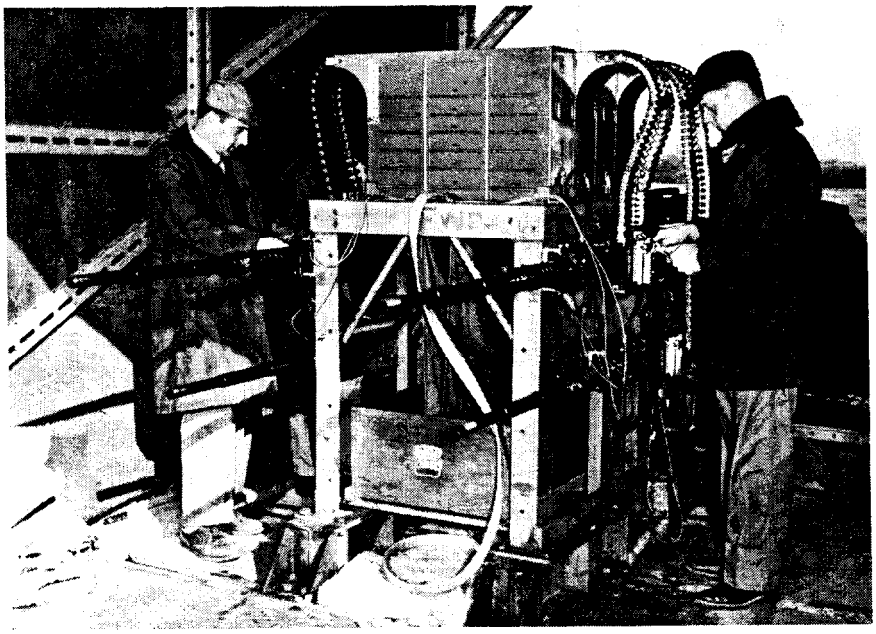
AEEL has been experimenting with a mineral known as barium titanate. It is shaped in relatively simple moulds to a cylindrical form. A coat of silver is applied and then the cylinder is exposed to thousands of volts of electricity. The internal composition of the ceramic piece is so changed by this process that it becomes sensitive to minute pressures and gives off electrical energy when disturbed. These ceramic transducers become the heart of sonar and other underwater detection devices.

It takes a keen mind and a lively imagination to visualize what are the new wonders that will be produced electronically. There is a concentration of that kind of mind and imagination at the Aeronautic Electronic and Electrical Laboratory at Johnsville. Keen minds that probe the future and come up with the answers.

FILTERING MATERIALS FOR CERAMICS CAST

CERAMICS SILVER-COATED FOR ASW 'EARS'

ISOTOPES USED IN STUDYING SHIELDING



ARMS LAB WORKS ON DEVELOPMENT OF FEED MECHANISM FOR AIRCRAFT TURRET GUNS

AAL Military aircraft were built with one purpose in mind -to fight. As the aircraft improves and advances, so must the ordnance systems which are its weapons. With the advent of jet aircraft into the fleet, the need for research into advanced armament became critical. Since no commercial facilities for this kind of study existed, it was necessary for the Navy to undertake comprehensive studies in the field. The Aircraft Armament Laboratory of NADC was established in 1946 to meet this particular problem.

The AAL started in 1946 as a research and development laboratory. Later its function was changed to development only. But through the changes its mission has remained relatively constant. That mission is so broad that it encompasses practically every facet of design, test and evaluation of every kind of projectile.

The AAL, presently under the direction of Cdr. Hamilton 0. Hauck, is responsible for the development, design, alteration, construction, installation, flight testing and actual range firing of all naval air guns, missiles and rockets. Above all, theirs is the task of peering into the future to design and develop entirely new systems of naval air ordnance, to adapt new developments to naval warfare; in short, to do everything to keep the armament program ahead of the high speed development of modern jet aircraft.

The AAL works with scientists, with the Bureau of Aeronautics and with ordnance and airframe contractors. The problems it studies are not limited to the development of armament alone, but also with fitting the lethal hardware into the weapons system for tactical use.

Gun mounting, for instance, is a new problem with each new aircraft that is added to the Navy's arsenal. Guns must be located where their weight will not effect the flight characteristics on the aircraft. Explosive gases must be properly vented. Lubricants must be developed that will permit the guns to operate at extremes of temperature. Bomb and rocket release and detonation devices must be foolproof. These and myriad other related problem areas are under constant and careful study by the AAL.

