The global counter-insurgency campaign, which followed the 9-11 attacks produced the highest sustained operational tempo in helicopter operations since the Vietnam War of four decades ago. There have been much lower helicopter loss rates compared to Vietnam, due in large part to more survivable designs. Even so, helicopter loss rates are still high relative to fixed wing aircraft. Future conflicts, which might be conducted against nation state opponents, however, present an entirely different picture. This is due to the proliferation of advanced short-range air defence weapons, which are highly lethal against helicopters.

Of all modern aircraft, helicopters are the least survivable due to their low altitude and relatively low speed flight profiles compared with jet aircraft, and their high acoustic and radar signatures. These are inherent limitations of rotary wing aircraft, which cannot be easily or affordably designed out.

Formal survivability analysis is centred on two components: the first being susceptibility analysis that aims to measure the probability of an aircraft being hit; and the second vulnerability analysis, which aims to measure the probability of a hit with a given weapon inflicting fatal damage to the aircraft.

Central to discussion of helicopter survivability is the threat environment in which the aircraft must operate.

During the invasion of Iraq in 2003 and the subsequent counter-insurgency campaign the US Army experimented with a range of tactics, including the use of the AH-64D Longbow Apache to directly attack targets in the manner fighter aircraft would do, but suffered heavy losses in airframes due to concentrated gunfire.

The insurgents in Iraq had an abundant supply of Soviet supplied SA-7 SAMs and Chinese clones, and there are claims that newer Russian SA-16 and SA-18s may have been used. These have generally proven less than effective since much of the coalition helicopter fleet was equipped with infrared exhaust suppressors, active infrared jammers and flare dispensers. Many larger helicopters were also equipped with missile approach warning systems to cue countermeasures deployment. The most prominent kills achieved by MANPADS were transport aircraft, spurring the deployment of infrared jammers across coalition fleets.

While MANPADS have not produced the losses many anticipated, mostly due to good pre-emptive installation of countermeasures, losses due to larger calibre gunfire and rocket propelled grenades, from the RPG-7 upward, have remained a consideration. Tactics for the evasion of MANPADS involve low flying, which exposes helicopters to gunfire and RPG fire. Recent statistics in the media suggest that 40 per cent of US helicopter losses are due to RPGs and 20 per cent due to gunfire.

The latter are all short-range line of sight direct fire weapons, which typically have limited signatures compared to MANPADS. Muzzle flash and RPG motor burn flash are detectable but the shorter ranges compared to MANPADS shots result typically in less warning time for crews. The only redeeming aspect of the RPG, for its target, is that the RPG is unguided and accuracy declines strongly with distance, especially if crosswinds are present. This is often compensated for by operators who fire multiple round RPG salvoes to improve the odds of a hit. With shaped charge warheads built to defeat tank armour, RPGs are absolutely lethal if they can score a hit on any key structural
or power train components of a helicopter. While modern helicopter designs have robust measures to survive gunfire up to 23 mm calibre, including features like dry running gearboxes, large shaped charges produce far greater damage.

Numerous schemes have been proposed for the defeat of RPGs. These include a US inventor’s proposal for rocket launched deployable steel and Kevlar nets which are launched into the path of the RPG, or a Bulgarian metal alloy armour system which is claimed to be highly effective at defeating shaped charge RPG warheads.

Other than armour or countermeasures, evasive manoeuvre can be very effective in evading both RPGs and gunfire, but this is predicated on the pilot knowing he is under attack, and knowing where the attack is coming from.

A promising technology are acoustic detection systems, which use directional microphones and smart digital processing to detect the source of gun or RPG fire, and provide warning to the pilot to facilitate evasion. As with missile attacks, knowing where the attack is coming from as early as possible can mean the difference between life and death.

Another technology with much promise are smart mission management systems, which make use of digital terrain elevation maps and radio moderns to link to battlefield intelligence databases and ISR sensors. The author was recently given a demonstration by Elbit of their system, which has been installed in a range of Israeli military helicopters.

A very interesting and useful capability in this system is the ability to mark on the digital map, in colour, areas where the helicopter is within the line of sight of any specified point on the map. An operator can thus mark the known location of a MANPADS team, machine gun nest or RPG shooter team, and then use terrain masking to avoid detection and weapons fire. The system is integrated with a ruggedized tablet computer carried by infantry or special forces, which allows them to upload via radio datalink such threat information as the helicopter approaches. Whether the helicopter is being used to extract troops or provide fire support, this type of situational awareness aid can provide a major tactical advantage.

