A Northern Alliance fighter inspects MILAN anti-tank guided weapons in Kabul, Afghanistan, in November 2001.
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Light Weapons

PRODUCTS, PRODUCERS, AND PROLIFERATION

1

INTRODUCTION

Light weapons pose serious threats to human security. A shoulder-launched surface-to-air missile—commonly known as a man-portable air-defence system (MANPADS)—can be used to shoot down a civilian airliner with hundreds of passengers on board. A lone gunman can kill a head of state with a 12.7 mm sniper rifle from a distance of a kilometre or more. Lethal combinations of explosive power, technological sophistication, and range distinguish light weapons from small arms, and justify public concern over their illicit proliferation.

Yet, despite their lethality, most of the literature on 'small arms and light weapons' has focused on the first half of the equation: small arms, such as assault rifles and pistols. With the exception of a burgeoning international debate centred on MANPADS, international scrutiny has largely overlooked the illicit proliferation of light weapons.

This chapter addresses this imbalance and sheds light on the characteristics, development, and production of light weapons. It also looks at how they have been defined to date—specifically in the influential 1997 UN Panel of Governmental Experts report (UNGA, 1997). The chapter suggests additions to the Panel's list of light weapons, based on practical considerations related to their portability and to their use in armed violence.

The chapter distinguishes two categories of light weapons—guided and unguided weapons—in recognition of their important technological differences. Within each of these categories, the chapter profiles a range of specific weapons systems. It notes their producers, development, and important technological changes—whether indigenous or generated through licensing. It also presents available information on price, as well as marketing and worldwide distribution and proliferation. It pays special attention to craft production of light weapons, as well as the possession by non-state actors—including terrorist groups—of guided light weapons.

The chapter's main findings are as follows:

- At least 51 countries currently produce light weapons.
- Forty-five countries manufacture complete guided light weapons, while an additional five states manufacture components or upgrades for these systems.
- At least 31 countries produce light weapons under licence, but 26 additional countries produce weapons of foreign design without any licence, with an expired licence, or in an unclear licensing situation, underscoring the proliferation of risks inherent in intended and unintended technology transfer.
- Light weapons are becoming more lethal, more portable, easier to transport, less expensive, and longer lasting, increasing the prospect of their proliferation, especially to non-state armed groups.
- Armed groups have obtained numerous guided weapons and produce unguided weapons of increasing sophistication including rocket-propelled grenades, mortars, grenade launchers, explosively formed projectiles, and man-portable rockets.

- Some light weapons—principally anti-materiel rifles—are legally sold to civilians in several countries, including Switzerland, the United Kingdom, and the United States.
- We estimate that the average value of the annual production of anti-tank guided weapons (just one of the eight types of light weapons described by the UN) from 2001 to 2005 was USD 1.1 billion.

LIGHT WEAPONS: WHAT THEY ARE AND WHY THEY MATTER

Although there is some disagreement about the precise definition of 'light weapons', the threat such weapons pose to human security continues to come into greater focus. The first part of this section reviews efforts to define small arms and light weapons, focusing mostly on the list contained in the 1997 UN Panel report. It does not offer a new definition but does suggest some additional items to be included based on the criterion of portability. It also notes some developments in non-factory manufactured or 'craft' produced light weapons and ammunition. The second part discusses these weapons' importance and is divided into two subsections. The first notes trends in their operational capability and examines their effect even when they fail to work as intended or their use is only threatened. The second explores light weapons' proliferation—especially to armed groups—and highlights the use of improvised explosive devices as well as developments within craft production.

A working definition of light weapons

Governments have yet to agree on a universal definition of small arms and light weapons.[1] Differences of opinion have centred on civilian versus military classifications, and on whether certain weapons such as shotguns or hunting rifles should be included. Moreover, the distinction between what constitutes a 'small arm' and what qualifies as a 'light weapon' can vary from document to document.

Boutros-Ghali's much-heralded 1992 'Agenda for Peace' did not even mention small arms or light weapons.

Until the establishment, in 1996, of a Panel of Governmental Experts on Small Arms, the UN had not significantly addressed small arms and light weapons. Rather, the focus had been on weapons of mass destruction as well as conventional arms. Former UN Secretary-General Boutros Boutros-Ghali's much heralded 1992 'Agenda for Peace' did not even mention small arms or light weapons (UNGA, 1992). Three years later, in a 'Supplement to an Agenda for Peace', Boutros-Ghali did broach the subject. He spoke of the need for 'micro-disarmament' and used the terms 'small arms' and 'light weapons'. These terms were not clearly defined, however (UNGA, 1995, paras. 62–64). The UN Experts Panel filled this gap in its influential 1997 report. It roughly categorized certain varieties of small arms and light weapons, as well as their ammunition and explosives. The Panel classified 'small arms' as consisting of revolvers and self-loading pistols; rifles and carbines; sub-machine guns; assault rifles; and light machine guns. It included the following weapons within its light-weapons category:

- heavy machine guns;
- hand-held under-barrel and mounted grenade launchers;
- portable anti-aircraft guns;
- portable anti-tank guns;
- recoilless rifles;
- portable launchers of anti-tank missile and rocket systems;

- portable launchers of anti-aircraft missile systems; and
- mortars of calibres of less than 100 mm.

In addition, the Panel listed: ammunition and explosives, which includes cartridges (rounds) for small arms; shells and missiles for light weapons; mobile containers with missiles or shells for single-action anti-aircraft and anti-tank systems; anti-personnel and anti-tank hand grenades; landmines; and explosives (UNGA, 1997, para. 26).

The Panel provided additional clarity for some terms, obfuscated others, and chose not to address anti-personnel landmines. Notably, it used the concept of portability to delimit and distinguish small arms and light weapons from each other and from larger conventional weapons. According to the Panel, the defining characteristic of small arms was that they could be carried 'by one person'. By contrast, light weapons necessitated transportation 'by two or more people, a pack animal or a light vehicle' (UNGA, 1997, para. 27). The Panel indicated that anti-personnel landmines came under its mandate, but decided not to include them in its deliberations as the international community was dealing with the issue in other forums (UNGA, 1997, para. 31).[2]

The portability distinction was not, however, uniformly applicable to the weapons in the two categories. Some light weapons in the Panel's list, such as rocket-propelled grenade launchers, can be carried and operated[3] by a single person, while some small arms, such as light (as opposed to heavy) machine guns, may need to be transported and operated by a small team of people (particularly when large volumes of ammunition are involved).

For the purposes of this chapter, the Survey largely accepts the categorization for light weapons that the 1997 UN Panel of Governmental Experts used. Like the Panel, we have chosen not to address mines. We believe, however, that this subject merits greater examination as other forums address only anti-personnel landmines and these weapons are attractive for armed groups (see Box 1.1).

