

MILESTONES

Smart bombs in Vietnam

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A common misconception in the contemporary popular culture is that 'smart bombs' first emerged operationally during the 1991 Desert Storm bombing campaign. The reality is that radio command link guided Fritz X and Hs-293 glidebombs were used extensively by the Luftwaffe from 1943 through to 1945, taking a heavy toll on Allied shipping, and also used against key bridges in a vain attempt to stall the Allied ground offensive into Germany. The US Army Air Corps also used radio command link guided bombs in Burma and Italy, primarily against bridges, tunnel entrances and other like targets. In terms of operational impact and frequency of operational use, smart bombs only rose to genuine prominence more than two decades after their first use when the US Air Force and US Navy deployed them against a wide range of targets during the protracted air war in South East Asia.

When the US launched the Rolling Thunder bombing campaign against North Vietnam during the early 1960s it ran into difficulties. Much of the force structure planning for the US Air Force and US Navy during the 1950s envisaged combat against the Soviets in the European Theatre of operations, and it was expected that such combat would involve the large scale use of nuclear weapons against Soviet land targets and the Soviet surface fleet. This imperative shaped the design of most US combat aircraft but also the weapon systems they were equipped with.

Advancing technology over the previous two decades resulted in the replacement of piston engine combat aircraft with jets. During the era of piston engine aircraft, tactical targets were attacked with gunfire, unguided rockets or dumb bombs, usually from very low altitude flying dive trajectories. Gyro stabilized gunsights proved quite effective for this style of combat. During the Korean War, over a decade earlier, this technique worked quite effectively.

The world had changed by the mid 1960s. The PAVN (People's Army of Viet Nam) was supported by large numbers of often highly skilled Warsaw Pact and Soviet instructors, and lavishly supplied with anti-aircraft weapons by the Soviets and Chinese. The result was an air defence system across the north of Vietnam equipped with a density of Anti-Aircraft Artillery (AAA) pieces of all calibres which rivalled or exceeded the historical benchmark of Luftwaffe and Wehrmacht AAA defences during the 1944-1945 period. No differently, PAVN defences made extensive use of Soviet supplied SON-9/30/50 Fire Can / Fire Wheel / Flap Wheel gunlaying radars, and from 1964 onward deployed the S-75/SA-75 / SA-2 Guideline Surface to Air Missile (SAM) system. US aircraft had to deal with SAMs at high to medium altitudes, 57 mm, 100 mm and 130 mm AAA at medium altitudes, and barrages of 7.62 mm, 12.7



The Rockwell GBU-8/B 2,000 lb and GBU-9/B 3,000 lb HOBOS television guided bombs were used in the latter phase of the Vietnam war (Wikipedia).

mm, 14.5 mm, 23 mm, 37 mm and 57 mm gunfire at lower altitudes.

From a lethality perspective, a 750 lb, 1,000 lb or 2,000 lb bomb was more than often the only weapon effective against hardened and semi-hardened point targets, be they revetted aircraft, SAM and AAA emplacements, bridges or bunkers. The workhorses of the US bombing effort, the Air Force F-100 Super Sabre and F-105 Thunderchief, and Navy A-4 Skyhawk and A-6 Intruder were all committed to low altitude dive deliveries if they intended any kind of accuracy against such targets. This drove these aircraft into the optimal engagement geometry for the AAA defences, flying low and having to maintain a very accurate flightpath until the bombs were pickled off the racks. The result were mounting losses to AAA fire, an unsustainable situation in material / personnel losses and political costs.

While SAMs and radar directed large caliber AAA could be impaired by radio frequency jamming, visually aimed guns at low altitudes were a



The Maxson AGM-12C Bullpup command link guided missile was used with limited success during Rolling Thunder.



The 1,000 lb class AGM-62 Walleye I television guided bomb was the first "smart bomb" used in the Vietnam conflict.



