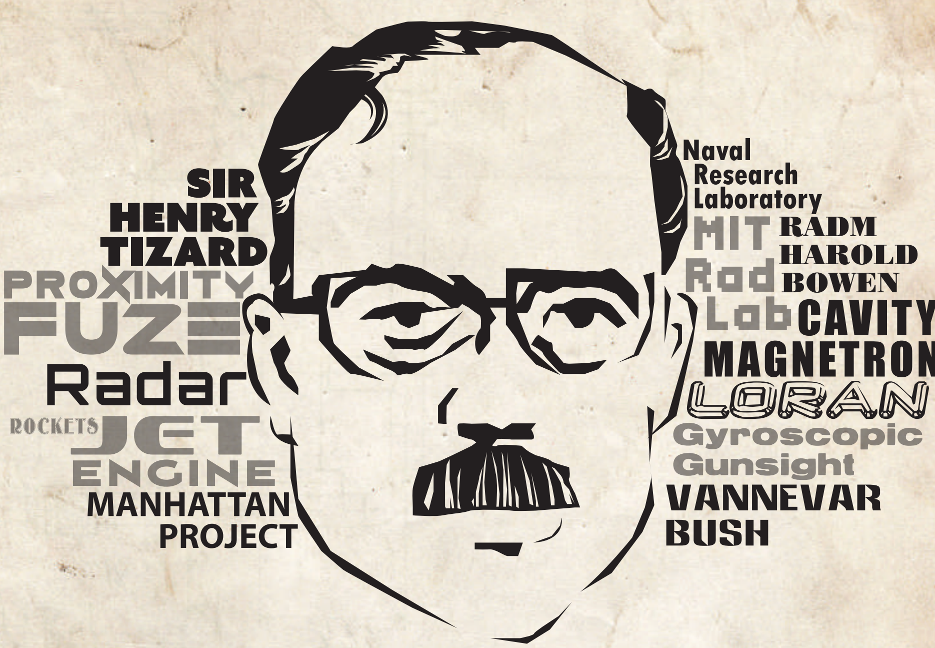


TIZARD MISSION

75TH ANNIVERSARY COMMEMORATION

11. 17. 2015

12-5 PM

THE TIZARD MISSION

To borrow and expand on an observation by George Bernard Shaw, the United States, the United Kingdom, and Canada are three nations separated by a common language. In the past occasionally separated by war, but nonetheless joined by strong common threads of origin, the notion of an Atlantic partnership at the beginning of World War II was an intriguing and perhaps even inevitable possibility—but it was surprisingly far away in the summer of 1940 as Great Britain and its Commonwealth fought on against Hitler and Mussolini in an increasingly desperate situation. While politicians found it difficult to overcome their differences, it would be a small group of scientists, engineers, and military officers who would prove to be an improbable catalyst for cooperation. What began as a sharing of technology ultimately blossomed into a war-winning—and enduring—military and political transatlantic alliance.

Faced with war industries already straining to maintain capacity, a population under daily threat of aerial attack by the Luftwaffe, and a merchant marine menaced by U-boats, Britain needed partners, if not allies, that could help them produce new weapons that were ready to move from the drawing board to the production line. Prime Minister Winston Churchill entrusted Sir Henry Tizard, a distinguished scientist who had been instrumental in leading Britain's effort in the 1930s to create the first working radar, with a mission to bring a host of new—and heretofore secret—technologies to Canada and the United States. The hope was that this sharing would lead not only to reciprocity on the part of the Americans in sharing their secrets, but more importantly to the utilization of American and Canadian surplus production capacity to help win the war against the Axis.

In September 1940, Tizard and his small team brought with them to the United States plans for a host of weapons and systems, from the Whittle engine, the first British jet engine, to designs for rockets and gun sights. In all, there were more than 20 different technologies. Most important of all, the team brought with them the remarkable cavity magnetron—at only a few months old, it was by far the newest of all the technologies carried by the mission. The magnetron made possible radars that were both small and powerful, prerequisites for fitting them in aircraft and other platforms and the subsequent expansion of radar's use on, and above, the battlefield. The unprecedented openness of the Tizard Mission produced immediate results, as new technologies were made available for weapons in the air, on land, and at sea. And a new spirit of cooperation and trust was established, paving the way for even greater collaboration once the United States joined the Allies in December 1941.