The Panel did not define or provide an example of a light vehicle (or of a pack animal for that matter). For our purposes, a light vehicle is not heavily armoured, has four-wheel drive, and is designed for off-road use. There are many such vehicles, with varying capabilities. For our standard 'light vehicle', we chose one that was of low-to-moderate performance: the Russian UAZ-3151. This vehicle can transport up to 800 kg (1,760 lbs) on its chassis.[4] We estimate that four people, their kit, and fuel account for 500 kg (1,100 lbs). This leaves a maximum of 300 kg (660 lbs) for a light weapon, mounted on the vehicle chassis, and requisite ammunition. The maximum towing capacity of a trailer without brakes is 600 kg (1,323 lbs) (Jane's, 2000, pp. 308–09). If one accepts that a trailer and its accou-

Box 1.1 **Mines: products and proliferation concerns**

The Ottawa Convention has made considerable progress in reducing the number of producers and global stockpiles of anti-personnel landmines. For example, according to the Landmine Monitor, whereas more than 50 states are known to have manufactured these weapons, as of 2007 fully 38 had ceased to do so (LM, 2007, p. 13).[5] The convention is also believed to have brought a virtual if not total halt in the trade of this weapon, even among states not party to the treaty. Other types of man-portable mines, however, continue to be produced and developed. Anti-vehicle mines[6] have also attracted considerable attention, in large part because they continue to have a humanitarian and post-war impact by impeding reconstruction and development aid. Man-portable anti-ship and anti-helicopter mines, however, have generated less interest. While the numbers of these weapons in circulation are comparatively small, each weapon's destructive power is considerably greater. Two limpet mines (so named because like a mollusc they are small and can attach easily to a vessel's hull) were used to sink the *Rainbow Warrior* in 1985 (*Guardian,* 2007). Multiple limpet mines weighing only 10-20 kg (22-44 lbs) each could sink a cruise ship or a ferry, and would be difficult to protect against (Bonomo et al., 2007, pp. xvii, 8, 58-60).

trements can weigh up to 200 kg, then that leaves a maximum weight of 400 kg (882 lbs) for a light weapon designed to be towed. We assume no pack animal can transport more than a light vehicle, either on or off a road.

We have, therefore, slightly amended the Panel's list of mortars, using the Panel's own defining characteristic of portability. Mortars more than 100 mm in calibre are included in our analysis if they are designed to be transported by people, on a pack animal, or by a light vehicle. Argentina, for example, previously manufactured a 120 mm mortar that three infantrymen could disassemble and transport on their backs.[7] Moreover, many 120 mm mortars can be towed and sufficient ammunition carried on the same vehicle to be considered as light weapons. Mortars of 155 mm and 160 mm, on the other hand, weigh much more than 1,000 kg (2,205 lbs) with their requisite trailer, rendering them too heavy for inclusion according to the criteria we have established. While some of these systems could be towed by more robust and capable light vehicles, such carriers could not transport sufficient ammunition for the weapon to be operated as intended. The same emphasis on design explains why we do not necessarily consider the Minigun to be a light weapon (see Box 1.2).

With respect to grenade launchers, our working definition includes *both* hand-held *and* under-barrel models as they are distinct weapon systems. We also refer to 'automatic' grenade launchers rather than 'mounted' as many mounted models are also designed to function on tripods. As elsewhere, the defining feature of all these grenade launchers is their portability.

Some weapons omitted from the Panel's list altogether have been added. Rockets that are man-portable and launched on rails, not through tubes, are included. There are many examples of such weapons being produced and used in today's armed conflicts. All of them are craft manufactured.

Our analysis, however, does not include medium machine guns or general-purpose machine guns (GPMGs). The Panel distinguishes between 'light' and 'heavy' machine guns in name only and provides no reference to the size of the cartridges fired. We have defined heavy machine guns as fully automatic weapons that fire small-calibre cartridges exceeding 10 mm, but less than 20 mm, in calibre. (Indeed, with the exception of some pistols and revolvers,[8] we generally define firearms in the light weapons category as those chambered for 10 mm calibre rounds and larger.[9]) We slot medium machine guns and GPMGs into the 'light' UN category as they fire cartridges smaller than 10 mm (usually 7.62 mm) and are mounted or equipped with a bipod. We acknowledge, however, that such 'light' machine guns on a coaxial mount can fulfil a similar function to a heavy machine gun, though with a reduced range.

For the most part, this chapter does not focus on light weapons ammunition and explosives.[10] We have, however, profiled improvised explosive devices (IEDs), including explosively formed projectiles (EFPs, also known as explosively formed *penetrators*).

Box 1.2 The 5.56 mm and 7.62 mm Miniguns: light weapons?

The electrically fired 7.62 mm Minigun and 5.56 mm 'Mini-Minigun', both multi-barrelled machine guns developed in the 1960s that fire several thousand rounds of ammunition per minute, are clearly not 'small arms' as described by the Panel, but are they light weapons? The weapons themselves are relatively light, weighing less than 40 kg, but the requisite ammunition needed to allow the weapon to function as intended is very heavy due to the rate of fire. The UAZ-3151 that we have chosen to represent light vehicles could carry enough ammunition for it to function at continuous fire for a couple of minutes or so at most. (The external power supply would not be an issue as the gun could be run off the vehicle's battery or Power Take Off (PTO) unit.) The many tens of thousands of rounds of ammunition that these guns fire to operate as designed explain why helicopters and tracked vehicles serve as the weapons' platform.

Finally, we have chosen not to include examples of historic conventional arms, including live-firing replicas, which some people would consider to be light weapons. Thus, for example, a small-scale replica of the 19th-century Gatling gun with four barrels and a 720-round magazine is not covered.[11] Nor are replicas or refurbished models of machine guns from the late 19th and early 20th centuries such as the Maxim, Vickers, or Lewis, which normally fired a .303 in. (7.7 mm) cartridge and therefore do not qualify as a light weapon for the purposes of this study.[12]

Importance of light weapons

Light weapons are important because of each weapon's lethality, the growing number of producers, and their proliferation in the hands of non-state armed groups. States have begun to recognize the threats they pose to human security and the global economy (principally in respect of threats to civilian aviation). Many states have contributed tens of millions of dollars to destroy surplus light weapons, especially MANPADS, and improve stockpile security. There has also been a noticeable trend since the late 1990s for confidence-building and technology-control measures originally designed for conventional weapon systems to be modified to apply to some light weapons (Small Arms Survey, 2005, ch. 5). Such initiatives underscore the importance the international community attaches to controlling certain light weapons—and for good reason.

Lethality of light weapons

A single light weapon can be extremely lethal, notwithstanding its small size. A 60–120 mm mortar can cause casualties within a 15–35 m (49–115 ft) radius from point of impact (Jane's, 2004, pp. 677–751).[13] Lofted into heavily populated environments, these inexpensive and unsophisticated weapons can kill scores of people. This is exactly what happened in 2003 when Guinea-backed Liberians United for Reconciliation and Democracy (LURD) rebels laid

Bosnian soldiers and a bystander carry away the body of a casualty of a mortar shell attack on Sarajevo's main downtown marketplace in February 1994. © Laurent Rebours/AP Photo siege to Monrovia. Hundreds of civilians were killed and thousands injured when mortar rounds rained down on the Liberian capital (HRW, 2003). Almost a decade earlier the 1994 Sarajevo market massacre that claimed more than 60 lives and injured more than 200 was the result of a single 120 mm mortar shell (Smith, 1994).

A heavy machine gun can saturate an area with bullets one kilometre and further from the weapon. In the Eastern Equatoria state of southern Sudan, a pastoralist group reportedly used a 12.7 mm machine gun (along with other small arms and light weapons) in an ambush that killed more than 50 civilians from another tribe in May 2007 (Small Arms Survey, 2007b, p. 2).