ACL UNTIL a few years ago, scientists were hindered in their search for new knowledge by the fact that it was virtually physically impossible to make all of the computations necessary to prove or disprove theories evolved from then known facts. They were overcome by sheer arithmetic. They solved their own problem by developing giant computers, impossible before the advent of the electronic age.

The Naval Air Development Center was no exception. In the summer of 1950, the NADC formed its Analytical and Computer Laboratory. This new facility, now under Cdr. I. K. Blough's direction, went into business in a big way with the largest electronic analogue computer in existence,-Typhoon, so named, no doubt, because it is ready to cope with a veritable tidal wave of numbers.

Electronic Computers, sometime miscalled "Brains", are of two varieties---digital and analogue. The digital computer is, in effect, a gigantic adding machine, solving the problems fed to it by an astromical number of additions, many of which are retained, for use at the exact moment they are required, in what is usually called an electronic memory. The analogue computer is infinitely more complex;

ANALOGUE COMPUTER "TYPHOON" SOLVES AERODYNAMIC AND ENGINEERING PROBLEMS

set up to solve difficult differential equations in an infinitesimal fraction of time that would be required for the pencil and paper method.

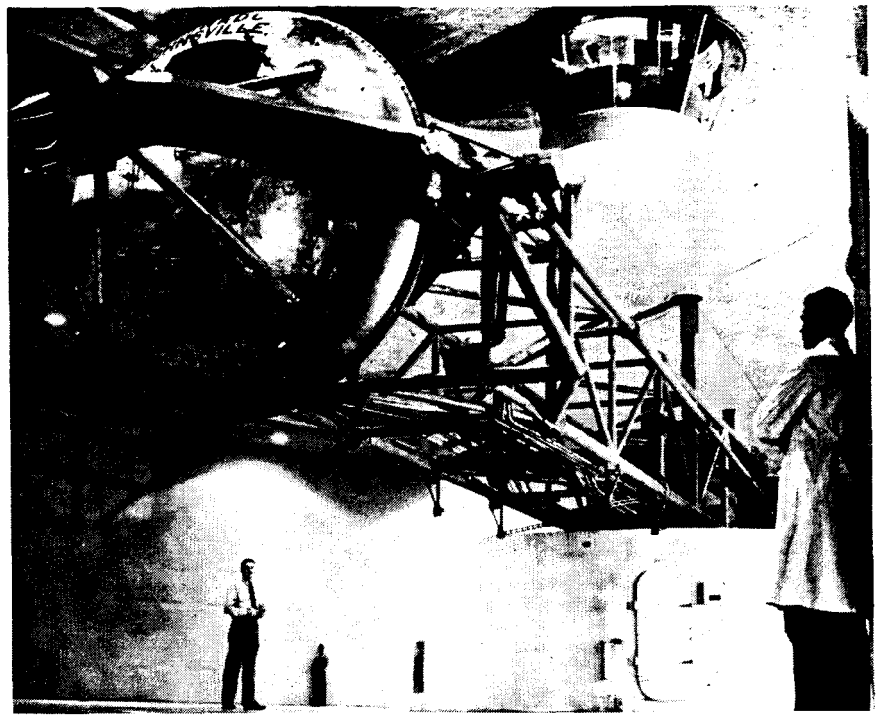
Typhoon, built by RCA for the Navy, makes airplanes fly and missiles shoot them down long before the first order is placed for the first sheet of aluminum for the first prototype model. The ACL, working with industry, saves millions and millions of dollars in proving that the gleam in the eye of the scientist can or cannot be turned into a practical piece of hardware that will add to the arsenal of the Navy's weapons.

Here is how a typical problem might work. A guided missile contractor has an idea or a requirement from the Navy that will accomplish a specific mission in the destruction of enemy aircraft that might possibly attack our forces. The scientists who conceived the basic design of such a missile reduce all of the projected data about the missile to a series of (to the layman) completely unintelligible formulae. Listed in sequence along the edge of a huge sheet of paper, these mathematical equations represent everything that is planned for the projectile-speed, power plant, wingspan, length, drag, length of time in flight, and a hundred other details of aerodynamics.