The outcome, meaning, and legacy of the Tizard Mission and their interactions with their American and Canadian counterparts in the late summer of 1940 are the subjects of this one-day commemoration.

1100-1200	**Registration:** Networking Event, and Refreshments
1200-1205	**Welcome:** Richard Williams, Counseller, Defence Research and Development, Embassy of Canada
1205-1215	**Opening Remarks:** His Excellency Gary Doer, Ambassador of Canada to the United States America
1215-1225	**Opening Remarks:** Rear Admiral Mathias Winter, Chief of Naval Research
1225-1245	**Keynote Talk:** Dr. John Holdren, Assistant to the President for Science and Technology and Director of the White House Office of Science and Technology Policy
1245-1305	**Keynote Talk:** Prof. Vernon Gibson, Chief Scientific Adviser, Ministry of Defence
1305-1325	**Keynote Talk:** The Honorable Sean J. Stackley, Assistant Secretary of the Navy (Research, Development, and Acquisition)
1325-1340	**Break**
1340-1510	**PANEL: The Tizard Mission and the Opening of Transatlantic Technology Exchange** **Moderator and Commentator:** Dr. Randy Papadopoulos, Secretariat Historian, Department of the Navy **Panelists:** Prof. David Zimmerman, University of Victoria Mr. Roger Connor, Smithsonian National Air and Space Museum Dr. Hermione Giffard, Utrecht University
1510-1530	**Break**
1530-1630	**PANEL: Reflecting on the Present and Future of Tizard Mission Technologies** **Moderator and Commentator:** Dr. Larry Schuette, Director of Research, Office of Naval Research **Panelists:** Dr. Bruce Danly, Superintendent, Radar Division, Naval Research Laboratory Dr. Dale Carlson, Technical Advisor Propulsion, Air Force Research Laboratory
1630-1700	**Panel—Canada-UK-US Technology Collaborations** **Moderator:** Mr. James Peddell, Attaché, Defence Science and Technology **Panelists:** Dr. Marc Fortin, Assistant Deputy Minister, Science and Technology, Department of National Defence Mr. Roland Knott, Head, Defence Science and Technology Strategy Rear Admiral Mathias Winter, Chief of Naval Research

Cavity Magnetron

Canada Science and Technology Museum

When the members of the Tizard Mission arrived in Washington DC in September 1940, they carried with them a black metal deed box that contained, among other things, a special vacuum tube known as a cavity magnetron—E1189 Serial No. 12. Manufactured by the General Electric Company Ltd. at Wembley in North London, the magnetron was the result of several years of research and development aimed at creating a viable and powerful source of microwaves for radar systems.

Microwave radar promised better resolution, smaller equipment, and greater directionality—and therefore range—than existing systems. But researchers had not been able to achieve both centimetric wavelength and sufficient power levels until the team of Henry Boot and John Randall at Birmingham University put together their first high-power magnetron in February 1940. Through that summer, General Electric joined the effort to refine and manufacture the tubes, producing no fewer than 11 versions of the magnetron. In August they made the first tube with 8 cavities instead of the original 6. This was the tube that the Tizard Mission took with them to North America.

A month later, the British scientists unveiled No. 12 in front of a somewhat skeptical audience in Washington. The American researchers found it hard to believe that this diminutive device could generate 10 kilowatts of power at a wavelength of 10 centimeters. But when they turned it on, it did just that. This magnetron had a dramatic impact on the development of high-resolution radar during the war and, ultimately, gave the Allies a significant technical advantage over German research efforts.

When the Tizard Mission left Canada in fall 1940, they left No. 12 with officials of the National Research Council of Canada to serve as a template for their development and production work. There it stayed until 1969 when the NRC entrusted it to the care of the recently opened Canada Science and Technology Museum.

