The Bumblebee Project

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Towards the end of World War II in the Pacific Theater the Japanese resorted to Kamikaze suicide attacks on US Navy vessels in a futile attempt to stop further US advancement. Kamikaze, meaning "the divine wind" evoked the miraculous delivery of the Japanese from a Mongol invasion in the thirteenth century, when Kublai Khan's invasion fleet was dispersed and some of its ships capsized by a sudden typhoon. By the end of 1944 only a divine miracle would spare the Japanese from another invasion. Enter the Kamikaze pilot. By crashing their bomb-laden aircraft into US ships, it was thought of as an honorable way to die for their country. Though used in a limited capacity during the final months of 1944, exaggerated claims by the Special Attack Corps escalated the tactic throughout the rest of the war. Though the number of US ships actually sunk by Kamikaze attacks was small the damage inflicted on ships, loss of life, and number of wounded servicemen was great. At the time there were two tiers of fleet defense, aircraft flying combat air patrol and shipboard AAA (anti-aircraft artillery). A new layer of defense was in need and the Navy began to develop their own surface-to-air missile program. They had two working prototypes by early 1945, the Little Joe and Lark, but both were a long way from becoming practical for front-line use. At this time the Navy decided wisely to commission the Applied Physics Laboratory of John Hopkins University (APL/JHU) under BUORD sponsorship to further develop this new technology. The project was named Bumblebee and included participation by various government and industrial agencies. These all became known as "Section T" and all of the missiles developed directly from this program start with T: Terrier, Talos, Triton, Typhon, and Tartar. Bumblebee's main objective was to research and develop guided missile technology and to deliver to the Navy a surface-to-air missile system. As grandiose as it sounds the program was very well managed and developed much of the guided missile technology in use today.

Talos

Though the Talos (RIM-8) was the initial mainstream effort of Bumblebee it was not the first missile of the program to go into service. The design was a ramjet-powered sustainer with a separable solid rocket booster. Bendix was contracted in 1945 to develop the fuel metering system for a ramjet engine. In three months they flew a working model 6 inches in diameter made from a section of P-47 exhaust pipe to a distance of 6.25 miles. It also produced more power than the P-47's engine. It was during the guidance testing program that a test missile, STV for Supersonic Test Vehicle developed into the Terrier and would see operational service several years before the Talos. The RIM-8 was the first production missile to incorporate ramjet propulsion, however several ramjet missile programs were in work at the same time as Talos. The solid rocket booster was required to boost the missile to a speed for the ramjet to start. At the time the ramjet was the most efficient motor available. It burned kerosene or a napha/kerosene mixture and required only 1/6 to 1/8 the fuel that a comparable rocket motor of the time would need to attain the same speed and thrust duration. It flew at mach 2.5 and a nose mounted pitot tube that in combination with a temp probe modulated the fuel flow regulated speed. Early versions had a maximum range of approximately 65nm and flew below 30,000 feet. Performance enhancements came as a result of continued improvements the guidance system making mid-course guidance more efficient The RIM-8 was controlled by 4 hydraulically actuated wings. The launching ship provided guidance. The Talos used beam riding for mid-course guidance and SARH (semi-active radar homing) for terminal guidance. When launched the missile was gathered within the beam of the ship's target tracking radar. When near the target guidance would switch over to another radar for SARH mode. The four interferometers mounted around the nose where used for this terminal phase of the intercept. A proximity fuse detonated the HE continuous-rod or W-30 nuclear warhead (5kt yield). The HE continuous-rod warhead was lethal to 100 feet. The W-30 warhead was to be used against large aircraft formations or in a surface-to-surface role against large ships. The Talos entered service in 1958 and the last firing from a ship was November 1, 1979 from the USS Oklahoma City (CG-5). Several rounds were converted to RIM-8H anti-radiation missiles. During the Vietnam War USS Chicago, CG-11 used the RIM-8H to take out many radar sites. The Chicago also intercepted two North Vietnamese Mig-17s at a range of 50nm. After retirement from active service the remaining missiles were used as target drones designated MQM-8 Vandel until the late 1980's.

