Dino A. Brugioni is a native of Missouri and attended schools in Bevier and Jefferson City. During World War II, he flew in 66 bombardment and a number of reconnaissance missions over Europe, receiving the Purple Heart, the Air Medal with eight oak leaf clusters, and a Presidential Unit Citation. After the war, he received his B.A. and M.A. degrees in foreign affairs from George Washington University. He joined the Central Intelligence Agency in 1948 and became an expert on Soviet industrial installations. In 1955, he was selected as a member of the cadre of founding officers of the National Photographic Interpretation Center. As a senior officer at the Center, he was involved in the exploitation of U-2, SR-71, and satellite imagery in strategic and crisis situations. He also discovered and analyzed World War II aerial photography of the Auschwitz-Birkenau death camp. Mr. Brugioni has received a number of awards for his work including a citation from President Kennedy for his performance in the Cuban Missile Crisis. Since his retirement from the CIA in 1982, he has written extensively on the application of aerial and spatial imagery to intelligence and environmental problems. He recently authored *Eyeball to Eyeball, the Inside Story of the Cuban Missile Crisis*. A Civil War buff, he wrote *The Civil War in Missouri*, and a number of articles dealing with the war in the West.

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RECONNAISSANCE, SURVEILLANCE
AND
IMAGERY INTELLIGENCE
HOW IT EVOLVED

DINO A. BRUGIONI

THE INTELLIGENCE PROFESSION SERIES
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Reconnaissance, Surveillance And Imagery Intelligence: How It Evolved

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INTRODUCTION

From Balloons To Blackbirds

Reconnaissance, Surveillance

And Imagery Intelligence:

How It Evolved

Man must rise above the earth--to the top of the atmosphere and beyond--for only then will he fully understand the world in which he lives.
Socrates ca. 450 B.C.

Reconnaissance, Surveillance, and Imagery Intelligence are defined by the Department of Defense in *Dictionary of Military and Associated Terms* as follows:

"RECONNAISSANCE: A mission undertaken to obtain, by visual observation or other detection methods, information about the activities and resources of an enemy or potential enemy; or to secure data concerning the meteorological, hydrographic, or geographic characteristics of a particular area."

"SURVEILLANCE: The systematic observation of aerospace, surface or subsurface areas, places, persons, or things, by visual, aural, electronic, photographic, or other means."

"IMAGERY INTELLIGENCE: Intelligence information derived from the exploitation of collection by visual photography, infrared sensors, lasers, electro-optics and radar sensors such as synthetic aperture radar wherein images of objects are reproduced optically or electronically on film, electronic display devices or other media."

EARLY INTEREST

Military commanders have always been concerned that their combat preparations and operations not be observed either covertly or overtly; concomitantly, they have been just as eager to view such activities by their opponents. From antiquity, military tacticians have always sought the "high ground" for optimal observation of the enemy.

Long before the capability of human flight, the concept of how the earth must look from the air fascinated the intellectual and common mind. To look at the world from a new perspective, to see the terraqueous planet that did not conform to the anthropocentric view preoccupied both military and scientific interests. Artistic pictorial maps of "bird's eye" views of cities and activities had been created as early as the 1500s. The military assumed an early interest in balloon reconnaissance and, in 1794 at the Battle of Fleurus, French observers used balloon reconnaissance to track the movement of Austrian troops. Even before the advent of the camera, portable optical instruments such as telescopes, binoculars, reconnoitering prisms, and trench periscopes afforded commanders a clearer "high ground" view of the scope of the battle.

Prince Puckler-Muskau, in an 1817 balloon ascension over Berlin, described what he saw: "No imagination can paint anything more beautiful than the magnificent scene now disclosed to our enraptured senses: the multitude of human beings, the houses, the squares, and the streets, the highest towers gradually diminishing, while the deafening tumult became a gentle murmur, and finally melted into a deathlike silence. The earth which we have recently left lay extended in miniature relief beneath us, the majestic linden trees appeared like green furrows, the river Spree a silver thread, and the gigantic poplars of the Potsdam Allee, which is several leagues in length, threw shadows over the immense plain."[1]

Such descriptions excited the imagination and teased the mind, and artists went aloft in balloons and painted or sketched what they saw beneath them. One of the first airborne imagemakers was the American artist George Catlin who, in 1827, painted "Topography of Niagara" from a balloon and provided a near-vertical view that later closely resembled aerial photographs.

In 1849, Arme Laussedat, an officer in the French Engineer Corps, conceived the idea of using terrestrial and aerial photography in the compilation of topographic maps for military purposes. The Parisian photographer, Gaspard Felix Torunachon, who used the pseudonym Nadar, was the first to try to photograph the earth from a balloon. In 1858, at an altitude of 262 feet over the Val de Bievre on the outskirts of Paris, he took the first aerial photograph.

On 13 October 1860, photographer James Wallace Black ascended twice above Boston in the balloon *The Queen of the Air*. Drifting at 1,200 feet, Black exposed six photographic plates, one of which still survives. The photographic interpretation was provided by Oliver Wendell Holmes, the future Supreme Court Justice, who was also a photographer and a student of Black. "Boston, as the eagle and the wild goose see it, is a very different object from the same place as the solid citizen looks up at the eaves and chimneys."

Identifying and describing the principal landmarks, he added: "The Old South and Trinity Church are two landmarks not to be mistaken. Washington Street slants across the picture as a narrow cleft. Main Street winds as if the cow path which gave it a name has been followed by the builders of its commercial palaces." Holmes concluded: "As a first attempt it is on the whole a remarkable success; but its greatest interest is in showing what we may hope to see accomplished in the same direction."[2]

THE AMERICAN CIVIL WAR

The American Civil War provided the first real impetus for aerial reconnaissance from balloons. From the outset of the War, Confederate and Federal forces both sought to develop new devices and techniques that might effect a speedy victory. President Lincoln was especially receptive to new devices which showed promise of making the conflict short and decisive.