Western Electric 700 Cavity Magnetron

National Electronics Museum

The original British cavity magnetron ran at 3,000 MHz. When it was demonstrated in the United States, the U.S. Navy was very interested, but their early fire control Mark 1 radars were operating at 500 and 700 MHz. It would take some time before they had the other components ready to build a full 3 GHz radar system. Western Electric scaled up the cavity dimensions to make a magnetron that operated at 700 MHz, and successfully integrated it into the Radar Equipment Mark 3 in 1941. The first U.S. production cavity magnetrons were the Western Electric WE 700 series. Thirty magnetron prototypes were manufactured by Western Electric based on the E1189. This is number 6, which was given to the engineering manager of the Westinghouse radio division in Baltimore, Maryland. The unit subsequently was passed to the head of the radar section and then to one of the founding board members of the National Electronics Museum.

Northern Electric Cavity Magnetron

National Electronics Museum

The Northern Electric cavity magnetron was manufactured in Canada and based on the design of the original Tizard mission tube, but it more closely follows the design of the WE D-160052 with a slightly different tuning.

RCA Sylvania 2J32

The RCA Sylvania 2J32 cavity magnetron was the production version of the British cavity magnetron (E1189). The Sylvanias were fielded to most notably in the SCR-584 fire control radar, the SCR-570 airborne search radar, and the AN/APS-2 surface ship and airborne serach radar. By the end of World War II over a million of these tubes were produces and are still readily available today.

BC-929-A Rebecca Interrogator Indicating Unit (AN/APN-2 Rebecca-Eureka System)

National Air and Space Museum

While the Tizard Mission emphasized core technologies such as air-to-surface-vessel radar, other highly significant systems not immediately anticipated in the fall of 1940 soon emerged. The Rebecca-Eureka system played a crucial role, both as a guidance system for airborne assaults and as the foundation for the modern radar transponder. As in radar, the system was made possible by the cathode ray tube oscilloscope and the crystal oscillator. In pathfinder mode, the Rebecca interrogator initiated the pulse at a rate of 300 per minute and the 30-pound Eureka portable ground station issued a response. This 20-mile-range system was primarily intended to be carried into action by a small pathfinder squad that would drop ahead of the main formation and then site the equipment in the landing zone. A system of low-level blind bombing was also developed for the equipment, but may not have been used operationally. Postwar applications included guidance for in-air refueling.

The APN-2 display was remarkably useful. In addition to providing range and azimuth to the Eureka beacons, it could serve as a display for Babs radar approach beacons, the YH pulsed radar navigational beacon, and seven IFF frequencies. It also was a receiver for “H” blind bombing (Rebecca-H) late in the war. The ability of the operator to send coded messages with the unit also made it invaluable as a secure communications device for the drop zone.

Rebecca-Eureka followed the pattern of many Tizard Mission technologies in defining the effectiveness of Anglo-American cooperation by playing to each nation’s strengths. The British Telecommunications Research Establishment conceived the idea and brought it a functional form, while the Radiation Laboratory and Radio Research Laboratory in the United States brought it to a refined form with lighter tubes and other elements better suited to mass production and the operational environment. The airborne landings to reinforce the Salerno beachhead in September 1943 constituted the first major test of Rebecca-Eureka, where it was regarded as an outstanding success.

