**The Development of RADAR and SONAR**

[*Science and Its Times*](http://go.galegroup.com/ps/eToc.do?rcDocId=GALE%7CCX3408503840&inPS=true&prodId=GVRL&userGroupName=68046&resultClickType=AboutThisPublication&contentModuleId=GVRL&searchType=BasicSearchForm&docId=GALE%7C5APC)

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Background

For hundreds of years, non-mechanical underwater listening devices (listening tubes) had been used to detect sound in water. As early as 1882, the Swiss physicist Daviel Colladen attempted to calculate the speed of sound in the known depths of Lake Geneva.

Based upon the physics of sound transmission articulated by nineteenth-century English physicist Lord Rayleigh (1842-1914) and the piezoelectric effect discovered by French scientist Pierre Curie (1509-1906) in 1915, French physicist Paul Langevin (1872-1946) invented the first system designed to utilize sound waves and acoustical echoes in an underwater detection device. In the wake of the Titanic disaster, Langevin and his colleague Constantin Chilowsky, a Russian engineer then living in Switzerland, developed what they termed a "hydrophone" as a mechanism for ships to more readily detect icebergs (the vast majority of any iceberg remains below the ocean surface). Similar systems were put to immediate use as an aid to underwater navigation by submarines.

Improved electronics allowed the production of greatly improved listening and recording devices. Because passive SONAR is essentially nothing more than an elaborate recording and sound amplification device, these systems suffered because they were dependent upon the strength of the sound signal coming from the Page 539  |  [Top of Article](http://go.galegroup.com/ps/retrieve.do?sgHitCountType=None&sort=RELEVANCE&inPS=true&prodId=GVRL&userGroupName=68046&tabID=T003&searchId=R1&resultListType=RESULT_LIST&contentSegment=&searchType=BasicSearchForm&currentPosition=2&contentSet=GALE%7CCX3408503840&&docId=GALE%7CCX3408503840&docType=GALE#content) target. The signals or waves received could be typed (i.e., related to specific targets) for identifying characteristics. Although quite good results could be had in the hands of a skilled and experienced operator, estimates of range, bearing, and relative motion of targets were far less precise and accurate than results obtained from active systems, unless the targets were very close—or made a great deal of noise.

The threat of submarine warfare during WWI made urgent the development of SONAR and other means of echo detection. The development of the acoustic transducer that converted electrical energy to sound waves enabled the rapid advances in SONAR design and technology during the last years of the war. Although active SONAR was developed too late to be put to much of a test during WWI, the push for its development reaped enormous technological dividends. Not all of the advances, however, were restricted to military use. After the war, echo-sounding devices were placed aboard many large, French ocean-liners.

During the early battles of WWII, the British Anti-Submarine Detection and Investigation Committee (its acronym, ASDIC, became a name commonly applied to British SONAR systems) made efforts to outfit every ship in the British fleet with advanced detection devices. The use of ASDIC proved pivotal in the British effort to repel damaging attacks by German submarines upon both British warships and merchant ships keeping the island nation supplied with munitions and food.

While early twentieth-century SONAR developments proceeded, another system of remote sensing was developed based upon the improved understanding of the nature and propagation of electromagnetic radiation achieved by Scottish physicist James Clerk Maxwell (1831-1879) during the nineteenth century.

In the 1920s and early 1930s, Scottish physicist and meteorologist Sir Robert Alexander Watson-Watt (1892-1973) successfully used short-wave radio transmissions to detect the direction of approaching thunderstorms. Another technique used by Watson-Watt and his colleagues at the British Radio Research Station measured the altitude of the ionosphere (a layer in the upper atmosphere that can act as a radio reflector) by sending brief pulses of radio waves upward and then measuring the time it took for the signals to return to the station. Because the speed of radio waves was well established, the measurements provided very accurate determinations of the height of the reflective layer.

In 1935, Watson-Watt had the ingenious idea of combining these direction- and range-finding techniques, and, in so doing, he invented RADAR. Watson-Watt built his first practical RADAR device at Ditton Park.

Almost immediately, officials at the Royal Air Ministry asked Watson-Watt whether his apparatus might have the potential of damaging or downing enemy aircraft. Watson-Watt responded that radio wave transmissions were far too weak to achieve this end. Regardless, he suggested to Ministry officials that radio detection was feasible. In 1935, Watson-Watt wrote a letter titled "Detection and Location of Aircraft by Radio Methods." Watson-Watt carefully set forth that reading the weak return signal from an aircraft would pose a far greater engineering challenge than encountered in his meteorological experiments. The signal sent out needed to be more than a hundred times more energetic. In addition, a more sensitive receiver and antenna would need to be fabricated.

Shortly thereafter, without benefit of a test run, Watson-Watt and Ministry scientists conducted an experiment to test the viability of RADAR. The Watson-Watts apparatus was found able to illuminate (i.e., detect) aircraft at a distance of up to 8 mi (13 km). Within a year, Watson-Watt improved his RADAR systems so that it could detect aircraft at distances up to 70 mi (113 km). Pre-war Britain quickly put Watson-Watt's invention to military use and by the end of 1938 primitive RADAR systems dotted the English coast. These stations, able to detect aircraft regardless of ground fogs or clouds, were to play an important role in the detection of approaching Nazi aircraft during WWII.

The development of RADAR was not the exclusive province of the British. By the outbreak of WWII all of the major combatants had developed some form of RADAR system. On many fronts battles were often to be influenced by dramatic games of scientific and technical one-upsmanship in what British war-time Prime Minister Sir Winston Churchill called the "Wizard War." During the war, Watson-Watt became one of those wizards as he took up the post of scientific advisor to the Royal Air Ministry.

By the end of the war the British and American forces had developed a number of RADAR types and applications, including air interception (AI), air-to-surface vessel (ASV), Ground Page 540  |  [Top of Article](http://go.galegroup.com/ps/retrieve.do?sgHitCountType=None&sort=RELEVANCE&inPS=true&prodId=GVRL&userGroupName=68046&tabID=T003&searchId=R1&resultListType=RESULT_LIST&contentSegment=&searchType=BasicSearchForm&currentPosition=2&contentSet=GALE%7CCX3408503840&&docId=GALE%7CCX3408503840&docType=GALE#content) Controlled Interception (GCI), and various gun sighting and tracking RADARs.

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Ironically, WWII induced design improvements in SONAR technology that laid the foundation for the development of non-invasive medical procedures such as ultrasound in the last half of the twentieth century. Sound- and electromagnetic signal-based remote sensing technologies and techniques became powerful medical tools that allowed physicians to make accurate diagnosis with a minimum of invasion to the patient.

Remote sensing tools such as RADAR and SONAR also allow scientists, geologists, and archaeologists to map topography and subsurface features on Earth and on objects within the solar system. SONAR readings led to advances in underwater seismography that allowed the mapping of the ocean floors and the identification of mineral and energy resources.

RADAR systems are critical components of the modern commercial air navigation system. One British wartime invention, Identification Friend or Foe (IFF) RADAR, used to identify and uniquely label aircraft, remains an important component in the air traffic control system.

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