Professor Joseph Henry, then Secretary of the Smithsonian Institution, endeavored to interest Federal forces in using hydrogen-filled balloons for reconnaissance purposes. Thaddeus Sobieski Coulaincaourt Lowe, a 19-year-old Ohio balloonist who had caught the eye of Professor Henry, was granted an interview with President Lincoln on 11 June 1861. To show the value of balloon reconnaissance, Lowe made a number of ascents from the grounds of the Smithsonian. On 18 June 1861, Lowe ascended with telegraphic equipment loaned by the American Telegraph Company and transmitted the following message to the President via the War Department: "This point of observation commands an area nearly fifty miles in diameter. The city, with its girdle of encampments, presents a superb scene. I take great pleasure in sending you this first dispatch ever telegraphed from an aerial station and, in acknowledging indebtedness to your encouragement, for the opportunity to demonstrate the availability of the science of aeronautics in the military service of the country."[3]

Terrain maps where the Federal and Confederate forces would eventually fight were terribly out-of-date and lacked details required for planning military operations. Major Leyard Colburn of the 2nd Connecticut Infantry went aloft with Lowe and sketched a map of a portion of Fairfax County, Virginia, after the Battle of Bull Run. It was so accurate that Virginians familiar with the county could immediately recognize the roads, terrain, and houses. Brigadier General Daniel Tyler telegraphed General Irwin McDowell, Commander of the Army of the Potomac: "I have not been much of a convert to ballooning in military operations, but the last ascent made by Major Colburn of the 2nd Connecticut Volunteers this P.M. and the map of the country, rough as it is, which he made during the ascent convince me that a balloon may at times greatly assist military operations."[4]

There is no available evidence, either in Lowe's papers, in the Department of Defense archives, or in the papers of Union military leaders to show that Lowe took any aerial photos from his balloons. There are references, however, that on one occasion when Lowe took Matthew Brady aloft, the balloon was too unsteady for Brady to make a time exposure.

Lowe continued to experiment with telegraphing

information from aloft. On 24 September 1861, Lowe ascended and by telegraph-wire directed Union artillery fire onto unsuspecting Confederate troops at Falls Church, Virginia. It was the first aerial spotting of artillery fire. The commander of the artillery battery, pleased with the results, sent Lowe the following message: "The signals from the balloon have enabled my gunners to hit with a fine degree of accuracy an unseen and dispersed target area. This demonstration will revolutionize the art of gunnery."[5]

Supporting land and naval operations from barges along the rivers and at sea were afforded a number of advantages by the launching and unencumbered movement of the balloons. On 12 November 1861, Lowe conducted aerial observations of Confederate positions near Budd's Ferry (present day Quantico) from the balloon-boat *George Washington Parke Custis*. This ascension from a specifically designed balloon platform paved the way for the Navy's effective use of the air as an element of sea power.

BALLOONS, KITES, ROCKETS, AND PIGEONS

After the Civil War, there were many experiments using balloons, kites, rockets, and pigeons to lift cameras aloft. A photo rocket, conceived by the Frenchman Anedee Denisse in 1888, would reach its apogee and the camera would photograph the terrain below and then be returned to earth by parachute. Alfred Nobel designed a photo rocket in 1897. In 1895, Lt. Hugh D. Wise of the 9th Infantry Division, US Army, experimented with photo kites at Madison Barracks, New York. An 18-foot high kite was launched towing a box camera below. Triggered by a timing device, the camera took pictures from an altitude of 600 feet. Only a few years later, in 1906, photographer G. R. Lawrence sent a camera aloft on an array of 17 kites to record destruction resulting from the San Francisco earthquake. In 1903, Dr. Julius Neubronner patented a miniature camera carried by pigeons.

Ill-equipped and inexperienced American balloonists in June 1898 performed the first reconnaissance of the Spanish-American War, confirming the presence of the Spanish fleet in the harbor of Santiago, Cuba. These same balloonists contributed to the victory at San Juan Hill by directing artillery fire onto Spanish forces and by delineating potential attack routes for the American forces.

HUMAN AERIAL RECONNAISSANCE

The idea of human flight had become an obsession. The Frenchman Jacques Henri-Lartugue wrote: "There's one thing all of us want to do – to get up in the air. In my sleep, I can fly. I want to fly all of the time. I can't get enough of it."[6] On 17 December 1903, at Kitty Hawk, the Wright brothers achieved a 120-foot, 12-second flight with their fabric airplane. But the airplane was still far from becoming an instrument of sustained flight. Octave Chanute, a close friend and some-time mentor of the Wrights would write them in 1906 when they were convinced that no one would be able to develop a practical airplane in five years. "I cheerfully acknowledge that I have little idea how difficult the flying problem really is and that its solution is beyond my powers, but are you not too cocksure that yours is the only secret worth knowing and that others may not hit upon a solution in less than many time five years?"[7] The Wright brothers would suffer a big disappointment when, on a demonstration flight on 17 September 1908 for the US Army at Fort Myer, Virginia, the engine failed and ended in a tragic accident in which Lieutenant T. E. Selfridge was killed and Orville Wright badly injured. In 1909, the Wright brothers went to Europe and achieved the first photograph known to have been obtained from an airplane: a motion-picture taken by Wilbur Wright over Centocelli, Italy. Returning to the US in the summer of 1909, the Wright brothers staged a series of airplane speed and maneuver trials at Fort Myer, Virginia, for the US Army. The Army, duly impressed, bought its first airplane. In 1910, the US Navy began flight experiments and Eugene Ely flew a Curtiss biplane from the deck of the cruiser, *Birmingham*. US naval aviation was born.