A rocket launcher firing a shaped charge warhead can penetrate armour plating on the most advanced tanks or reinforced bunkers, not to mention most domiciles. For example, a PG-7L shaped charge warhead for the ubiquitous RPG-7 is capable of penetrating 600 mm (23.62 in.) of armour, 1.3 m (4.27 ft) of reinforced concrete, and more than 2.5 m (8.2 ft) of logs and earth (Jane's, 2007c, p. 477). Shaped charges can be used in a variety of ways, which do not always necessitate the use of factory-manufactured weapons. One example is the use of explosively formed projectiles where a shaped charge or explosive can be used on its own as an improvised explosive device. Such an EFP, weighing no more than a few kilograms (several pounds), can accelerate to speeds of 2,000 m per second—more than twice as fast as a 12.7 mm machine-gun cartridge when fired (Atkinson, 2007b). This force permits the weapon to penetrate a substantial amount of armour plating on armoured vehicles or 762 mm (30 in.) of concrete (Blair, 2007). EFPs have claimed a much higher percentage of US casualties than their limited use would suggest (Gordon, 2007; Atkinson, 2007d).[14]

The 1994 Sarajevo market massacre was the result of a single 120 mm mortar shell.

The potential effectiveness of MANPADS is well known (Small Arms Survey, 2004, pp. 77–97), if perhaps overstated. Long-haul aircraft typically transport two hundred or more passengers, making them attractive targets for a group intent on causing many casualties. Since the late 1970s almost one civilian aircraft per year on average has been reportedly fired upon with such weapons, resulting in hundreds of casualties (USDoS, 2005) (see Table 1.1). Yet most of these attacks have occurred in war zones, and some regions remain largely unaffected; not a single civilian aircraft has been hit by a MANPADS in North America or western Europe, for example. Moreover, many missiles miss their targets and those that strike do not necessarily achieve their aim. (Attacks on military targets with MANPADS have been more frequent, and especially effective against helicopters.)[15]

The ancillary effects of an attack can be severe even if the missile misses its target or is believed to exist but has not been fired. The attack on an Israeli aircraft departing Mombasa for Tel Aviv in November 2002 resulted in two Strela SA-7 missiles missing their target and the plane landing safely in Tel Aviv as scheduled. But the ramifications for the Kenyan economy were severe.[16] The November 2002 attack, coupled with Britain's decision to halt British Airways flights to Nairobi for a short period in 2003 because of fears of an attack on its aircraft (which did not materialize), resulted in what Kenyan tourism officials described as the worst crisis to hit the country since its independence (BBC News, 2003).[17] A 2005 RAND Corporation study of MANPADS threats to the civil aviation industry concludes that airline cancellations and downturns in tourism arising from such threats would have significant repercussions on the global economy (Chow et al., 2005).

Availability of light weapons

Light weapons, like small arms, are widely produced and readily available. As enumerated in greater detail in following sections of this chapter, more than 50 countries produce light weapons. The reason more do not do so is not technological barriers to the production of certain systems, but rather the fact that the markets are so open that their needs are met easily through commercial transactions. The technology required to make many light weapons rests

Table 1.1 **Selected incidents of reported MANPADS attacks on civilian aircraft**

Date	Location	Target	Fatalities	Description
03.09.78	Zimbabwe	Air Rhodesia Vickers 782D Viscount	38	An SA-7 missile hit the passenger plane's right wing shortly after take-off from Kariba. The plane crash-landed. Zimbabwe People's Revolutionary Army (ZIPRA) rebels, responsible for the shooting, subsequently killed many of the plane's survivors.
12.02.79	Zimbabwe	Air Rhodesia Vickers 748D Viscount	59	ZIPRA fired on the aircraft with an SA-7 after it left Kariba, hitting the left engine, killing all aboard.
08.11.83	Angola	Angola Airlines Boeing 737-2M2	130	Immediately after taking off from Lubango, the plane crashed. National Union for the Total Independence of Angola (UNITA) rebels claimed credit for downing the plane with a missile. The Angolan government blamed the crash on a technical malfunction.
04.09.85	Afghanistan	Bakhtar Afghan Antonov AN-26	52	The plane was shot down with a surface-to-air missile shortly after take-off from Kandahar.
16.08.86	Sudan	Sudan Airways Fokker F-27	60	The Sudan People's Liberation Army (SPLA) firing an SA-7 brought down the aircraft shortly after take-off from Malakal.
11.06.87	Afghanistan	Bakhtar Alwatana Antonov AN-26	53	The plane was shot down near Khost on its way from Kandahar to Kabul.
08.12.88	Western Sahara	Two T&G Aviation Douglas DC-7CF	5	Two aircraft on the way from Senegal to Morocco were hit (in an engine) with SA-7s while flying at 3,352 m (11,000 ft) over Western Sahara. One crashed, killing all five aboard. The other managed to land safely in Morocco.
06.04.94	Rwanda	Rwandan government Dassault Falcon 50	12	The plane, carrying the presidents of Burundi and Rwanda from peace talks in Tanzania, was shot down on approach to Kigali.
10.10.98	Democratic Republic of the Congo	Lignes Aeriennes Congolaises Boeing 727-30	41	The plane was shot down with an SA-7 missile shortly after take-off from Kindu.
02.01.99	Angola	Transafrik Lockheed L-100-30 Hercules	9	UNITA shot down the plane some 20 minutes after take-off from Huambo on the way to Luanda. (A Hercules aircraft had suffered a similar fate upon departing Huambo a week earlier, in which 14 people perished.)
28.11.02	Kenya	Arkia Boeing 757-3E7	0	Two SA-7 missiles missed the plane carrying 271 people shortly after take-off from Mombasa.
22.11.03	Iraq	European Air Transport Airbus A300B4-203F	0	An SA-7 missile hit the cargo plane's wing as it climbed past 2,438 m (8,000 ft). The heavily damaged plane returned to Baghdad safely.
23.03.07	Somalia	Transaviaexport IL-76TD	11	The plane crashed after one of two SA-18 missiles fired by Hizbul Shabaab hit the plane shortly after take-off from Mogadishu.
13.08.07	Iraq	Nordic Airways MD-83	0	Pilots of the passenger jet said two missiles were fired at their plane after take-off from Sulaimaniya.

Sources: ASN (2007); Chivers (2007); USDoS (2005); UNSC (2007, para. 39) on know-how that was widely acquired before the Second World War (WWII) or has been produced under licence for more than 25 years. Their portability and concealability in transit increase the ease of such transfers.

Like small arms, most light weapons have a shelf life that outlives the time span of one generation (10–15 years) of weapon technology. This allows states to transfer—often at a steep discount or for free—older generation models. Many of the recipients lack adequate safeguards for their weapons stockpiles or are engaged in hostilities with non-state actors in which the latter seize materiel in combat. Once in the hands of non-state actors, unguided light weapons in particular require relatively little maintenance and are able to withstand harsh conditions. Guided weapons, on the other hand, such as MANPADS (discussed in detail below), that have sophisticated battery-powered guidance systems and require significant training and practice for effective use may present certain challenges to non-state actors.

Improvised explosive devices are understandably attracting considerable attention because of their use in Iraq (see Box 1.3), but their significance is much broader than their use and effectiveness in that conflict. During 2006

Box 1.3 A 'new' light weapon: improvised explosive devices in Iraq

Improvised explosive devices (IEDs) are not unique to Iraq, but never before have they been deployed in such numbers and used with such deadly effect. The *Washington Post*'s Rick Atkinson, for example, reports that the US military encountered these devices in Afghanistan, but there were fewer than 25 in 2002. Most were unsophisticated, many set off by tripwires. In Iraq crude time-delayed IEDs have given way to pressure-plate triggers and increasingly sophisticated radio-controlled weapons that can be activated at distances that measure in kilometres. In some four years in Iraq, insurgents have employed more than 80,000 IEDs. The following account reflects the US experience in combating IEDs in Iraq.