The Texas Instruments GBU-1/B "BOLT117" 750 lb laser guided bomb was the first such weapon to be used in combat, and proved highly successful (Wikipedia).

more difficult problem. It was soon realized that increasing bombing accuracy from higher altitudes at higher speeds would be the most effective measure to overcome losses to barrage AAA.

Attempts to use the Maxson AGM-12 Bullpup radio command link guided standoff missile proved less than effective. The missile carried a bright flare on its tail and the operator would manually steer it to impact with the intended aimpoint. Accuracy remained a problem especially since the operator needed a clear view of the target, and this more than often forced the aircraft to lower altitudes and shorten distances.

The US Navy-developed AGM-62 Walleye television guided glidebomb was trialled in Vietnam. With cruciform wings it had a range of less than ten nautical miles. The nose housed a gimbaled stabilized thermionic television camera and the seeker electronics employed a contrast lock circuit, which permitted the operator to lock the seeker onto some feature of the viewed image. Once the seeker locked on to the target, the bomb could autonomously fly to impact. After initial Navy operations with the AGM-62, the US Air Force trialled the weapon in 1967 with the 8th TFW (Tactical Fighter Wing) at Ubon, from the F-4D Phantom.

Persistent problems with seekers being unable to acquire lock, or losing lock in flight due to poor target contrast against the background were exacerbated by the frequent low cloud, haze and fog characteristic of South East Asia. More than often the launch aircraft had to fly much closer to the target to acquire a reliable lock.

The US Air Force did not abandon this idea, and contracted Rockwell in 1967 to develop the GBU-8/B HOBOS (Homing Bombing System), which entered operational trial use in 1969. The HOBOS was a much larger and more lethal weapon than the Walleye, and involved the fitting of a guidance and wing kit to a Mk.84 low drag 2,000 lb bomb, and later the M118 3,000 lb bomb in the GBU-9/B variant. Like the Walleye, the HOBOS used a nose mounted "Lock On Before Launch" (LOBL) TV guidance package. The HOBOS used a strake kit and tail mounted wings with trailing edge controls, and was used with some success against high contrast targets like bridges.

Walleye and HOBOS were not spectacularly successful due to limitations of the thermionic vidicon camera technology. Both weapons evolved during the 1970s and 1980s, with the radio datalink-equipped Walleye and GBU-15 glidebomb, the latter a datalink equipped successor to the HOBOS being used with considerable success in Desert Storm. Rocket-boosted thermal imaging AGM-130 glidebombs based on the GBU-15 were

used with great success in the 1999 bombing of Serbia, and Afghanistan in 2001. The current production Russian GNPP KAB-500Kr and KAB-1500Kr weapons are direct derivatives of the HOBOS.

Far more successful than television guided bombs were the early laser guided bombs. Laser technology emerged during the late 1950s, and allowed the design and construction of extremely bright sources of single colour coherent light, which could be easily collimated and focused into a small spot at distances of miles, or tens of miles.

The idea behind laser bomb guidance was borrowed from the earlier technique of semi-active radar homing, used in SAMs and air-to-air missiles. The target would be illuminated with a laser and the homing seeker in the bomb would fly the weapon to impact. The seeker used four electrically identical photo-detector elements placed behind a lens, and the guidance system flew the weapon so that all four elements received equal illumination. The use of laser guided weapons required a laser illuminator device be carried by at least one aircraft in a strike package armed with such weapons. This device is termed a 'laser designator'.

The first laser guided bomb to be used operationally was the Texas Instruments GBU-1/B contracted under the Paveway program, often labeled the 'BOLT-117' – short for BOMB, Laser Terminally guided – with the M117 750 lb general purpose bomb. The GBU-1/B Paveway I introduced the now common annular wing gimbaled seeker arrangement, now used in US, Russian and Chinese laser guided bombs.