Gloster E.28/39 Pioneer

National Air and Space Museum

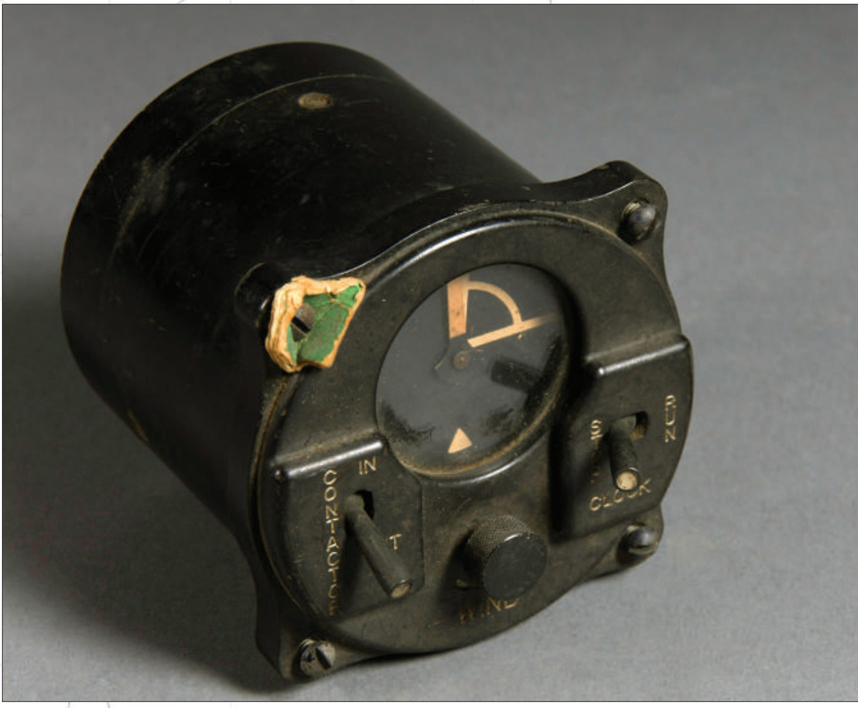
The Gloster E.28/39 was the first Allied jet aircraft and was the most significant early demonstration of the jet propulsion technology dialogues begun during the Tizard Mission. The successful demonstration of Frank Whittle's WU test bench centrifugal flow turbojet in 1937 generated sufficient interest in the Air Ministry to fund further developments. The outbreak of war and rumors of German jet development led to the funding of a demonstrator aircraft powered by the W.1 Power Jets engine. Flight Lieutenant P.E.G. Sayer began flight taxi tests on 7 April 1941 with a nonairworthy engine, and made the first flight on 15 May, about 21 months after Germany's turbojet-powered Heinkel He 178. A second E.28/39 flew in 1943.

Even before the E.28/39's first flight, the Air Ministry began developing specifications for a turbojet fighter that Gloster would eventually deliver as the Meteor. The Meteor was the first and only Allied jet to see active combat during the war. Nonetheless, an extensive array of Whittle-engined aircraft was under development in Great Britain and the United States by the end of the war, ranging from the British Vampire to the American P-80. Had the war continued, Allied jet aircraft would have played a much more significant role. As it was, Whittle's engine had enormous implications for Anglo-American military power in the early Cold War.

If the Norden bombsight was a sticking point of American openness during the Tizard Mission exchange, the Whittle turbines were a point of British reticence. As the United States moved closer to entering the war, these reservations lifted and the Whittle engine played a decisive role in wartime American turbojet engine development led by General Electric's adaptation of the Whittle engine, beginning with the J31.

Identification Unit Contactor, BC-608-A Pipsqueak

National Air and Space Museum



In the aftermath of the Tizard Mission, American forces prepared for the contingency of operating in Britain. This included learning to operate under the British Chain Home air defense radar that proved crucial for Britain's security during the Battle of Britain and the Blitz. During the initial operational employment of the Chain Home, the limited radar coverage and organizational resources were directed at locating approaching enemy formations, rather than tracking friendly aircraft over British soil. Locating the interceptors to direct them to enemy formations required an interim system of location consisting of established radio direction finding (RDF) networks.