Insurgents are believed to possess an almost limitless production capability and have exhibited planning and resourcefulness. The stockpiles of munitions throughout Iraq when Saddam Hussein's regime was overthrown have been estimated to number at least 650,000 tons (589,676 metric tonnes) of explosives, reportedly less than half of which had been secured more than a year after the invasion. Moreover, insurgents pilfered huge quantities of bomb-making materials that had been 'secured'. Less than 10 kg of explosives (about what a 155 mm artillery round can deliver) properly placed can destroy the heaviest armoured vehicle in service with US forces. In some cases insurgents have configured more than 20 artillery shells to explode simultaneously. Insurgents who, US government analysts believe, once took days to conduct surveillance of a site and bury the device in advance of the ambush are thought now to often successfully complete such preparations in two hours or less. Moreover, the number of bomb-makers in Iraq has grown (although the United States is undertaking concerted efforts to reduce their number). The United States has compiled information on 169 bomb-making networks representing numerous ethnic groups and political objectives. Each cell is believed to consist of five to ten members (not all of them bomb-makers). They do not believe this number to be comprehensive.

Countermeasures have been only partially effective. Passive measures include body armour for soldiers and additional armour protection for motorized vehicles, as the majority of vehicles operating in Iraq with US forces were not armoured–and as noted above, even the largest tanks can succumb to IEDs. Both of these measures are palliatives.

Active measures to disable the IED are numerous, but many have fallen far short of objectives. They include what might be described as traditional devices to jam frequencies used to cause an explosion, or manually rendering the weapon inoperative. The electronic countermeasures have shown themselves to be effective in certain instances, but they have created unintentional problems of electro-magnetic compatibility, such as interfering with communications as well as command-and-control equipment. Newer approaches include aerial and video reconnaissance to monitor and detect insurgent activity and the emplacement of the devices. Natural phenomena such as sandstorms and man-made 'countermeasures' such as strewn trash degraded the efficacy of these technical innovations. The US programme was discontinued after it was deemed that a concerted three-month effort in 2004 to fully employ such resources was unsuccessful.

Recently, electronic countermeasures have proven more effective against IEDs, but this has not slowed their use. Rather, Iraqi insurgents are now favouring devices that are detonated in ways other than by radio control. In 2003 the number of IEDs used reached 100 a month. In 2004 the number reached 100 a week. By 2007 the number had approached 100 a day. As of 2007, the United States had suffered more than 20,000 casualties in Afghanistan and Iraq from IEDs.

Sources: Atkinson (2007a; 2007b; 2007c; 2007d) and 2007 more than 20 non-state armed groups in 19 countries and territories were reported to have employed IEDs. They have been made out of landmines (of both the anti-personnel and the anti-vehicle varieties), rockets, artillery shells, and other munitions (Moser-Puangsuwan, 2007). While many of these devices come from materiel (various kinds of munitions), some are fashioned from commercial civilian materials.

Non-state armed actors are producing light weapons other than just IEDs. They produce rockets, mortars, and grenade launchers. They also produce the munitions for these weapons (see Box 1.4).

Box 1.4 **Craft production of light weapons**

Non-state armed groups—and some territories outside state control—produce numerous light weapons of various levels of sophistication. Weapons produced include man-portable rockets and launchers, mortars and their munitions, as well as grenade launchers. Successful production depends on the skill level among members or supporters of the armed group, their access to appropriate resources, and the group's ability to take and hold territory in which production facilities can be maintained. The groups and weapons listed here are representative and not exhaustive.

Various Palestinian armed groups produce light weapons. The Ezzedine Al-Qassam Brigade of Hamas, for example, manufactures the Al-Qassam rocket.[18] The Al-Qassam, first introduced in 2001, has subsequently seen improvements in its payload and range. According to initial reports there were at least three variants with different ranges (about 3–10 km), warheads (0.5–20 kg), and weights (5–90 kg). More recent reports have the rocket's range expanding to 12–14 km with distances up to 20 km expected. The one constant appears to be the weapon's imprecision and a relatively short-lived propellant that makes stockpiling the rocket impractical. It is foreseen, however, that improvements to the propellant will eventually allow the weapon to be stored for extended periods. This would permit the weapon to be fired en masse after numerous rockets have been produced. More than 4,000 Al-Qassam rockets have been fired into Israel, with over 1,000 Al-Qassams fired from Gaza in 2006 alone. The Al-Aqsa Martyrs Brigade of Fatah, the Al-Nasser Salah Al-Din Brigade of the Islamic Resistance Committees, and the Al-Quds Brigade of Islamic Jihad all produce their own rockets. The Quds 4 two-stage rocket of Islamic Jihad is reported to have a greater range than any Al-Qassam (Richardson, 2002; Blanche, 2003; Richardson, 2004a; Ben-David, 2006; Jane's, 2007a; Richardson, 2007).

An Al-Qassam 2 rocket rests on a tripod in Gaza, 2002.
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Man-portable rockets reportedly are also being produced by rebels in Iraq. The United States claims to have recovered home-made rockets and rocket launchers in various parts of the country (Jane's, 2006b; USDoD, 2007).

The Revolutionary Armed Forces of Colombia (or FARC, for Fuerzas Armadas Revolucionarias de Colombia) also produce a range of light weapons. According to field research conducted by Pablo Dreyfus, the FARC have created War-Front Workshops (or TFGs for Talleres de Frente de Guerra) with help from co-opted technicians of the state-owned factories producing defence equipment for the Colombian government, known as INDUMIL (for Industria Militar). TFGs began operations in 1995. Materiel produced includes 60 mm, 81 mm, and 120 mm mortars, although it took some five years for all the kinks to be worked out in the serial production of these weapons and munitions. These workshops manufacture other light weapons such as grenade launchers as well as munitions for light weapons including rifle grenades and mortars (Dreyfus, 2005).[19]

In South-east Asia, numerous non-state armed groups have been reported to produce light weapons. The Liberation Tigers of Tamil Eelam (LTTE), for example, have produced a rocket—the Pasilan 2000[20]—with a 25 kg warhead (Chalk, 1999, pp. 6, 12), an RPG known as the Arul 89 (*India Today,* 1997), and mortars (Jane's, 2005). Elsewhere in the region, groups in Myanmar are said to produce 60–107 mm mortars, and at least one group, the Moro Islamic Liberation Front in the Philippines, has fabricated replicas of US and Soviet 40 mm RPGs (Davis, 2003; Koorey, 2007).

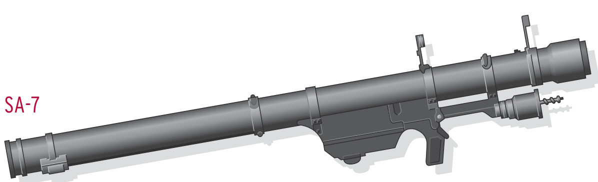
Some territories that have effectively seceded and are not under effective control of the 'former' capital also reportedly produce light weapons. There are numerous—albeit not always substantiated—reports that describe events in the self-declared Republic of Transdniester. According to a UN study, law-enforcement officials confiscated 53 handcrafted 40 mm multi-shot grenade launchers that were fabricated in that territory (SEESAC, 2006, p. 113, n. 156). Moreover, advertisements circulating in Transdniester in 2003 promoted the production and sale of homemade 'Kryzhovnik' mortars (IA, 2005, p. 2).