The potential value of the airplane as a possible reconnaissance platform was first noted by British, French, and Italian military leaders. The Germans experimented with photoreconnaissance aircraft in the 1911-1912 period but preferred the zeppelin which provided a more stable platform for picture taking. Training of military aviators began in earnest. Glenn Curtiss started training pilots in San Diego, California. American aerial photography was initiated in 1911, when a pilot training in a Curtiss pusher aircraft leaned out of his cockpit to photograph San Diego's harbor. Soon afterward pilots everywhere were taking pictures of earth with hand-held cameras. The Wright brothers meanwhile established a flight school at Montgomery, Alabama, in 1910 on the site where Maxwell Air Force Base now stands. In 1910, Orville Wright staged a spectacular air show at Belmont Park flying his new plane "Baby Grand" at speeds reaching 80 miles per hour. Later, he took "Baby Grand" to a record altitude of 9,714 feet.

The airplane had a great advantage over balloons, rockets, pigeons, and kites for reconnaissance, in that it could be flown at a specific altitude at a specified speed and could cover a much larger area.

WORLD WAR I

Although plagued with many operational problems, the use of aerial photography experienced a quantum leap in World War I. The airplanes were vibrating, bouncing platforms, not exactly ideal for taking photos. To dampen vibrations, pilots and mechanics soon devised a variety of makeshift suspension systems, some using sections of inner tubes or rubber sponges, others using improbable but functional items such as tennis balls. The cameras were mounted on the sides of the aircraft, and the slipstream made plate changing a difficult and fumbling operation.

Automatic cameras were developed during the war that could take photographs in rapid succession over a prescribed area. Pasted together, these photographs formed a "mosaic" which, properly scaled, could be made into accurate battlefield maps. Later, cameras were designed to acquire overlapping photos. Two adjacent photographs, called stereoscopic pairs, provided three-dimensional views when viewed in a stereoscope. Heights, widths, and lengths could be measured precisely. World War I was characterized by trench warfare and photo interpreters soon established "signatures" for the various pieces of military equipment and operations. A target "signature" was defined as a set of specific characteristics (a unique pattern) which could be measured and used to identify an object. Specific object characteristics included intrinsic properties such as size, shape, and texture. Photo interpreters were able to make firm identifications of specific gun positions, logistic areas, and more importantly – by studying comparative trench photography – pinpoint "jump-off" trenches and, thereby, predict offensive operations.

During the first weeks of the war, in the wreckage of a zeppelin, the French found an aerial camera far superior to theirs or the British, prompting a renewed effort in developing reconnaissance cameras. In the United States, a school of aerial photography was established by the Army at the Eastman Kodak Company in Rochester and another at Cornell University.

An important event in the history of aerial photographic reconnaissance and interpretation occurred in March 1915 when, for the first time in the history of warfare, British Forces attacked Neuve Chapelle based on maps prepared solely from aerial reconnaissance.

American military leaders now recognized the importance of aerial reconnaissance; the Army's chief signal officer, Gen. George P. Scriven, testifying before the House Military Affairs Committee in 1914, exalted the airplane as "the farseeing eyes of a commander." Col. Edward Steichen, later a famous photographer, commanded the Photographic Section of the American

Expeditionary Forces. He wrote: "The consensus of expert opinion, as expressed at the various inter-Allied conferences on aerial photography, is that two-thirds of all military information is either obtained or verified by aerial photography. The success with which aerial photographs can be exploited is measured by the natural and trained ability of those concerned with their study and interpretation. The aerial photograph is itself harmless and valueless. It enters into the category of 'instrument of war' when it has disclosed the information written on the surface of the print."[8]

As the quality of the imagery improved, accurate measurements of objects became practical, and a new science, photogrammetry, was born. The principal use of the early aerial photographs was the construction of maps and charts for military purposes. Among the aircraft used for photoreconnaissance during the war, the deHavilland DH-4 proved to be one of the most versatile and reliable, because of its airborne stability. A restored DH-4 reconnaissance aircraft now hangs in the Smithsonian Air and Space Museum.

BETWEEN THE WARS

Following World War I, US governmental agencies were quick to see the value of aerial reconnaissance in performance of their assigned tasks. The aerial photo not only offered a speedier and more accurate method of accomplishing reconnaissance, but also was economical. It offered a means to conduct observations where terrestrial observations were restricted or could not be physically accomplished. The value of the aerial photo in peaceful applications was recognized by Earnest Lester Jones, Superintendent of the Coast and Geodetic Survey, when he wrote in 1919: "There has been much talk, in recent months, in regard to surveying the country from airplanes. This is a subject in which the Coast and Geodetic Survey is much interested, because it seems probable that the airplane can be used to a great extent in revising the topography along the shore of the country, and in some parts of the interior, and also in making original surveys."[9] In 1922, Professor W. T. Lee wrote an amazing paper entitled "The Face of the Earth as Seen From the Air" pointing out the many and varied uses of peacetime aerial reconnaissance. Lee's predictions were realized as exploration of remote areas of the world by aerial surveys became indispensable in a broadening search for raw materials, especially oil during the 1920s and 1930s.

Photo technology, in general, precursed photo interpretation capabilities. The late Arthur C. Lundahl, the nation's eminent photo interpretation spokesman after World War II, probably stated it best when he said: "Each photo interpreter looks at a photo through the window of his experience." Lundahl also likened the development and application of aerial photography to the invention of gunpowder. Just as gunpowder changed warfare, aerial photography has revolutionized and impacted nearly every method we employ to observe and solve earth-science problems.