Other anti-helicopter weapons have emerged. An idea the Soviets introduced was a proximity fused ‘anti-helicopter mine’ which used a rocket charge to propel an explosive warhead upward, detonated by a proximity fuse, spraying the victim helo with spall and shrapnel. Some sources claim that Iraqi insurgents improvised a similar weapon, that Iraqi insurgents improvised a similar weapon, that Iraqi insurgents improvised a similar weapon, that Iraqi insurgents improvised a similar weapon, that Iraqi insurgents improvised a similar weapon, that Iraqi insurgents improvised a similar weapon, that Iraqi insurgents improvised a similar weapon, that Iraqi insurgents improvised a similar weapon, that Iraqi insurgents improvised a similar weapon, that Iraqi insurgents improvised a similar weapon, that Iraqi insurgents improvised a similar weapon, that Iraqi insurgents improvised a similar weapon, that Iraqi insurgents improvised a similar weapon, that Iraqi insurgents improvised a similar weapon, that Iraqi insurgents improvised a similar weapon.

The ongoing counter-insurgency effort will continue to drive evolution of helicopter survivability aids, and we are likely to see more sensors, better armour, and more situational awareness aids exploiting computer technology. What the campaign to date has demonstrated is that opponents frustrated with the ineffectiveness of high technology MANPADS have turned to creative tactics applied to the use of low technology weapons.

On the sophisticated high technology end of the threat spectrum, used by nation states to provide defensive fire, and to react quickly enough to develop a new generation of battlefield air defence systems, they still remain on offer, hosted on their original tracked chassis as battlefield point defence weapons. The very short reaction times and high rate multiple target tracking capabilities will allow these weapons to intercept guided missiles fired by helicopters, and fire at the launching helicopter concurrently.

In the longer term high power lasers are emerging as a preferred C-RAM (Counter Rocket Artillery Mortar) solution, and will thus likely be applied to the defence of ground forces against missile firing helicopters.

While signature reduction has been proposed for helicopters and considerable effort invested into the stillborn Comanche project, the likely solution for dealing with advanced battlefield air defences will be Digital Radio Frequency Memory based deception jammers, intended to frustrate the engagement radars used to aim/guide the weapons.

**HISTORICAL PERSPECTIVE**

The Vietnam war was the first conflict in which helicopters were used heavily, both for fire support and mobility of troops. The principal US Army helicopter was the lightly built UH-1 Iroquois or ‘Huey’ series, later supplemented by the heavy CH-47 Chinook. The Marines entered the conflict with the CH-34 Chotaaw (S-58/Wessex), replacing it with the CH-46 Sea Knight, and from 1967 the CH-53 Sea Stallion. The Air Force operated the HH-3 initially for deep penetration search and rescue, or special forces raids, later supplementing them with HH-53B/C.

Most of the survivability measures incorporated in the airborne, engine and transmission design of modern Western military helicopters were based on the lessons of the Vietnam conflict.
kill a helicopter before it could complete its anti-
missile engagement cycle.
The 9K331 Tor or SA-15 Gauntlet replaced the
1960s SA-8 with a new arrangement, combining
eight vertical launch missile tubes in a turret
equipped with a circular scan search radar and a
large target and missile tracking engagement radar
on the front of the turret. The SA-15 would scan
the horizon and upon detecting a helicopter rotor,
would slew its turret, lock on with the engagement
radar, and rapidly fire a pair of missiles to kill the
helicopter before its Hellfire missiles reached their
intended target.
The venerable ZSU-23/4P was replaced by the
2K22 Treugolnik / Tunguska or SA-19 Grison, a
combined 30 mm SPAAG and missile system using
a similar radar package to the SA-15 but armed
with very high speed two stage tube launched
missiles.
The US Army responded to this threat by developing
the AH-64D Longbow Apache, which combined
a mast mounted millimetric wave band search
and engagement radar with the ‘fire-and-forget’
millimetric band active radar seekered equipped
Hellfire variant. A passive precision radio-frequency
interferometer was added to permit the system to
sniff out the emissions of the SA-8, SA-13, SA-15
and SA-19 search radars. The Longbow Apache
could remain behind cover, raising only the mast
mounted sensor package to search for targets,
only popping up for a few seconds to fire a salvo
of Hellfires at a detected target. This author flew
this weapon system from the gunner’s seat in
1999, and the effectiveness of the Longbow radar
was very good, it could detect and identify moving
targets in a single sweep.
The European Tiger was modelled very much
along the Apache model, but using later airframe
technology, and with different role optimisations.
In conclusion, survivability will remain an ongoing
problem for rotary wing aircraft, and we will see
further evolution in survivability measures, and
weapons used against rotary wing aircraft.

Flares are effective against older MANPADS, but ineffective against newer seeker technologies, and radar
directed SAMs and SPAAGs.

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