The designator developed for the Paveway was by modern standards primitive. The Martin-Marietta AVQ-9 Paveway Airborne Laser Designator (ALD) or 'Zot' was a gyro stabilised optical telescope and boresighted laser emitter attached to the F-4D Phantom fighter. The Weapon Systems Officer (WSO) would manually aim the telescope at the target through the side of the Perspex canopy, and use a trigger to fire the laser. Another aircraft carrying the laser-guided bomb would then drop the weapon on a radio call, while the designator equipped aircraft painted the target with the laser.

The 8th TFW deployed the first laser guided bombs in mid-1968. The weapon proved spectacularly accurate, with claims that half of the bombs dropped scored direct hits, and the overall Circular Error Probable (CEP) claimed at 8 ft (likely overstated). Because the bomb kit was much cheaper and simpler than the TV guided weapons, it could be bought in larger numbers. It is fair to observe that the Paveway was the first genuinely successful and affordable guided bomb.



The Ford AVQ-10 Paveway laser targeting pod overcame the limitations of the earlier AVQ-9 Paveway Light cockpit designators and was the preferred system in 1972.

Initial use of the Paveway in North Vietnam proved successful, dramatically reducing the number of sorties and bombs dropped to achieve desired effect. One or two smart bombs could do the same damage as dozens of dumb bombs. Even though bombing operations over the North ceased in August 1968 the weapon continued in use over the Ho Chi Minh Trail where there was no shortage of lucrative targets.

The AVQ-9's basic design forced the aircraft designating the target to orbit above the target in a steep banking turn, to permit the backseater to maintain visual track of the aimpoint until the bomb hit. Other aircraft would then engage the target with laser guided bombs, with the 'master bomber' equipped with the laser designator painting the targets and using radio calls to direct weapon drops.

The Paveway system was not without its problems, as the operator had to have a clear line of sight to the target, and the bomb seeker a clean line of sight to the laser spot on the ground. Smoke, clouds, fog, dust and haze presented ongoing problems, with the operator losing track of a target or the bomb going ballistic. The simple autopilot in the GBU-1/B required that the operator account for potential weapon ballistic undershoot, this often requiring that the spot be positioned behind the target relative to the approaching bomb.

The PAVN and their Warsaw Pact instructors, keen observers of US tactics, monitored all radio traffic and studied US publications. They quickly determined that the Paveway Light equipped lead bombers were the lynchpin of US operations, and these quickly became priority targets for large caliber AAA and SAM shots. If the bomber orbited the target it was likely Paveway Light equipped. The aim was to attrit the US supply of Paveway Light equipped aircraft and operators faster than they could be replenished.

Initial success of Paveway led to further rapid developments. Operational experience led to the development of the Ford-Aeroneutronic AN/AVQ-10 Paveway Knife targeting pod, a design that set the pattern for targeting pods.

The large 1,200 lb weight Paveway Knife was carried on a wing pylon. The front of the pod was designed to swivel about the pod's lengthwise axis, and it contained a stabilized boresighted TV and laser illuminator package, which could sweep fore and aft. Paveway Knife could cover much of the hemisphere beneath the aircraft, allowing manoeuvre while illuminating the target, and greatly expanding possible tactics to evade hostile fire.

The US Air Force also funded the development of further bomb kits based on the same laser seeker technology. The GBU-1/B Paveway I kit was

adapted to the M118 3,000 lb bomb, the Mk.84 2,000 lb bomb, the Mk.83 1,000 lb bomb, and a range of cluster bombs under the Pave Storm effort. The result was a family of laser-guided weapons.

A major problem for the US Air Force was the short supply of pods, which were expensive and slow to produce. In early April 1972, the 8th TFW had only seven Pave Knife pods. The Pave Knife and Paveway I were used heavily during the 1972 Linebacker I and II bombing campaigns, and resulted in much more precise bombing and much greater combat effect than seen during the 1960s Rolling Thunder campaign.