It is easier to record with a high degree of confidence what non-state armed groups produce than to document what they procure from others. The proliferation of MANPADS is fairly well established and it is clear that many non-state groups have used these weapons (see Table 1.1). But, as the incident of so-called 'Steyrgate' underscores, *reports* of diversion or illicit transfer do not always reflect reality. In this case, a report that Austrian 12.7 mm calibre anti-materiel rifles, sold to Iran, were recovered from rebels in Iraq was subsequently discredited (Wezeman, 2007). Annexe 1.1 presents information on guided light weapons in the possession of non-state armed groups. It includes unconfirmed as well as confirmed reports of holdings. Even established 'sightings' must be treated with caution given political agendas as well as poor journalism and research. Nevertheless, the compilation of reports provides a basis for discussing the nature and cause of the proliferation of these weapons. This can in turn lead to the development of policies and programmes designed to address this challenge.

GUIDED LIGHT WEAPONS

Guided light weapons are shoulder-launched or pedestal-mounted, and fire a missile that can be directed towards the target after launch. First introduced in the mid-1950s, these systems differ from unguided light weapons because once the projectile is released its trajectory can be altered in flight either by the operator or by an automated guidance control system. Early models require that soldiers manually steer missiles until they reach (or miss) their intended target. The drawback of this, however, is that soldiers are vulnerable to counterattack while controlling the missile in flight. Improvements in weapon technology in the last few decades have reduced the threat of counterattack. New-generation missiles travel greater distances, and engage targets autonomously with homing devices that enable the gunner to take cover, relocate, or reload immediately after firing.

SA-7



Man-portable air defence systems (MANPADS)

Man-portable air defence systems are short-range surface-to-air missile systems[21] intended for attacking and defending against low-flying aircraft. Some are crew-served (known sometimes as CREWPADS, although we use MANPADS generically), but most are easily handled by a single individual and are shoulder-launched. MANPADS are generally categorized into three types of guidance system: passive infrared (IR) seekers, laser and radio command to line-of-sight (CLOS), and laser-beam riders.[22] Initial models could engage a target at altitudes of around 2,000–3,000 m and from slant ranges[23] of about 4,000 m (Jane's, 2006a, pp. 3–50; 1985, pp. 132–7). They were often inaccurate and susceptible to basic countermeasures. Moreover, they could engage aircraft only from behind. Today's most advanced systems can effectively engage aircraft at ranges of up to 8,000 m from multiple directions. Their effectiveness against large fixed-wing turbojet aircraft (as seen in Table 1.1) should not be exaggerated, however.[24]

Initial development of MANPADS began in the 1950s. Anti-aircraft guns from WWII were of limited use, and consumed vast quantities of ammunition against increasingly fast jet aircraft. The United States developed the Redeye—which got its name from the infrared homing device in its nose—over the better part of a decade, and it entered into production in the mid-1960s (Parsch, 2002). The Soviets countered in 1968 with the Strela-2 (also known as the SA-7, which is used here, or Grail).[25] Both were 'tail-chase' systems (their guidance was provided by an

IR-seeking homing head so they had to be fired from behind the target to home in on the engines' exhaust). By the end of the 1960s only these two countries produced MANPADS, although Sweden and the United Kingdom had undertaken research and development of indigenous weapons.

The 1970s saw significant changes to the industry. The United States began development of the Stinger missile system in 1972 (Parsch, 2002) and production began in 1979 (Jane's, 2006a, p. 43). Work on the Soviet Strela-3 (SA-14 Gremlin) began in 1968, and it entered service six years later in 1974 (Jane's, 2006a, p. 30). Like their predecessors, these systems used IR devices, but they had been improved to engage targets from all directions (not just from behind). Second-generation IR systems also achieved a greater range and accuracy. The British Blowpipe system was based on radio CLOS technology, but the Swedish RBS-70 differed in that it used a laser beam-riding tracking system that was more resistant to countermeasures (Jane's, 1985, pp. 133–44).

Whereas the first 25 years of MANPADS research and development had resulted in just four countries producing weapons, the next 25 years saw this number rise considerably—only partially because of formal licensing agreements. By 2007, 31 countries had manufactured an entire system, had produced important components, or had created systems that upgraded certain aspects of an existing system such as enhancing target acquisition (see Annexe 1.2).

The US has destroyed more than 20,000 MANPADS since 2002 in some two dozen countries.

Licensed production and reverse engineering (unauthorized copying of existing systems) of mostly early Soviet models largely explain this increase in states' production of MANPADS. The issue of licensing is sensitive and contentious for the Russian Federation and many former Warsaw Pact countries. Moscow claims that current MANPADS systems are being produced illegally in some of these countries. Those accused retort, however, either that no such licence exists or that the models being produced are their own missiles after years of indigenous improvements (Small Arms Survey, 2007a, pp. 20–21). For some producers there is no pretence of any licence having existed. In the late 1970s, for example, the Egyptians produced a reverse-engineered copy of the SA-7, called the Ayn-al-Saqr. In 1974 the Egyptian government allegedly supplied Beijing and Pyongyang with examples of this SA-7 in appreciation of their support during the 1973 Yom Kippur War. Subsequently, both China and North Korea produced their own versions of the weapon (Jane's, 2006a, p. 10). There are also reports that the US Stinger has been produced under licence and illegally copied, albeit not as widely as Soviet models.[26]

Improvements to later generation IR MANPADS include greater range and accuracy, and better resistance to IR countermeasures (Jane's, 2006a). Many systems also have larger warheads, with proximity, delay, or grazing fuses, which increase the missiles' lethality, hit probability, and, in some cases, the types of targets that can be engaged. The Bolide is a new High Velocity Missile, which is compatible with the RBS-70 launcher. By one account it reportedly has a range of 10,000 m and is effective against both ground and sea targets (FI, 2007c).

Newer models are not just more capable but considerably more expensive. Older IR systems such as the SA-7 and Stinger used to cost an estimated USD 25,000–40,000. Newer generation models like the laser-beam riding RBS-70 and British Starstreak, however, sell today for about USD 220,000 (FI, 2007c; TGC, 2007).

More than 100 countries—and non-state actors—possess these weapons. MANPADS have been transferred to at least 125 countries (FI, 2007b). Of the 500,000–750,000 MANPADS believed to be in circulation, some 99 per cent are estimated to be in state inventories. But many governments and regional organizations deem the stockpile management procedures for tens of thousands of these weapons to be wanting (see, for example, Schroeder, 2007). The United States alone has destroyed more than 20,000 MANPADS since 2002 in some two dozen countries (USFNS, 2007). Many non-state armed groups possess MANPADS (see Annexe 1.1), the result of deliberate government policy, seizure, corruption, lax export controls, and stockpile mismanagement. Batteries can last 20 years and more (Eagle Picher, 2003), making older systems still attractive on the secondary market.

Fourth-generation missile systems currently under development are incorporating more advanced guidance and sensor systems for improving accuracy at greater altitudes and ranges (CRS, 2006). Raytheon, for instance, is completing development on an upgrade to the US Stinger that enables the gunner with better cueing and target-acquisition capabilities. This variant is expected to provide a separate helmet with rangefinder that communicates with the missile via an Enhanced Position Location Reporting System (EPLRS) radio (Richardson, 2004b).