Both military and civilian innovators were active in the interwar period, particularly in the design of single- and multi-lens cameras for mapping and charting purposes. High- and low-speed shutters were developed to take aerial photographs under a variety of lighting and depth-of-field conditions. Shutterless cameras and moving film magazines were also developed. Experiments were conducted using gyroscopes to stabilize the cameras. Major George Goddard of the Army Air Corps (later to become a US Air Force general) was one of the principal experimenters and, after conducting a variety of experiments, opted for the trimetrogon camera system (one vertical and two oblique-angle cameras) which allowed photographs to be taken simultaneously to create a "three dimensional" image. It was also preferred because aerial mosaics could be formed from the images and, since there were overlapping photos, they could be studied in stereo. Major Goddard also experimented with

pyrotechnics to permit taking photographs during periods of darkness.

In addition to developing the proper reconnaissance camera, an appropriate reconnaissance aircraft was a key goal of interwar research. Such a plane had to have the requisite speed, stability in flight, unobstructed vision in all directions for navigation, and a high ceiling. During the 1930s, the US Army Air Corps developed a series of observation aircraft (O Series) that had radio listening and detection capabilities, along with an aerial photographic system. The O-43 could cruise at 164 mph while the later O-47 cruised at 220 mph. Private companies were also developing aircraft for reconnaissance. The Abrams Aerial Survey, a private mapping and charting company, introduced the "Explorer" – the only plane, at that time, specifically designed to take aerial photos for mapping and charting purposes. The "Explorer" was an extremely stable, pusher-prop plane with a large plexiglass nosewindow for unobstructed vision in all directions, so cameras could be mounted on a variety of platforms.

It was painfully surprising in 1940, however, to find how little attention the American armed services had paid to the intelligence potentialities of aerial photography by not developing an integrated photographic intelligence program. At the time, the Germans were leading the world in reconnaissance, primarily because of the Zeiss lens and camera technology, and also in the interpretation of imagery. General Oberst Baron Werner Von Fritsch, Chief of the German General Staff, wrote in 1938: "The nation with the best photo interpretation will win the next war."

WORLD WAR II

World War II reconnaissance experts soon found that the lumbering observation aircraft and reconnaissance bombers would not survive long in combat operations, so both the US and British experts took their fastest aircraft and converted them for reconnaissance. The US Lockheed F-5 Lightning and the British Spitfire and Mosquito became the principal reconnaissance vehicles. Certain bombers in formations were also equipped with cameras to record bomb patterns for bomb damage assessment studies – determining how many bombs actually hit their target, along with their effectiveness.

The main thrust of the British photo interpretation effort was the establishment of a photo interpretation school at Dansfield House, Medmenham, a palatial mansion on the north bank of the Thames between Marlow and Henley. A number of American officers trained by the British were involved in organizing in January 1942 the US Navy Photo Interpretation Center and School at Anacostia near Washington and the US Army Center at Harrisburg, Pennsylvania.

During the war, in the European Theater, American photo interpreters were quickly integrated with British and other Allied photo interpretation units. Prosecution of the war in the Pacific presented entirely different circumstances from the war in Europe. The geography was different, the enemy's base of operation was often beyond the range of most Allied aircraft, and there was little reliable information on the islands to be assaulted. The need for up-to-date information and maps for planning offensive operations was of paramount concern. The "uncontrolled mosaic" (assembling unrectified vertical aerial photographs quickly without accurate ground control to form a pictorial representation) proved invaluable in these endeavors. A reconnaissance plane assigned to photograph an area flew a predetermined track at a given altitude. The film was developed, prints made, assembled and a mosaic compiled. Photo interpreters would then painstakingly study and extract information from the photos on coastal defenses, airfields, supply dumps, communication centers, etc. Detailed studies were also prepared on beaches and their defenses, target charts for aviators, and approaches and egresses in preparation for amphibious landings. Three-dimensional terrain models derived from aerial photography were used to brief aviators and ground and naval commanders prior to a landing. Photo interpreters developed methods to determine underwater depths for invasion planning and provided information to the newly organized US Navy Underwater Demolition Teams for the removal of mines, tetrahedrons, posts, wire, and a variety of other enemy-placed obstacles designed to impede beachhead landings. Photo interpreters also became so adept at locating and identifying enemy antiaircraft weapons emplacements that

they were often called upon to help determine the safest target approach and departing routes for strike aircraft. The caveat "photo confirmed" on a World War II order-of-battle, bomb damage, situation report, or intelligence estimate became the hallmark of authenticity.

Despite the wide disparity of location and objectives, Allied photo interpreters devised three separate reporting phases for the photo interpretation effort: the flash or first-phase involved a quick interpretation of imagery and "flashing" of intelligence information deemed vital or immediate that might affect tactical operations or combat. Second-phase reporting involved a close study of the photos and a report prepared on the subject of concern. Third-phase reporting involved detailed research and preparation of a comprehensive report.

The greatest photo interpretation effort in history was applied to the preparations for Operation Overlord, the Normandy landings of 6 June 1944. Photo interpreters pored over thousands of aerial photos for days, pinpointing enemy beach defenses, troop dispositions, radars, lines of communications and transportation to the beaches. It was the photo interpreters who selected, analyzed, and constantly monitored the beaches and airborne landing areas to be assaulted by Allied forces. More than 1,700 officers and enlisted men working around the clock studied over 85,000 negatives and prints daily. This task alone took more than a half-million man hours. Other massive photo interpretation efforts were launched to support the invasions of the Philippines, Okinawa, southern France and preparations for the invasion of Japan.