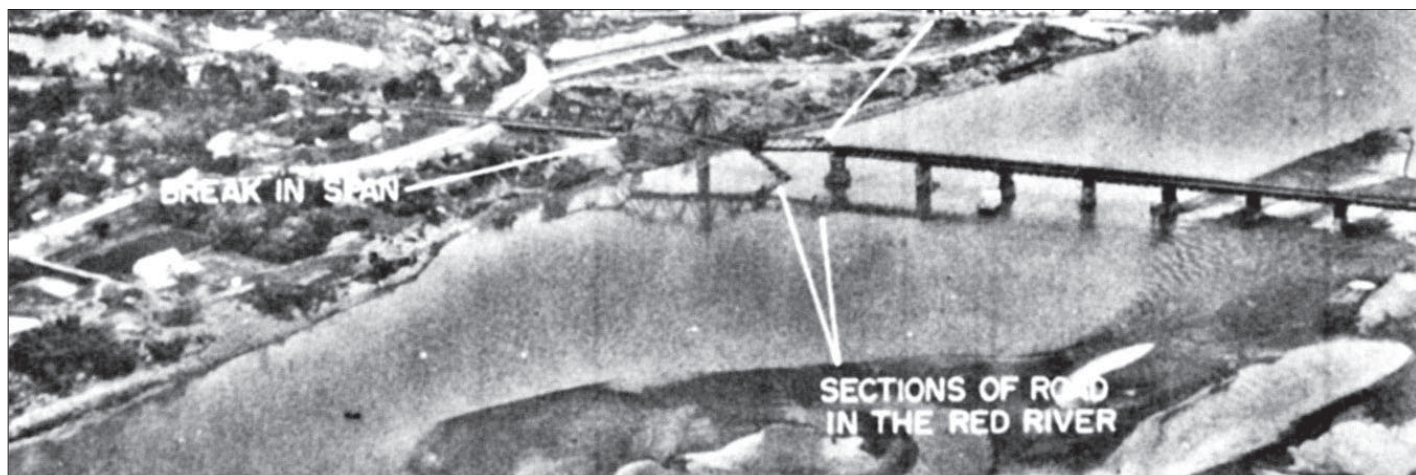
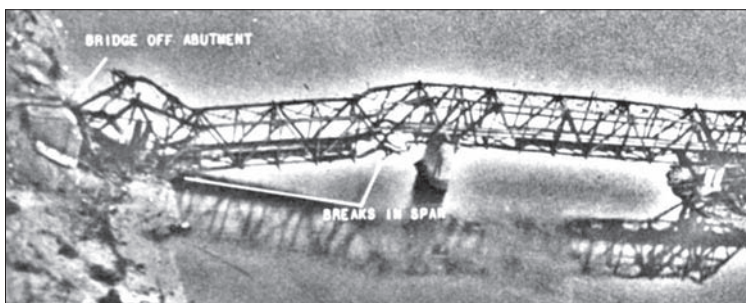
The success of smart bomb technology in the Vietnam conflict changed the character of aerial warfare, with subsequent air campaigns seeing the progressive displacement of conventional dumb bombs with smart bombs. The 1999 campaign against Serbia, the 2001 bombing of Afghanistan, the 2003 invasion of Iraq, and more recent counterinsurgency bombing operations have been fought predominantly using smart bombs. No less importantly, today's production Raytheon Paveway

IV is a direct evolution of the GBU-1/B guidance kit, the Russian KAB-500/1500Kr direct evolutions of the GBU-8 HOBOS, while most contemporary laser targeting pods use much the same configuration as the AVQ-10 Pave Knife, even if they are a small fraction of its size and weight, and vastly more sophisticated and capable.

Sources:

1. Marshall L. Michel, III, Clashes: Air Combat over North Vietnam, 1965-1972, Naval Institute Press, 2007.

Bomb damage assessment imagery of targets killed by Pave Knife equipped Phantoms of the 8th TFW at Ubon, armed with Paveway laser guided bombs.



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