Personnel of the Analytical Computer Lab translate these formulae into electronic circuits that can be fed into the *Typhoon.* It may take six weeks to two months to relate the mathematics to electrical circuits. When this has been done the electronic circuits are fed into ***Typhoon.*** This probably will take another six weeks. Each circuit must be tested individually to work out the particular formula that it represents,

The characteristics of the missile are in the machine. The flight pattern of the plane it is pursuing is in, the flight time of the missile is set at, let us say, one minute. The big moment has arrived. The missile is about to fly — electronically. The switch is thrown and one minute later the results of the flight are graphically displayed on paper.

By simulating flight conditions *Typhoon* can fly a missile or an aircraft on many flights at the merest fraction of the cost of one test flight.



LARGEST HUMAN CENTRIFUGE INVESTIGATES HUMAN BARRIER, EFFECT OF "G" FORCES

AMAL Man overcame the so-called Sonic Barrier in 1947 when the first plane buffeted its way through the speed of sound and the first human raced into the unknown and became super-sonic. We are now making our first assault upon what has come to be known as the heat barrier—the speed at which friction of atmosphere will make now known metals unsuitable for aircraft and missile construction.

But there has been developing along with the advanced speeds of aircraft another kind of barrier, less discussed but no less important-the Human Barrier. Since the inception of the science of aeronautics, man has had to accept environments in which his body was not created to exist. He has risen to altitudes far beyond the tolerances of the flexible human system. He has invented the artificial aids that he needs to maintain life and consciousness and alertness. Now with the inception of really high speed flight the problem of high acceleration or "G" forces looms larger than ever.

Rapid changes of direction in an aircraft subject the human body, designed to operate under the influence of its own weight or the pull of one "G", to forces beyond the capacity of the body to withstand without damage. The injurious effect of acceleration is the product of the amount of "G's" and the length of time they are exerted on the man. Now we need to know how much a pilot can stand. For how long? In what position—sitting, standing, prone or supine?

In 1949 there was added to the facilities of the Naval Air Development Center the Aviation Medical Acceleration Laboratory. Here personnel of the Navy's Medical Corps conduct investigations with the use of a human centrifuge to define the limits of human tolerance to acceleration. Their interest runs also to the effects of high "G" forces applied to various parts of the body.

The centrifuge at AMAL, the world's largest, can produce forces up to 40 "G"—forty times the weight of the man who is being tested. The cockpit or gondola of the centrifuge in which the subject is placed is at the end of a 50-foot arm which is rotated by a giant 4,000-hp electric motor. Volunteers are whirled in a variety of positions at speeds that will produce the desired acceleration while the scientists study the effect of the "G's" on their bodies. The work of AMAL now under Capt. H. G. Shepler, will guide future aircraft, pilot equipment and safety device design.

APEL

Since nations first adapted the aeroplane to the business of waging war, one of its most important uses has been for reconnaissance. It is axiomatic that you can see more from the roof than from the sidewalk, so navies and armies started looking *over* the enemy.

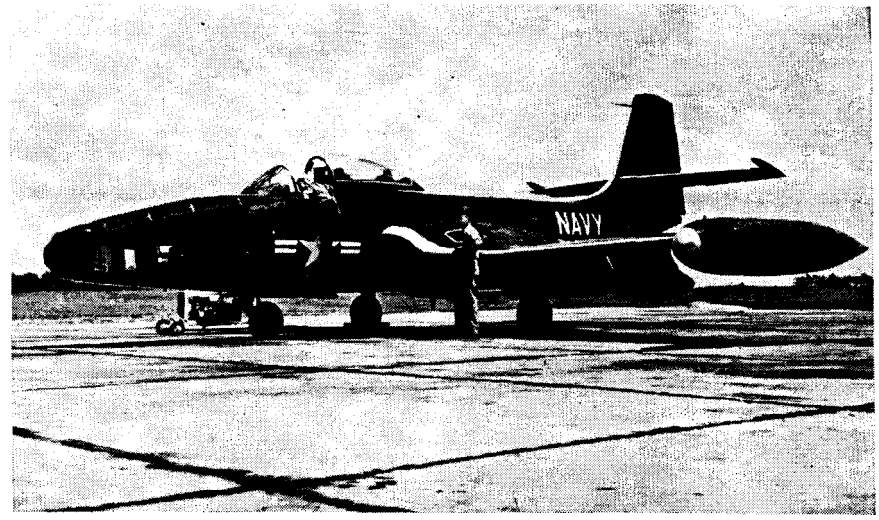
True, you could see more, but the old human equation entered the picture and the effectiveness of aerial reconnaissance was limited by the accuracy of the "guestimate" of the returning observer. How acute his vision, how retentive his memory, how accurate his estimate-these were the question marks of aerial observation. Equip the observer with a camera and the record of what he saw becomes undeniably accurate and available for detailed study by trained interpreters. Out of this necessity grew aerial photography.