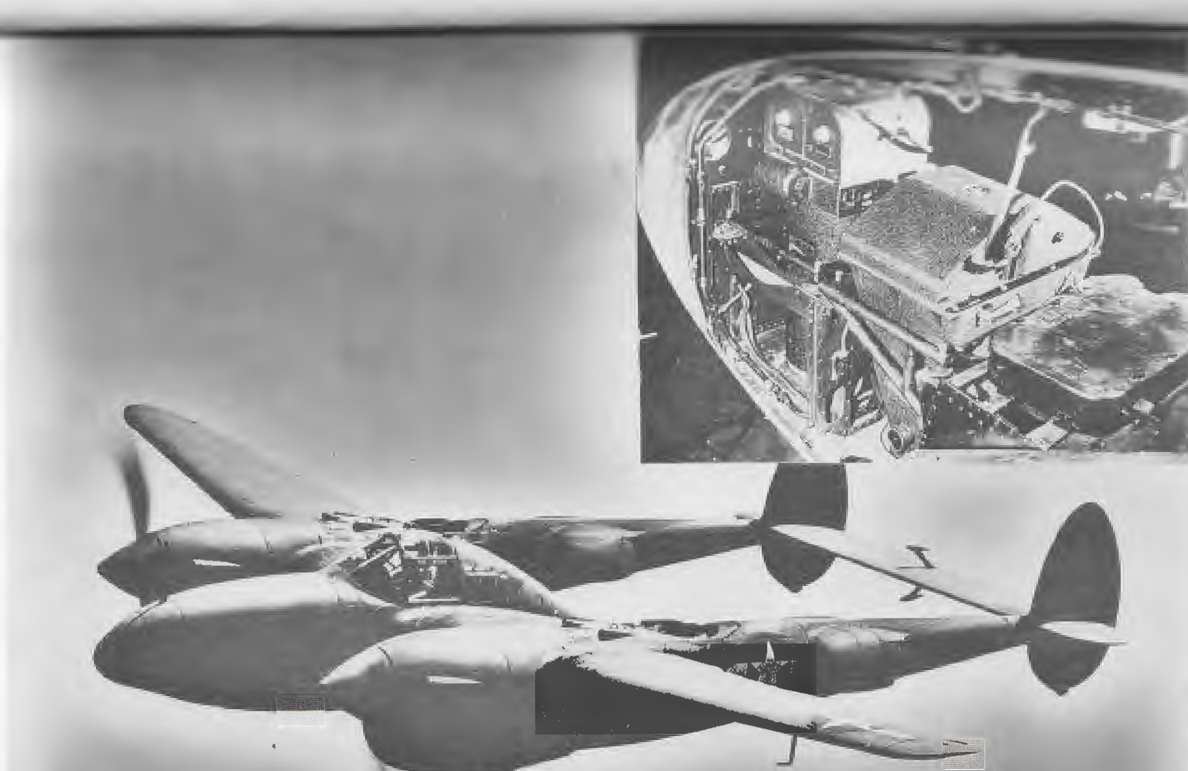
During World War II, the Allies used extensive strategic bombing to cripple German and Japanese industries. The planning and coordinating agency finally developed for these efforts was the Joint Target Group, established by the Army Air Corps and the Navy in Washington, D.C. in the fall of 1944. The Joint Target Group not only nominated the targets but also recommended the type of ordnance to be used and proposed the strategy for conducting operations in varying weather conditions.

In all these responsibilities, reconnaissance and photo interpretation were crucial, finding application in development of sea and air navigation charts, reconnaissance maps, battle maps, terrain studies, bombardment and bombing aids, underwater depth determination, aids for amphibious operations, bomb damage surveys, camouflage and concealment studies, and preliminary surveys for military construction of bases.

Reconnaissance took on many new forms not only from the ground, the air, and the sea but also from beneath the sea through the use of periscope photography. Intelligence procedures were also established for the location and analysis of underground military and industrial installations. World War II not

only greatly advanced the art and science of aerial photography and photogrammetry, but also spurred the development and use of remote sensing devices, including color infrared, thermal infrared, and radar systems. In the post-war period these detectors were applied to the development of airborne optical-mechanical scanners, radiometers, and spectrometers.

After the war, President Roosevelt and later President Truman authorized a massive effort by the armed forces to conduct the United States Strategic Bombing Survey, an evaluation of the bombing efforts of the war. The conclusion for the Pacific survey stated: "Although viewed with indifference and skepticism at the beginning of World War II, aerial photography ultimately became the most important single source of intelligence in the Pacific War...[and] played an important part in more phases of military and naval operations than any other sources."[10]



The P-38 or F-5 Reconnaissance Aircraft.
Department of the Army

The Bridge Over the River Kwai. In the foreground the damaged railroad bridge. In the background the bridge the prisoners