Terrier/Tartar

The second and most significant result of Project Bumblebee was the Terrier/Tartar series of surface-to-air missiles. Originating as a guidance test vehicle for the Talos the BW-O Terrier entered service in 1951 and it's descendant the RIM-66/67 SM-2 (Standard Missile 2) is still in front-line service today. Consolidated/Vultee (later Convair and later still General Dynamics) began producing missile test vehicles in 1944 with the Gnat (CTV) and later the Snoot (STV).

The Gnat was a test bed for staging and wing-controlled guidance. Snoot was a progressive step from Gnat and was used as a guidance testbed for the Talos program. During this testing it was decided to use the data obtained from these two programs to develop a new missile, the 13.5-inch diameter Terrier. Since then the Terrier has gone through three major changes and many more upgrades. The first production model, BW-0 and BW-1 (RIM-2A/B) is the most unique. It had a four fin, solid fuel booster. The solid fuel sustainer had four fixed tail fins and four pneumatically controlled mid-body wings. The BW series (beam-riding, wing controlled) were produced from 1951 to 1958 totaling about 3,800 missiles.

In 1951 APL/JHU and GD began work on a tail controlled missile program to enhance maneuverability, as the RIM-2A/B was ineffective against fast moving, highly maneuverable fighters. The first test vehicle, STV-4 was 15 inches in diameter and had a solid fuel booster and sustainer. The tail surfaces were hydraulically actuated from a hot gas power supply that provided a longer period of controlled flight over the earlier RIM-2A/Bs pneumatic APS. All STV-4 shots were pre-programmed and the final design settled on a dorsal fin configuration over fixed wings. STV-5 was used for guidance testing but all shots were pre-programmed as well. The STV-6 was the same as STV-5 but reduced to 13.5 inches in diameter. The final test vehicle, XBT progressed into the BT-3 (beam riding, tail controlled). The BT-3 (RIM-2C) began production in 1958 for a total of 3,200 rounds and had a different appearance. Performance enhancements over the BW's included a new sustainer, longer duration APS, and the nuclear capable BTN-3A/N (RIM-2D). The BTN-3 carries a W-45-0 nuclear warhead with a 1kt yield. These may still be in use as the program to equip the newer Standard Missile with nuclear capability has been deferred by Congress. By the mid 1950's APL/JHU developed a small SARH system adapted from the Sparrow system and was tested in BW airframes. The tests were successful and further refinements resulted in the XHW-1 guidance system. The XHW-1, a new autopilot, and tail control system were tested with the recently developed Dual Thrust Rocket Motor (DTRM). These vehicles, all flown pre-programmed were know as TARTAR CTV (control test vehicles). The Tartar program was initiated to provide a medium range SAM for smaller ships that could not handle the size requirements of the Terrier. The next phase vehicle TARTAR HTV, (homing test vehicles) validated the program and in 1959 GD began producing the BASIC TARTAR (RIM-24A). About 600 were completed for use on Adams class DDG's. Numerous guidance changes, a change from a mechanical scan to an electronic scan antenna, and second generation DTRM became the IMPROVED TARTAR or IT. Roughly 1,800 were built between 1961 to 1963. The SARH guidance and tail control advantages were built into roughly 800 Terriers (RIM-2E) at the same time. The Tartar Reliability Improvement Program or TRIP was initiated to improve tactical effectiveness. This was through switching over to solid state electronics, quick spin-up gyros, multiple target ability, and greater resistance to electronic counter-measures (ECM). Many of the previously delivered missiles were reworked with these new abilities and became known as retrofits or ITR (RIM-24C) and HTR (RIM-2F). Most of the breakthroughs from the TRIP project went into a totally new missile system, the Standard Missile.

Typhon

The Typhon, also known as the "Super Talos" was the supreme vision of early Bumblebee planning. It was to utilize a shipboard phased array search and guidance radar and the technical hurdles were huge. It was to be powered by a solid fuel booster and a mach 5 capable ramjet sustainer. The RIM-50/55 would have had a range of approximately 170 nm which in 1961 was only rivaled by the USAF's CIM-10 Bomarc. The Typhon never went past several test firings as the promise of the Standard Missile and extent of ship rework required to make ships Typhon capable sealed it's doom.

Triton

Designated XSSM-N-4 the Triton was the only Bumblebee project conceived that was not a surface-to-air missile. It was to be a cruise missile capable of being deployed on submarines featuring a foldable airframe. The Triton would have been carried a low yield nuclear warhead, probably the 5kt W-30 and a combination map matching, inertial navigation guidance system. It was a very ambitious program but was canceled during the test vehicle phase.