Other recent advances include the introduction of automated command-and-control systems. Belarus and Israel in particular have developed the Shlem and Red Sky, respectively. These are integrated multiple launch systems that rely on global positioning and infrared technology to reach targets with greater accuracy. One added benefit is that the launch unit is equipped so that the operator can send cues to the launcher from a distance via computer (Gyürösi, 2003; Jane's, 2006c).

Spike

Anti-tank guided weapons (ATGWs)

An anti-tank guided weapon is a launcher, accompanied by a missile fitted with a warhead that the operator manually, automatically, or semi-automatically steers to its target. These weapons are primarily designed to knock out armoured vehicles and frequently possess a useful secondary effect against hardened or reinforced targets such as bunkers. They were created when advances in armour made traditional direct-fire anti-tank guns less effective. Moreover, ATGWs offer soldiers the ability to engage targets from greater distances with increased accuracy than is possible with unguided anti-tank light weapons. These weapons have an effective range of up to 8,000 m, and armour penetration nearing 1,000 mm (Jane's, 1985, pp. 49–69; 2007b, pp. 445–509). However, each generation of weapon varies greatly in terms of its guidance, lethality, and portability.

Initially produced in the 1950s, there have been three distinct 'generations' within the weapon system's development, all of which primarily concern the guidance of the weapon. Besides changes to these systems' navigation, there have been improvements in each generation's range and payload.

First-generation ATGWs were guided to the target after launch by a wire in the rear of the missile which was connected to the firing unit. The operator often used a joystick to manually control the direction of the projectile. Early launchers were as simple as a disposable transport box that was either placed on the ground or mounted on a vehicle. This system was known as 'MCLOS' for manual command to line-of-sight. They achieved effective ranges between 1,500 and 3,000 m, and delivered a maximum penetration of 500 mm (Jane's, 2007b, pp. 445–509). During WWII the Germans employed the X-7, the first MCLOS system (Gander, 2000, pp. 136–52). The French SS-10 and German Cobra, both modelled after the X-7, were the first ATGWs available for export, although they remained in production for only a short time (Jane's, 1975, p. 743; 1985, p. 51). In 1964, the 9M14 Malyutka, also known as the AT-3 Sagger (North Atlantic Treaty Organization (NATO) designation), became the first Soviet ATGW. A drawback of first-generation models, independent of their relative effectiveness, was that the gunner had to remain in the same position while the warhead was in flight. If the target was not effectively neutralized, or if there were other forces within range of attack, the ATGW operator was quite vulnerable.

Second-generation systems, known as SACLOS (semi-automatic command to line-of-sight), saw significant improvements in performance. After the missile is launched, the operator keeps the sight on the target, whereby automatic guidance commands are sent to the missile via wire, radio, or laser-beam-riding technology. The United States introduced the tube-launched, optically tracked, wire-guided missile (TOW) in 1968. Although many countries are now shopping elsewhere for ATGWs, by 2000 more than 600,000 TOW missiles and 15,000 launchers had been procured, making the system the most widely deployed of all ATGWs (Gander, 2000, p. 140). France and Germany jointly began producing the Missile d'Infanterie léger antichar (MILAN, infantry light anti-tank missile) shortly thereafter. SACLOS missiles outperform first-generation systems with accuracy rates exceeding 90 per cent. Moreover, SACLOS missiles reach effective ranges between 2,500 and 5,500 m with warhead armour penetration of up to 900 mm, almost twice the range and payload of first-generation models (Jane's, 2007b, pp. 445–509).

The international community has expended comparatively little energy to destroy excess stockpiles of ATGWs.

Despite advances made in SACLOS models, operators were still vulnerable to counterattack due to their immobility. Third-generation guidance systems ameliorated this threat by having IR lasers installed on the nose of the missile to lock on and reach the target automatically. Unlike wire-guided and laser-beam-riding missiles, IR technology enables the operator to reposition or reload immediately. First developed in the 1980s, these 'fire and forget' (FaF) guidance systems allow the operator to retreat immediately after firing. The most notable of these weapons is Israel's Spike, which moved beyond 'fire and forget' to 'fire and correct', whereby the operator can change the target during missile flight (TGC, 2007). Other IR ATGWs include the Indian Nag and the US Javelin. Maximum range varies considerably. Whereas maximum ranges are typically between 4,000 and 8,000 m (Jane's, 2007b, pp. 445–509), some models have shorter firing ranges to suit current environments of combat (FI, 2007b). Moreover, IR models tend to be lighter and collapsible for transportability. These developments allow soldiers increased versatility in urban spaces. For example, these systems have been employed in Afghanistan and Iraq, where manoeuvrability is limited in comparison to prior military engagements in Vietnam and Latin America.

The costs of ATGWs vary considerably. The basic TOW and MILAN as well as other SACLOS missiles are priced at around USD 10,000 a piece. Third-generation systems that use IR guidance missiles cost considerably more—starting at between five and ten times the price of SACLOS missiles (FI, 2007c).

More than 30 countries have fully or partially produced ATGWs, but currently only six are fully manufacturing ATGWs with fire-and-forget guidance systems. Many of the countries that produced MCLOS systems have chosen to cease production for a variety of reasons: an obsolete design with low hit probability; gunner vulnerability; a limited ability to penetrate modern armour; and sufficient stockpiles to satisfy demand.[27] Roughly half of the systems produced are essentially copies of another country's design such as the Malyutka (Sagger), TOW, and Spike. Currently, roughly 14 countries produce ATGWs with technology acquired from six technology-owning countries, either with or without a formal licence. Most licensing agreements include offsets which are supplementary arrangements to compensate the purchaser in some fashion—either directly in terms of the item in question, or indirectly involving some other good or service (Small Arms Survey, 2007a, p. 12; see also Box 1.5).

Unlike with MANPADS, however, the international community has expended comparatively little energy to destroy excess stockpiles of ATGWs. As with MANPADS, ATGWs are to be found in the stocks of a great number of

Box 1.5 Licensing agreements and offsets: the case of the Spike in Poland

Israel has exported Rafael's Spike anti-tank guided weapon to several countries since Singapore first purchased the system in 1999. Subsequent orders have come from Finland, the Netherlands, Poland, and Spain. Several of these purchases have included licensed production and offset agreements.

The December 2003 deal between Poland and Israel for PLN 1.487 billion (USD 512 million) covered the sale of 2,675 missiles and 264 launchers with substantial local manufacture involved. Initial materials for the missile were provided by the Israeli manufacturer, with the Polish company ZM Mesko and Polish partners responsible for producing numerous components. Up to ten companies are to be involved, and hundreds of jobs created. The missiles' warheads, rocket engines (launch booster and sustainer), and launch tubes are among the parts to be made in Poland. All told, fully 70 per cent of the missile is to be manufactured in Poland. Rafael will supply the thermal imager, firing post, tripod, and simulators. Under the offset agreements, ZM Mesko will deliver 2,000 warheads and motors to Rafael. ZM Mesko will also be able to use some technologies received from Rafael to improve or develop other indigenous projects.

Sources: Holdanowicz (2004; 2007); Jane's (2005)

states. By one account, more than 100 countries have such weapons in their inventories (FI, 2007b). However, more than half of these states' arsenals are believed to possess mostly the less sophisticated and less able MCLOS systems. Non-state armed groups also possess ATGWs. Hezbollah, for instance, reportedly received hundreds of anti-tank guided missiles through state transfers from Iran and Syria (Wezeman et al., 2007, p. 410). But according to published reports fewer of these groups own ATGWs than possess MANPADS (see Annexe 1.1).