The Auschwitz-Birkenau Extermination Camp.
National Archives

U-2 photo of the discovery of MRBM missiles in Cuba. *US Air Force Photo*

Low altitude photo of MRBM missiles in Cuba. *US Air Force*

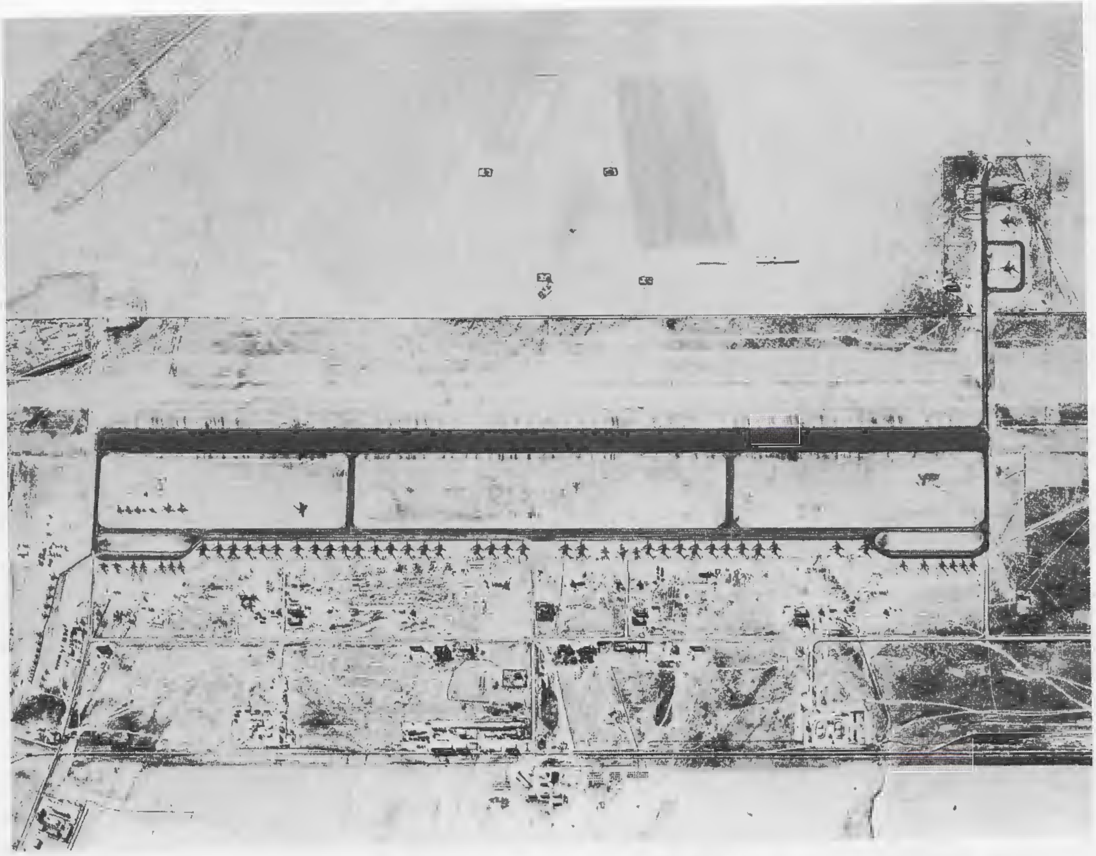
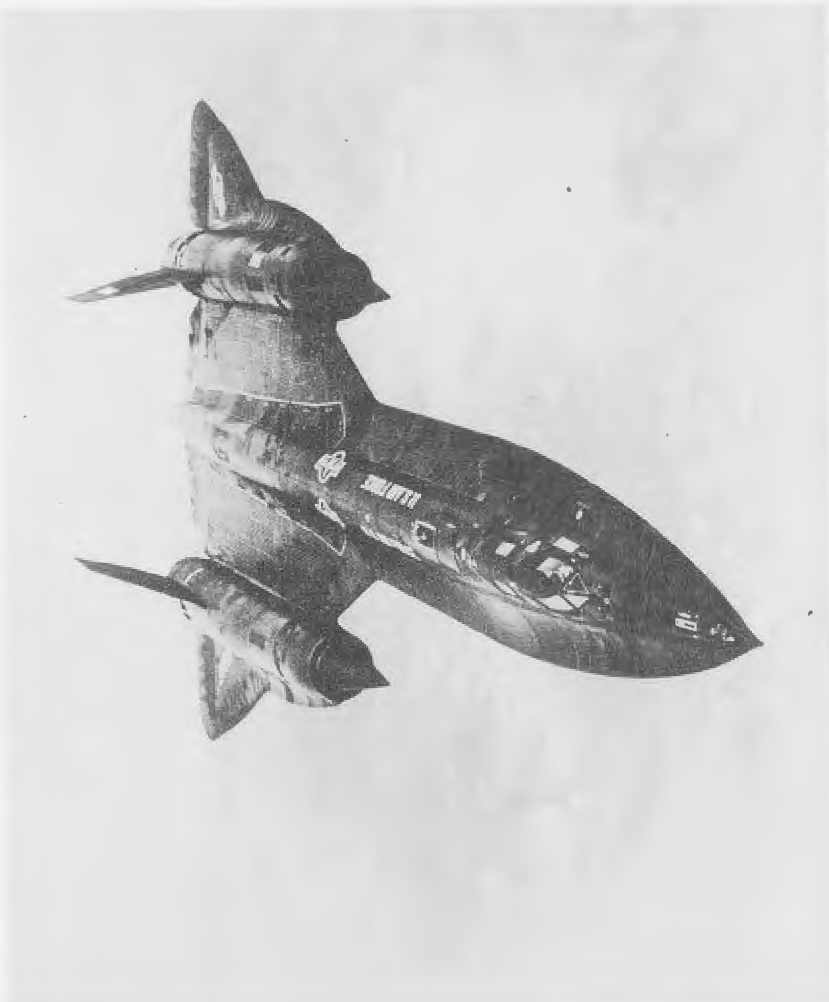


Photo of a Soviet Long Range Bomber Base revealing details and number of bombers proved that the bomber gap did not exist. *Central Intelligence Agency*

The U-2



The SR-71

THE COLD WAR PERIOD

Successive events in the immediate post-war period provided ample evidence that the USSR would become the principal military, political, and economic adversary of the United States. The Berlin blockade was one early indicator of suspect Soviet actions that confronted President Truman in 1948. In 1949, the Soviets detonated a nuclear device. The US intelligence community had little knowledge of the details of that event or where or how the weapon had been produced. Attempts to procure the needed strategic intelligence on the Soviet Union in order to provide estimates for the policymakers met with repeated failures. In late 1953, a US military attache observed a heavy jet intercontinental bomber (later designated the Bison) at a test and experimental airfield near Moscow. The Soviets now possessed atomic weapons and a capability of delivering them to targets in the United States.