Standard Missile

While it does not start with a "T" the Standard Missile is certainly part of the Bumblebee legacy. During the Tartar Reliability Improvement Program (TRIP) it became apparent that more gains could be made with an entirely new missile system. The objective was to produce a medium and long-range missile that minimized compatibility changes and modular in design for ease of upgrade. There are four main Standard sub-types; the Standard Missile 1 (SM-1), Standard ARM (STARM AGM-78), Standard Missile 2 (SM-2), and the Standard Missile 2 Aegis. The name Aegis actually refers to the shipboard system for which the Aegis missile takes full advantage. Throughout the Standard Missile program the medium range (MR) missile has been referred to as Tartar and extended range missile as Terrier.

SM-1 development began in parallel with TRIP and production began in 1965. Through a system of orderly "Block" changes, improvements have continued to be introduced into the missile. Improvements over the ITR and HTR were vast. While the ITR/HTR required 20 seconds to fire due to continued use of vacuum tubes the SM-1 could be fired in two seconds. The SM-1 also proved itself more effective against low flying and surface targets. It was more resilient to ECM and utilized an improved target detection device. The Standard in all of its versions uses solid state electronics and all electronic controls. The SM-1 and SM-2 look identical externally. Each is 13.5 inches in diameter and has a solid fuel motor. They also have four control tail fins and four forward mounted dorsal fins similar to ITR's and HTR's but with longer strakes. The ER versions use an 18-inch diameter solid fuel booster with four fixed fins.

The Standard ARM (anti-radiation missile) or STARM was developed in 1968 to extend the range and kill effectiveness of the then available Shrike (AGM-45). STARM appeared outwardly like the SM-1 MR except for six radially mounted antenna near the radome, foldable tail fins, and slightly different radome. The missile was launched after an enemy radar signature was detected, designated and handed off to the missile. It used a passive tracking system for guidance so the target was unaware of the launch. The STARM flew a flat trajectory during midcourse guidance. As it neared the target it would "pop up" to develop a finer depression angle for improved accuracy. The missile would then pitch over and approach the target straight down and detonate approximately 50 feet above the radar. Specially equipped "Wild Weasel" aircraft of the US Navy and Air Force deployed the STARM. The Navy platform was the A-6B and A-6E STARM Intruder. The Air Force employed the F-105G Thunderchief and F-4G Phantom II. The last versions of the AGM-78 had the ability to launch with an offset azimuth angle of 180° or at a target directly behind the launching aircraft. In addition to the AGM version a surface launched STARM (RGM-66D1A) has been fitted in special twin coffin launchers on several Patrol Gunboats (PG's). Each ship carried four STARMs one on each launcher rail and the second in an auto-loading magazine. STARM was also loaded on several Frigates (FG's) being fired from modified ASROC launchers. While this application was primarily for anti-ship use it also had AAW capability.

The SM-2 was primarily developed for the Aegis combat system. However the original SM-2 program was expanded to provide most of the SM-2 abilities for non-Aegis platforms. This was called the CG/SM-2 program These changes involved primarily weapons control, radar, and software. The enhancements in mid-course guidance resulted in a missile with twice the range of the SM-1 and nearly that of the Talos. The Aegis combat system incorporated on Ticonderoga class cruisers and Arleigh Burke class destroyers is one of the most advanced and sophisticated weapons systems in the world. Developed in response to the threat of mass missile saturation attacks, the core of the system is the SPY-1 phased array radar and UYK-1 computer. Each ship has four large planar arrays mounted on the superstructure. Each array has 4,100 radiating elements controlled by the UYK-1 to produce, and steer multiple beams for target search. Each target is evaluated and queued in priority of threat. The system is able to track and guide up to 18 SM-2 missiles in the air at once. The latest versions of the standard missile, SM-2 ER Block IV Aegis and SM-2 MR Block III Aegis are probably the most advanced surface-to-air missiles today. Both have a larger sustainer and improved guidance, autopilot electronics, data link communications, and ECM resistance. They are noticeably different from earlier Standard Missiles. The airframe is longer to accommodate the larger DTRM and the dorsal fin is redesigned to maintain neutral stability. The ER Block IV also has a new solid fuel booster. It is significantly shorter, finless and uses four steerable nozzles. Both can be launched from the new Mk 41 vertical launch system (VLS) that is incorporated on most Ticonderoga class and all Arleigh Burke ships.