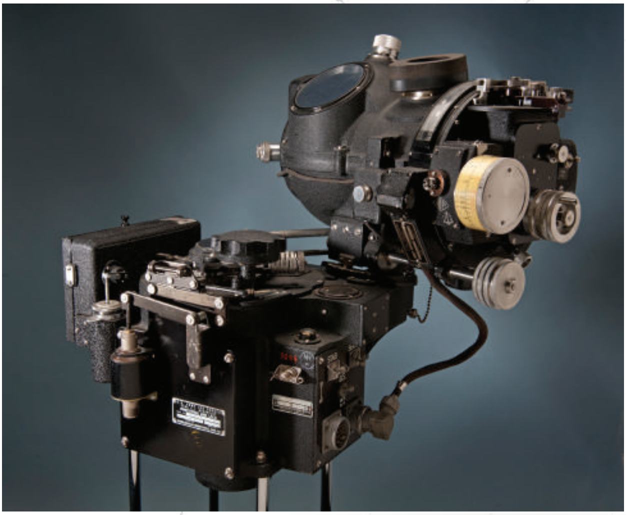
The "Pipsqueak" identification unit contactors like this one were the solution before the advent of dedicated identification friend or foe (IFF) transponders. Pipsqueaks were essentially timers for communication radios that broadcast a 14-second carrier wave every minute, which allowed the RDF stations to determine a fix (but also prevented the pilot transmitting during a period indicated by the arc on the dial). The BC-608 Pipsqueak was an American variant of a British unit developed in 1939 that entered production in January 1942. As the Chain Home system grew in capability and coverage, the need for the contactor disappeared and true IFF transponders took their place. Production was only about 500 units.

Norden M-9B (Mark XV) Bombsight

National Air and Space Museum

The Norden bombsight was the most contentious technology of the Tizard Mission exchange, as U.S. prohibitions on its sale or transfer created a sour note in negotiations. Although the Norden was the most closely held American technology during the war and a principal tool in the daylight bombing campaigns by U.S. Army Air Forces, Navy, and Marine Corps land-based bombers, it was never as accurate, secret, or novel as it was portrayed by the wartime press. The U.S. Navy procured the Norden Mark XI in 1923 to address the problem of level bombing against maneuvering surface vessels. In 1928, development began on a more capable version—the Mark XV—which began tests in 1931. The Mark XV remained in U.S. service until well into the Vietnam War in the 1960s.

Several technical elements contributed to the sight's reputation. An accurate gyroscope steadied a powerful telescopic sight, while a capable rate end computer created a solution to the bombing problem. The pilot received guidance for the bomb track from a pilot's direction indicator and could redirect the path of the aircraft to stay in formation using a "formation stick" side-controller that interfaced with a Minneapolis-Honeywell C-1 autopilot. While bombing from altitudes below 15,000 feet and at speeds less than 200 miles per hour, the sight could reliably strike naval targets. Wartime conditions, however, reduced the accuracy of the bombsight and meant that the Norden never lived up to its on-paper potential.

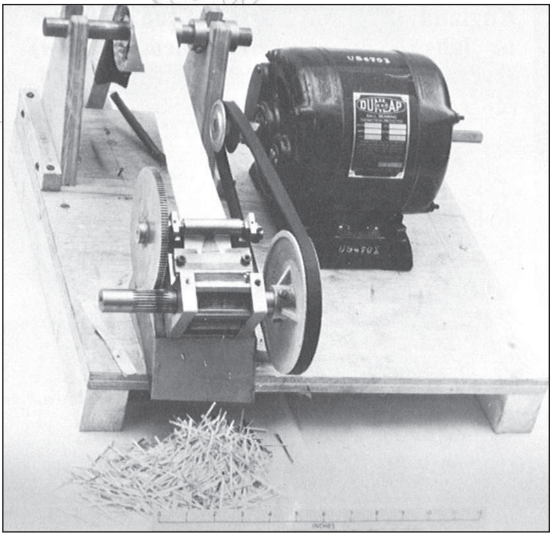


Ignorant of its potential limitations, Britain had repeatedly sought to acquire the Norden during the late 1930s, but was continually rebuffed by the Roosevelt administration. The Tizard Mission hoped to break through the American intransigence, but Roosevelt continued to demur, citing political concerns. Only after Pearl Harbor did the restrictions on the Norden's release to Britain lift. By early 1942, however, the Royal Air Force had settled on its nighttime bombing campaigns where the Norden was of no value.