Recent developments of ATGWs have been aimed at designing more versatile weapons for use against varying ground targets. Rather than utilizing ATGWs solely in an anti-tank capacity, reports from Iraq demonstrate that these weapons are more likely to be used against 'low-value' targets, such as passageways and concrete walls.[28] With nearly 1,000 missiles fired in Iraq by 2005, the US Javelin has filled this role. The Javelin missile, however, is expensive for use against low-value targets. In response, the United States has begun research on the Spike (not to be confused with Israel's ATGW), a new lightweight fire-and-forget missile. It is expected to carry an average unit price of USD 4,000, and to be effective against stationary or moving ground targets and low- and slow-flying helicopters (FI, 2007c).

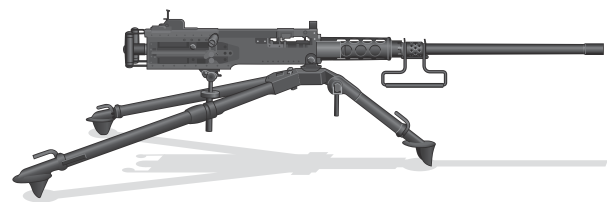
UNGUIDED LIGHT WEAPONS

Traditionally, unguided light weapons differ from their guided weapon counterparts in that the system operator cannot change the missile's course after it is fired. This does not mean unguided weapons are less accurate than guided weapons—they just cannot be directed while in flight (although technological developments are allowing the trajectories of some new mortars to be manipulated). Unguided weapons reach their intended targets through both direct and indirect fire. With direct-fire weapons, the target is seen directly, through a sight, in contrast to indirect-fire weapons, which have no direct line of sight to the target. Training and improved fire-control mechanisms permit even indirect weapons such as mortars to be extremely accurate at distances exceeding the most advanced man-portable air-defence systems. Recent technological progress has blurred the distinction between these two types of weapons, however. The development of 'smart' mortar bombs that can hit their intended targets with higher probabilities than traditional systems relying only on ballistics could have grave consequences should this technology proliferate to terrorist groups.

This section is organized into two parts: the first reviews systems that fire cartridge-based ammunition; the second covers weapons that launch rockets, mortars, and grenades.

Weapons firing cartridge-based ammunition

Heavy machine guns (including anti-aircraft guns)



Browning M2

Heavy machine guns are those capable of firing 12.7 mm (.50 calibre) ammunition to calibres of up to 20 mm, where it is generally accepted that cannon ammunition starts. They are man-portable, but are typically mounted on vehicles or ground mounts as an anti-personnel and anti-aircraft weapon. They are effective against personnel, light armoured vehicles, low- and slow-flying aircraft, and small boats. Modern heavy machine guns are belt-fed, recoil-operated, air-cooled, and have an effective range of up to 2,000 m (Jane's, 2007c, pp. 353–415). For all intents and purposes any heavy machine gun can serve in an anti-aircraft role. The distinction between heavy machine guns' ability to fire on land and air targets rests largely on the placement of the firer and the type of weapon mounting and sights.

Heavy machine guns date back to the late 1800s. However, most modern models fashion themselves after the US Browning .50 Calibre M-series Heavy Machine Gun, first designed in 1918. Extended firing of this calibre weapon generated very high temperatures, rendering the gun barrel a potential hazard for shooters. During the First World War (WWI) weapons such as the Browning M1921 used a water-cooling system to reduce the barrel's heat. To overcome the inconvenience associated with water-cooling, the 1928 Browning M2HB (Heavy Barrel) replaced this system, and addressed barrel heat with a thicker barrel construction which acted as a heat-sink and allowed higher volumes of fire to be obtained. The Soviets responded to the Browning in 1938 with the DShK, which featured similar capabilities to those of the Browning M2. The Soviets and later the Russians replaced the DShK with newer models, such as the NSV (1971) and Kord (1998). Improvements in weight, reliability, and production capability made these weapons superior to their predecessor (Jane's, 2007c, pp. 381–91). In contrast to developing new models, the United States continued to produce improved variants of the Browning M2 for the better part of the 20th century.

These two systems remained the global norm until 1986, when the M2HB-QCB (quick-change barrel), developed by FN Herstal of Belgium, introduced significant changes to the original model. The QCB variant reduced the risk of ammunition jamming (Hogg, 1999, p. 216).

More than 20 countries worldwide have produced heavy machine guns. Currently, nearly half of them have ceased production, primarily of the 14.5 mm heavy machine gun. With the exception of the Chinese, who have developed one new model each decade since the 1950s, most countries produce copies or variants (either licensed or unlicensed) of the Russian DShK and the US Browning M2 (Jane's, 2007b, pp. 353–415). Pakistan, for example, produces its 12.7 mm Type 54 anti-aircraft gun under an official licence from China, which itself acquired the DShK technology without formal licence from the Russian Federation (Small Arms Survey, 2007a, p. 19).

As noted earlier, heavy machine guns have made their way into the arsenals of non-state armed groups. It is not clear which avenues are most commonly used for illicit procurement, but what remains uncontested is the impact of these weapons when they are misused (see above).

Despite few technological changes over the past century, developments are under way to equip armies with more powerful and versatile heavy machine guns. The XM312 .50 calibre machine gun, under development by the US firm

General Dynamics Armament and Technical Products (GDATP), is claimed to be nine times more accurate than the Browning M2. It has reduced recoil, enabling the shooter to keep focused on the target. Moreover, it can be quickly converted to the XM307, a 25 mm grenade launcher system. Nearly half the weight of the M2, it is expected to be one of the lightest 12.7 mm machine guns on the market when it enters service (General Dynamics, 2007).

Barrett M82

Anti-materiel rifles

Anti-materiel rifles are designed primarily to engage and neutralize a variety of targets at distances well beyond a kilometre. Specialized ammunition enables the weapon to pierce light armour and (parked) aircraft, but the rifle can be, and has been, used for anti-personnel purposes. Most of the weapons in this class are chambered for 12.7 mm (.50 calibre) ammunition, but some fire cartridges of up to 20 mm. The effective range for 12.7 mm and 14.5 mm anti-materiel rifles is 1,000–2,000 m (at the upper threshold, at least three times the effective range of a 7.62 mm assault rifle), but use of a mount can extend the range and its ability to engage the target.[29] A 20 mm anti-materiel rifle typically has an effective range of around 2,000 m (Jane's, 2007b, pp. 287–96).

Anti-materiel rifles have found favour among many countries' militaries as well as law-enforcement bodies, and are being widely produced. Rifles firing ammunition larger than 10 mm date back to WWI and were further developed during WWII. These weapons, which served ostensibly in an anti-tank capacity, were generally too heavy for a single soldier to transport. Other types of light weapons were developed to meet the same need, and rifles calibrated to fire large ammunition went out of favour. This changed dramatically in 1982 with the production of the Barrett M82. Although not designed to engage tanks, advances in ballistics, improvements in the weapons' design to reduce recoil and weight, and more destructive bullets resulted in a much more portable weapon that could engage a variety of targets. Today, 14 countries produce anti-materiel rifles that fire 12.7 mm, 14.5 mm, and 20 mm ammunition. The US manufacturer Barrett attempted to develop a weapon based on the M82 (and its successor the M107) that fired a 25 mm round, but this initiative was halted for technological reasons (Jane's, 2007b, p. 299).