The advent of the SM-2 Aegis has secured the Navy's AAW ability well into the next century. Aegis ships were on the front-line during the Gulf War and now relied on as much as the Aircraft Carrier when the US needs to show a presence somewhere on the globe. All of this developed as a result of a need to counter a threat 50 years ago.

Guide to US Navy Surface-To-Air Missiles

Comparison Guide to US Navy Surface-To-Ai

1. RIM-8 Talos
2. RIM-50 Typhon
3. RIM-2 Terrier BW
4. RIM-2 Terrier BT
5. RIM-2 Terrier BTN(Nuclear)
6. RIM-2 Terrier HT/HTR
7. RIM-24 Tartar
8. RIM-67 Standard SM-1,2 ER
9. RIM-66 Standard SM-1,2 MR
10. RIM-66 Standard SM-2 Block II MR
11. RIM-66 Standard SM-2 Block IV ER

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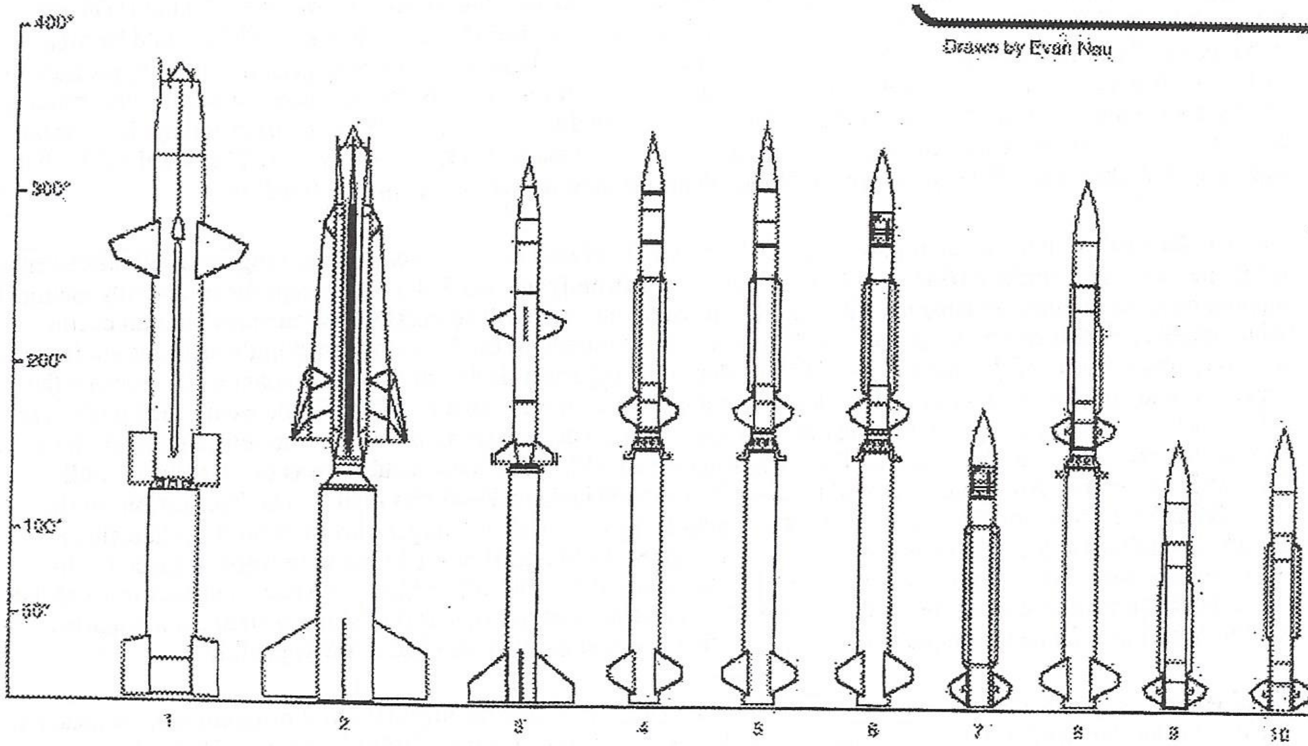

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