That this science has developed from the "Brownie Snapshot" stage is due in no small measure to the Aeronautical Photograhic Experimental Laboratory at Johnsville. The APEL performs research, development, evaluation and test of photographic equipment prototypes including aerial cameras, camera control systems, aircraft installations and photographic interpretation devices. It also provides aerial, motion picture and still photographic services for the other laboratories and departments of NADC.

The ten-year-old Photo Experimental Lab, now under the direction of Cdr. J. S. Leffen, faces many problems as it keeps up with the jet age. A recent project provided fleet photographic units with a high shutter speed, rapid picture sequence aerial camera specifically designed for low altitude, high speed photo missions. In this camera, the roll film is actually moving while the shutter is open to compensate for the movement of the aircraft over the ground, thus preventing blur on the finished film. This device was manufactured by APEL by redesigning an existing aerial camera rather than by building a new piece of equipment thus saving an incalculable amount of money.

Only by constantly developing photographic equipment that can keep up with tomorrow's aircraft can we depend upon sure, accurate intelligence.

NADC DEVELOPED 'COPTER CAMERA MOUNT



APEL ADDED 1/800TH SEC. SHUTTER TO CAMERAS OF F2H-2P FOR LOW-LEVEL PICTURES

AIL

So long as the Navy uses piloted aircraft, that long will it be necessary to take into consideration the old Latin proverb "Errare humanum est." Impossible as it is to make the human perfect, his probability of error can be notably reduced by making it easier for him to do the right thing. This is of concern to another of the laboratories of the NADC-the Aeronautical Instrument Lab.

Anyone who has seen the cockpit of a modern military aircraft knows the maze of instruments that are ranged on the panels in front of, above and below and to each side of the pilot. It is rapidly getting to the point where it is virtually impossible for one man to read, interpret and act upon the flood of information which is communicated to him by aircraft instruments. In this era of faster-than-sound aircraft it has become the task of the AIL to make it possible for the Navy pilot to assimilate all of the information he needs to fly and fight his plane in the briefest possible time.

AIL is constantly searching for new and better ways to simplify the pilot's job by changing the size of instruments, relocating them for easy visual reference or regrouping them according to their functions. Theirs is a never-ending pursuit for *more accurate* and more easily understood gauges. When you realize that a pilot must keep track of engine instruments, flight gauges, gunnery and bombing indicators, navigational aids, radios and radar it is a wonder that young men are accepted as Naval Aviation Cadets with anything less than two pairs of eyes.

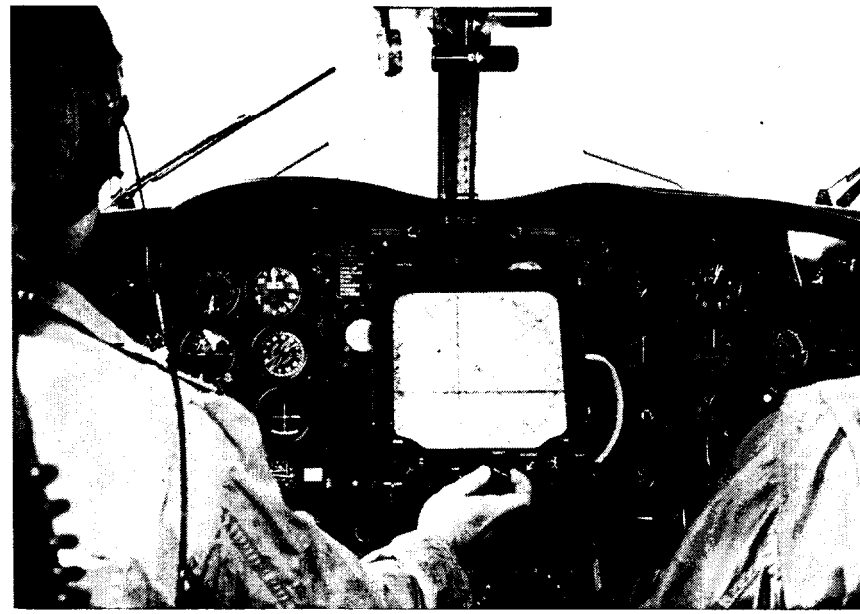
The Aeronautical Instrument Laboratory now under the directorship of Capt. P. G. Holt develops and tests flight and engine aircraft instruments, automatic control equipment to provide the Navy with the latest and best means of meeting varied combat or defense conditions.