Shortly after General Dwight D. Eisenhower assumed the presidency, he rather forcefully indicated that he was not pleased with the currency of US intelligence collection and estimates concerning Soviet strategic capabilities. He was convinced that modern science could provide the required intelligence and, on 26 June 1954, asked Dr. James Killian, Jr., the president of the

Massachusetts Institute of Technology, "to direct a study of the country's technological capabilities to meet some of its current problems."[11] The problems listed were primarily concerned with intelligence needs. Dr. Edwin Land, the eminent photo scientist and inventor of the Polaroid camera, was appointed to chair the Technological Capabilities Panel which concerned itself with the development of film, lenses, cameras, and the platform to carry them over prescribed targets. Dr. Land was guided by his personal credo: "My motto is to select things that are manifestly important and nearly impossible." He maintained that "discoveries are made by some individual who has freed himself from a way of thinking that is held by friends and associates who may be more intelligent, better educated, better disciplined, but who have not mastered the art of a fresh, clean look at the old, old knowledge."[12] Arthur Lundahl would remark: "Dr. Land was thinking all the time, an idea man of the first order. His mind was always at top speed – imaging, seeking solutions and fulfillment. He had a lifelong fascination with light and color." Lundahl added: "He did all of his work on horseback. He would stop, sweep the dust off his saddle bag and say let's go this way. He opposed having all research and development under a centralized command. He detested what he called the regulations, infringements, boards, panels, and red tape that characterized government research and development. He detested the people who sit around 'playing the bureaucratic games.' He instead said, 'Never separate R & D from the functioning people. Bootleg it, if necessary.' "[13]

The platform for the ultimate in reconnaissance for its time, the U-2, was designed by Clarence L. "Kelly" Johnson and built by the Lockheed Aircraft Corporation for the CIA. The U-2, test flown in August 1955, could fly at over 70,000 feet at 430 mph with a range 5,600 miles.

President Eisenhower, aware of the advances of reconnaissance and photo interpretation, proposed to the Russians at the Summit Conference in Geneva on 21 July 1955, that a mutual inspection program be negotiated for peace. The proposal, labeled "Open Skies" by the press, was summarily rejected by the Russians. Eisenhower subsequently approved operational U-2 missions over the Soviet Union.

THE U-2 and SR-71 ERA

Concomitant with the development of the U-2, the CIA hired Arthur C. Lundahl away from the Navy to establish its advanced photo interpretation center. The first flight of the U-2 over the Soviet Union took place on 4 July 1956. Subsequent missions would cross and criss-cross the Soviet Union. Within a few months, the so-called "bomber" myth was dispelled. Subsequently, the U-2 roamed over the Soviet Union and the "missile gap" was defused.

The U-2s were also flown during the Suez Crisis, the Lebanon Crisis, the Communist takeover of Tibet, the China Off-Shore Island Crisis, and in Vietnam. It was a U-2 mission over Cuba in October 1962 that showed Soviet offensive missiles capable of delivering nuclear warheads to nearly everywhere in the continental United States.

Lundahl said he would never forget briefing President Kennedy on the missile sites: "I placed the enlarged photos in front of the President, along with a magnifying glass, then stood behind him and pointed out the highlights over the President's shoulder. I showed him the various pieces of equipment that supported the medium range missiles. He looked up from the U-2 photos and looked me straight in the eye and said, 'are you sure?' " Lundahl replied, "Mr. President, I am as sure of this as a photo interpreter can be sure of anything. And I think sir, you might agree that we have not misled you on anything we have reported to you."[14] The crisis ended when the Russians agreed to remove the missiles and return them to the Soviet Union.

Responsibility for U-2 operations was taken over by the US Air Force in the mid 1960s and continues to this time.

Reconnaissance and photo interpretation were called upon to play a new role – monitoring a peace agreement. After the Yom Kippur War of October 1973, the United States proposed that U-2s could be used to monitor the truce agreed upon by Egypt and Israel. The U-2 missions proved so successful that the agreement between Egypt and Israel on 1 September 1975 provided for the continuation of the reconnaissance missions.

Even as the U-2s were bringing back invaluable intelligence information, a successor reconnaissance aircraft was being developed by the CIA. President Eisenhower was briefed on 20 July 1959 on the Lockheed developed A-11, later to be designated the SR-71 "Blackbird." The SR-71 was made public by President Johnson on 24 July 1964. It was designed to survey vast areas with a wide variety of sensors. It could fly at 2,100 mph at over 80,000 feet with a range of more than 2,000

miles without refueling, and had global range with aerial refueling. Operational responsibility for the SR-71 was later transferred from the CIA to the US Air Force. USAF SR-71 sorties began on 21 March 1968 from Japan, and later Okinawa, over North Vietnam. It was the most valued reconnaissance vehicle during the Vietnam conflict. In addition to the SR-71, combat reconnaissance, U-2s, and aerial photographic drones were employed over Vietnam. Because of the difficulty of determining military activity under the jungle canopy, a variety of sensors – including radar, infrared, and near infrared – were flown. Because of tight fiscal constraints, the SR-71 was deactivated prior to the 1990-91 Gulf War.

RECONNAISSANCE SATELLITES

On 18 August 1960, at 12:57 p.m. the US Discoverer XIV space satellite was launched from Vandenberg Air Force Base in California into an orbit having an apogee of 500 miles and a perigee of 120 miles. The reentry capsule was ejected over Alaska on its seventieth pass. This capsule, which contained a roll of exposed film, is now on display at the Smithsonian's National Air and Space Museum.