Prototype Chaff Cutter

National Air and Space Museum

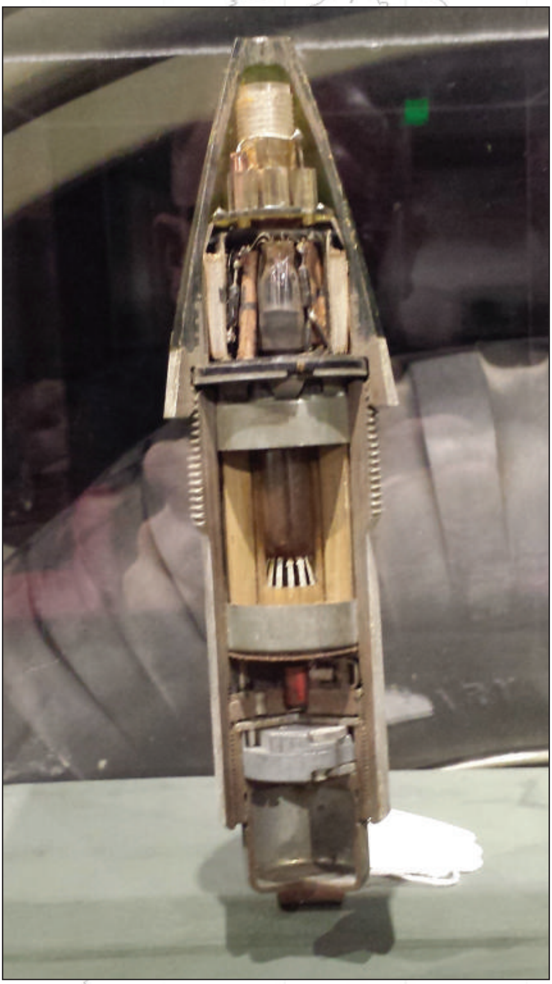
One of the most important joint taskings to emerge out of the Tizard Mission collaboration was the development of effective countermeasures against German radars. Harold Elliot of the Radio Research Laboratory devised this motorized cutter in 1943 to address the problem of manufacturing immense volumes of aluminum chaff while not revealing critical defense data by assigning the task to industry. Dr. Fred Whipple of the Radiation Laboratory realized that the most effective form of countermeasure was to release as many half-length dipoles as possible, which meant cutting the aluminum strips as finely as possible. Mass industrial production of chaff posed a security problem as production clearly indicated potential target frequencies (54 centimeters in the case of the German Würzburg radar). For this reason, the Radio Research Lab sought a solution to internalize large-scale production, a proposal that was ultimately discarded.



The cutter was merely a small-scale experiment in anticipation of the 27-centimeter dipoles dropped by the billions over Germany. Each cardboard packet initially contained a thousand of the finely cut dipoles. Each flat packet was considered a “dehydrated bomber” as it would bloom to a B-17-sized echo on release. German countermeasures included modifications to vary the Würzburg’s wavelength. The Allied countermeasure was a larger triangular packet (think Toblerone chocolate bar) that consisted of three sets of dipole lengths, each consisting of a thousand strands. Chaff played an enormously important role in the strategic bombing campaign against Germany, but also was essential to major operational deceptions, especially the D-Day landings and Operation Market Garden.

Proximity Fuze

National Electronics Museum



A proximity fuze detonates automatically when the distance to the target is close enough that the target will be damaged or destroyed by the weapon's explosion. British military researchers Sir Samuel Curran and W. A. S. Butement invented a proximity fuze in the early stages of World War II. The design was shown to the United States during the Tizard Mission. The fuze needed to be miniaturized and survive the high acceleration of cannon launch. Development was completed under the direction of physicist Merle A. Tuve at the Johns Hopkins University Applied Physics Laboratory. More than 2,000 American companies were mobilized to build some 20 million shell fuzes. U.S. Adm. Lewis L. Strauss wrote that, “While no one invention won the war, the proximity fuze must be listed among the very small group of developments, such as radar, upon which victory very largely depended.”

This commemoration is brought to you by the Office of Naval Research, the British Embassy Washington, and the Embassy of Canada in Washington, DC.