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Teammates—Over the next two months, the LeMay Center will highlight ways technological change influenced doctrine and military operations. Some innovations allowed us to *do things better*—improving way of doing things we were already doing. However, other innovations were truly revolutionary. These had far-reaching consequences that cascaded across military strategy and tactics to change national security and important aspects of society. This month we discuss the advent of precision guided munitions (PGMs), an innovation that allows us to do things dramatically better.



In World War II, only 20% of bombs dropped during daylight “precision” bombing landed within 1,000 feet of their aimpoint. This required the US to fly 1,000 heavy bomber sorties, dropping 9,000 bombs, to destroy a factory complex. During the Vietnam War, advancements in tactics, training, and navigational aids significantly increased accuracy. However, hundreds of sorties and munitions were still required to critically damage priority targets while entailing significant losses.

As a result of experimentation with bombs guided by radio signals, infrared sensors, TV, and laser designators. One of first combat tests of these weapons took place during Vietnam. The Thanh Hoa bridge, which had survived nearly 900 US sorties using unguided bombs, had become a symbol of North Vietnamese resistance. In April 1972, F-4s equipped with 16 early laser-guided bombs (LGBs) successfully destroyed the bridge without any losses.

In January 1991, the effectiveness of PGMs in Operation DESERT STORM captured the world’s attention. Although only 8% of all aerial munitions expended were precision guided, PGMs destroys the majority of strategic targets. In fact, laser-guided bombs (LGBs) alone, just 4.3% of all bombs, accounted for 75% of these targets. While PGMs guided by laser, infrared seekers, and visual light have limitations such as weather, smoke, and maneuver of the designating aircraft, the advent of Global Positioning System (GPS) technology greatly increased the flexibility and accuracy of guided weapons. GPS-guided weapons provided the first-ever near-precision all-weather capability. In addition, GPS-guided munitions gave one aircraft the capability to destroy a series of targets in one sortie that previously required multiple sorties. This greatly increased the efficiency of aerial warfare and the destructive power of a single aircraft.

US combat operations in Kosovo-Serbia, Afghanistan, and Iraq featured major increases in reliance on PGMs. In Kosovo, about 35% of ordnance were PGMs, including the newly introduced Joint Direct Attack Munition (JDAM), essentially a GPS guidance kit that turned large numbers of unguided bombs into guided weapons. JDAMs were used extensively in both Afghanistan and Iraq, with improved precision against fixed targets and moving targets. In fact, PGMs accounted for 60% of munitions in Afghanistan and 68% in Iraq. The increased reliance on PGM capability highlights their growing importance in modern warfare.

Why it matters today: In short, PGMs allow airpower to *do what it has always done best*, especially compared to previous conflicts. The advent of precision in Air Force combat



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operations exemplifies the tenets of concentration and flexibility in Air Force doctrine. Concentration focuses overwhelming power at decisive times and places, while flexibility allows airpower to shift from one objective to another, exploiting the joint principles of mass and maneuver. The use of PGMs greatly increases flexibility by freeing up often-scarce strike assets from flying multiple sorties against single targets. This allows airpower to concentrate effects at places and times that best put an enemy at a disadvantage.

For more info on the tenets of airpower, see Air Force Doctrine Publication (AFDP) 1, *The Air Force*. For more on the principles of joint operations, see Joint Publication (JP) 3-0, *Joint Campaigns and Operations* (common access card required). For more on specifics of targeting, see AFDP 3-60, *Targeting* and JP 3-60, *Joint Targeting*. You can also check out our latest podcast devoted to technological change and AI on iTunes, Spotify, Amazon Music, or at www.doctrine.af.mil.

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