Since the launch of the first satellite, reconnaissance experts realized they would not only have a stable platform for cameras and sensors but also a capability to conduct reconnaissance over large areas in near synoptic periods. During the 1960s, the placing of satellites in space revolutionized the collection of intelligence information. The importance of reconnaissance satellites and their findings was implicitly acknowledged in the Strategic Arms Limitation Treaties (SALT) with clauses specifically prohibiting interference with each other's "national technical means of verification." President Carter stated the classified satellites "have played, and will continue to play, an important role in the national security of the United States."[15]

The advent of high-flying U-2 and SR-71 reconnaissance aircraft, and the orbiting satellites, left no location on the face of the earth sufficiently remote or distant to preclude photographic collection. Orbiting camera systems can be aimed remotely by computer, be it over the jungles of Brazil, the sands of the Sahara, or the tundra of the Asian land mass. While other sources of information may require days of planning for collection and subsequent evaluation, translation, and verification, photography is readily interpretable and the information immediately verifiable.

The placing of remote sensors in space by NASA, especially the Earth Resources Technology Satellite (ERTS) system and later the LANDSAT, literally broadened the view and enhanced the perception of our universe. These satellites detect, record, and transmit details acquired by detectors sensitive to wave lengths not visible to the naked eye, from ultraviolet through the far infrared frequencies. These modalities are generally termed electro-optical intelligence. Clark Nelson, director of corporate communications for the French Spot Image Corporation, which operates an imagery system in space, stated: "The real trick is to make it easy to use. It is a tremendous amount of information that has to be put together before it's worth a dime to anybody." Interpreters had to be sensitized to the new forms and patterns recorded on imagery acquired by these sensors. In the late 1960s, there was a realization that the term photo interpreter was too restrictive and a new term "imagery analyst" was devised to convey the meaning that

a wide variety of images was being interpreted to come to more meaningful conclusions. Analysts began to discover, measure, and observe changes in earth resources, and the dynamic and often harmful processes by which man was effecting unnatural changes on his planet. Aerial photography and multisensor imagery have opened new vistas, both literally and figuratively, for scientists and engineers in numerous fields of endeavor. These same scientists and engineers, using data from imagery interpretation and applying ingenuity and technological refinement to their endeavors, have reaped a wealth of new information. Knowledge is being gathered in an ever accelerating rate, often faster than man can absorb it. More has been learned about planet earth through imagery analysis in the past 30 years than was known in the past 3,000 years. The future portends even greater opportunities for increased knowledge because sensor-collected imagery can be digitized. The combining of imagery interpretation expertise with computer technology, and their interactions and manipulations, provide for numerous innovative applications. Continuing computer and software advancements make the entire scientific information gathering and interpretation system manageable.

In 1965, NASA prepared a report for the US House of Representatives' Committee on Science and Technology which was subsequently passed to President Johnson. It read in part: "Down through the course of history, the mastery of a new environment, or of a major new technology, or of the combination of the two as we now see in space, has had profound effects on the future of nations; on their relative strength and security; on their relations with one another; and on the concepts of reality held by their people."[16]

On 18 September 1974, President Nixon addressed the UN General Assembly. He remarked: "Of all man's great enterprises none lends itself more logically or compellingly to international cooperation than the venture into space. We are just beginning to comprehend the benefits that space technology can yield here on earth."[17]

The successes and results of new reconnaissance systems prompted US Vice-President Walter Mondale, on 24 May 1978, to announce in a speech to the United Nations that the United States was prepared to consider requests for technical monitoring services such as aircraft photo reconnaissance and ground sensor detection in situations where such "eyes and ears of peace" might support disengagement agreements or other regional stabilizing measures.

The synergistic effect of combining reconnaissance with other sources is now accomplished on a daily basis and was best illustrated in the Gulf War. Representative Les Aspin, then chairman of the House Armed Services Committee, in an address to the American Institute of Aeronautics and Astronautics on 1 May 1991, said he had asked Bill Perry, an eminent scientist, to explain the

successes of the Gulf War. Aspin said Perry stated that "three critical categories had big multiplier effects and were at the core of the fact that this whole thing turned out to be the rout. His nominees were first his c-cubed-eye, or command, control, communications, and intelligence. In the Gulf War our commanders knew where the friendly forces were and where the enemy was to an unprecedented degree. This was the result of a number of things: spy satellites, AWACS [Airborne Warning and Control System], J-STARS [Joint Surveillance and Target Attack Radar Systems], airborne radars, global positioning satellites, aerial reconnaissance – all of these things put together allowed us to have an enormous knowledge of what was going on across the whole battlefield."[18]

Imagery interpretation has not been confined to planet earth. Prior to the advent of satellites, taking pictures of planets was strictly an earthbound event. Cameras and sensors have been employed in lunar and planetary probes and have sent back a wealth of new information that challenges age-old views, and provides data that raise hundreds of new questions. This new knowledge feeds new processes of thought and new understanding of many scientific disciplines and broad categories of technology. Satellites have travelled to the far reaches of the solar system to provide close-up details of our sister planets. These satellites have also allowed the investigation of the planets' interior, crust, biosphere, ice cover, and atmosphere and have provided invaluable information on our solar system and its creation.

The development of new reconnaissance systems will continue to be spurred by the Executive Department, the Congress, and the military in order to learn more and more details in a timely fashion before decisions are made, and to provide direct support to operational military forces.

We have gone to the top of the atmosphere and beyond and with every photograph taken and analyzed, we have indeed learned to better understand the planet and the universe in which we live.

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