Jet, helicopter, and conventional aircraft are assigned the laboratory in order to determine specific answers for use by the development and test engineer. The list of laboratory test equipment includes many unusual special devices, among which are tem-

perature and vibration machines covering a broad frequency spectrum and electrical analog computing equipment utilized as a flight simulator.

A shop, capable of manufacturing prototype models with the precision necessary for instrument work, executes the designs made as result of development. Current projects include development and test of pilot's dead reckoning position indicator, and the design, fabrication, and installation of experimental instrument panels in jet aircraft.

Aviation history was made at the AIL on 23 September 1950 when a helicopter controlled completely by an automatic pilot made its first successful flight. This was a result of the work of the Aircraft Instrument Laboratory in the rotary wing field.



AUTOMATIC DEAD RECKONING NAVIGATOR "PADRE" GIVES THE PILOT A CONTINUOUS FIX

AWRD

The newest member of the NADC family is the Air Warfare Research Department, whose job is to study the missions and tasks of naval aviation. This department, under the present directorship of Mr. Fred Gloeckler, is divided into three main divisions, the first of which considers the missions that the Navy must accomplish by the fleet defense, amphibious operations, undersea warfare, land-based attack, etc.

The second division considers the current advances and future trends of science to predict design trends; and the final division performs operation studies of naval air weapon systems and their employment determining as far as possible by this means anticipated losses, chances of success, and cost of operation in the Fleet.

Thus AWRD recognizes first the job to be done; second, the means to do it; and third how efficiently the Navy can anticipate carrying it out.

NAS

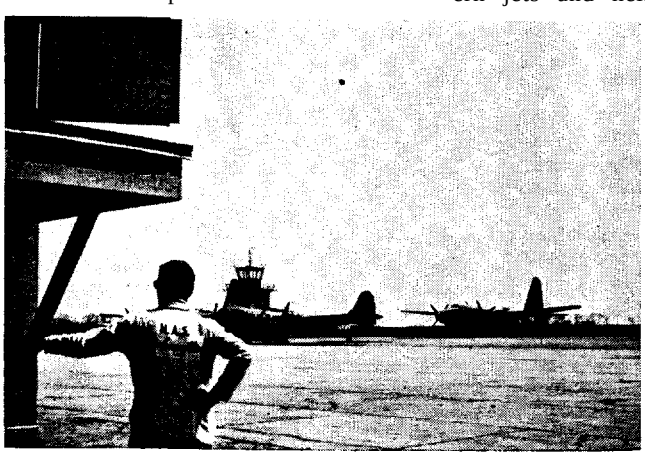
The Naval Air Station, Johnsville, Pennsylvania is home for the Naval Air Development and Material Center and for the Naval Air Development Center. Over and above that, the NAS, commanded by Cdr. C. H. Franklin, is 'charged with the highly important responsibility of maintaining and operating the more than 50 aircraft assigned to the several laboratories and departments of the development command.

When it is realized that this number includes most World War II types plus a representative number of modern jets and helicopters, it is easy to see that the maintenance and logistic problems of the air station are tremendous. A modern airfield with an 8,000-foot runway appropriate for jet aircraft is now a feature of Johnsville.

The Air Station is additionally responsible for all housekeeping and heavy maintenance functions and for the administration of all military personnel and Center communications.

Truly, it can be said when pilots and crewmen don their gear and man their planes, everything that they touch in, on and about their aircraft, at some time had the touch of the Naval Air Development Center somewhere in its research, design or development, a "touch" that has paid off in economy, safety and efficiency.

This answers the question, "What goes on at a Development Center?"



VARIETY OF PLANES MAKES JOHNSVILLE AIR STATION UNIQUE

BUSY NAS JOHNSVILLE FURNISHES HOME FOR NADMC AND NADC