The 12.7 mm rifle is popular with civilians in several countries, and numerous non-military versions are being produced to meet this demand. The civilian versions are generally heavier, less robust, and equipped with fewer optical and other electronic devices (although many of these items can be obtained commercially and fitted to most 'civilian' models) than the weapons designed to military specifications. In the United States alone, more than 20

Table 1.2 Examples of 12.7 mm (.50 calibre) anti-materiel rifle prices from US companies (USD)*

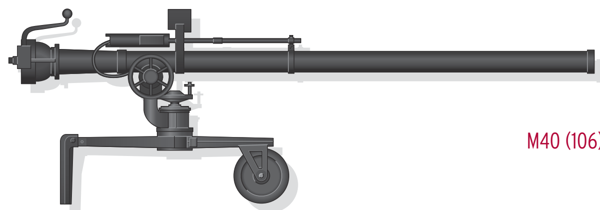
Company	Prices	Company	Prices	Company	Prices
A.L.S.	1,900	Christensen Arms	5,500	Robar	7,000
Armalite Inc.	3,000	East Ridge Gun Company Inc.	1,900-3,600	Safety Harbor Firearms Inc.	1,850-2,450
Barrett	3,000-8,050	E.D.M. Arms	2,250-8,500	Serbu Firearms	2,200-2,450
Bluegrass Armory	3,100	Ferret 50	3,300-4,000	Watson Weapons	2,150

*Prices are rounded to nearest USD 50.
Source: Leff (2007)

companies manufacture 12.7 mm calibre rifles (Boatman, 2004, pp. 51–52, 56, 58, 61; see Table 1.2 for a sampling of producers and prices). Interest in this type of firearm arises in part because it is legal for civilians in the United States to possess this weapon and because using these rifles has become a recognized sport not just in the United States but also in Switzerland and the United Kingdom.[30]

Non-state armed groups have also shown an interest in acquiring this weapon and in at least two cases have succeeded in obtaining some from civilian customers in the United States who have transferred them (illegally). Known instances are the Irish Republican Army (Vobejda and Ottaway, 1999) and the Kosovo Liberation Army (Sullivan, 2004).

Recoilless rifles and guns


M40 (106)

Recoilless rifles and guns fire projectiles that achieve a depth of penetration that would normally require a much heavier conventional recoiling weapon. They are light, but are able to fire large calibre ammunition (57–105 mm). Their basic design is based on a lightweight rifled barrel and a locked breech that is vented rearward. Upon firing, the projectile is launched in one direction, and a precisely balanced flow of propellant gases or a counter-mass is vented in the opposite direction. These competing forces balance out to eliminate the recoil forces encountered with conventional weapons. Some versions can be shoulder-fired, others such as the 105 mm version are mounted on a light vehicle, but most are mounted on tripods. The gun barrel, tripod, optical sight, and ammunition are typically carried separately by a four-person team. Recoilless rifles and guns have maximum firing ranges superior to most other light weapons (2,000–8,000 m depending on the calibre of the weapon), but their effective range is significantly less (Jane's, 2007c, pp. 445–504).

Traditionally classified as an anti-tank weapon, recoilless rifles and guns were developed first by Commander Cleland Davis, an US naval officer, prior to WWI (NYT, 1912). The Davis Gun was restricted to use as an aircraft weapon, and was later scrapped due to its impracticality.[31] The Soviets began trials in the early 1930s for an anti-tank recoilless weapon, known as the RK system, intended for infantry use. The gun remained in service only for less than a decade because it was too dangerous to handle. Finally, in 1946 the Swedish defence industry introduced the Carl Gustaf, a shoulder-fired recoilless weapon (Gander, 2000, pp. 124–26). With more than 90,000 produced since WWII (FI, 2007a), the Carl Gustaf M2 is the most popular shoulder-fired recoilless rifle. Despite advances in ammunition, the design of the original launcher has not changed much over time.

At least 25 countries have produced recoilless rifles and guns. Of these, only about one-third continue to produce them. The US M40 105 mm, otherwise known as the 106, is the most widely produced and distributed recoilless rifle, with exports to more than 30 countries and production of both licensed and unlicensed copies in Austria, China, India, Iran, Pakistan, South Korea, and Spain. The 106 is typically mounted to a vehicle, but can be transported short distances by a crew (Jane's, 2007c, p. 504). Since the late 1990s, however, armies have begun to phase out large calibre recoilless rifles, opting for smaller systems with shorter engagement ranges that are effective in urban combat and against bunkers.

Recoilless rifles and guns themselves have not changed dramatically over time. But they have expanded their utility to accommodate various types of ammunition, including high-explosive fragmentation rounds, close-defence shrapnel-type ammunition, smoke, illumination, and several other types of warheads (Jane's, 2007c, pp. 445–504).

M203

Hand-held, under-barrel, and automatic grenade launchers

There are three types of grenade launchers—hand-held, under-barrel, and automatic. They fire numerous types of grenades, including those filled with high explosives, lachrymatory agents (such as tear gas), bright burning compounds for illumination, and incendiary material. Most launchers fire NATO 40 mm or ex-Warsaw Pact 30 mm ammunition. Hand-held and under-barrel grenade launchers are effective against point targets at less than 500 m, and are most commonly used in military operations. Police forces occasionally use them to launch rubber or tear gas projectiles for crowd and riot control. Automatic grenade launchers, on the other hand, have a maximum effective range against point targets of 150–1,500 m and against area targets of up to 2,200 m (Jane's, 2007b, pp. 417–32).

In the post-WWII period, countries began developing 'hand-held' single-shot grenade launchers to replace the rifle grenade launcher. The most common of these was the US M79, which was widely used during the Vietnam War. In order to increase firing versatility, countries developed under-barrel grenade launchers. This is a complete weapon with its own barrel, trigger, and sights. It is attached under the barrel of the rifle to allow for either rifle or grenade fire from the same platform.

In 1967, The US began producing the MK 19—the first automatic grenade launcher to be used during the Vietnam War. The Soviets followed suit with the introduction of the AGS-17 in the mid-1970s. These weapons are light and compact, enabling them to be used in close to medium range battle (Jane's, 2007c, pp. 423–24, 431–32). Automatic grenade launchers are mounted on a tripod or vehicle, and are capable of firing 40–480 rounds per minute up to ranges of 1,700 m. The production status of the Russian AGS-17 is currently dormant, as it has been replaced with a newer model. It is in service with many countries throughout the world, and is produced under licence by China and Serbia (Jane's, 2007c, pp. 423–24).

The 1980s and 1990s saw the development of stand-alone rapid firing six-shot multiple grenade launchers. Their effective range does not differ from low-velocity single-shot grenade launchers, but their ability to fire up to six grenades within seconds constitutes an important difference. These have been used in urban warfare and small-scale conflicts. Examples of six-shot grenade launchers include the Russian 6G30 and South African MGL Mark 1 (Jane's, 2007b, pp. 332–33, 339).

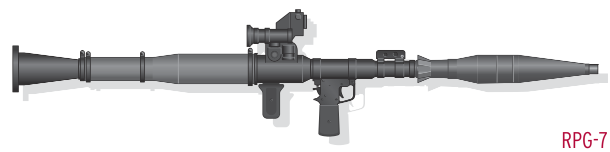
At least 25 countries currently produce one type or a combination of hand-held, under-barrel, and automatic grenade launchers. Manufactured in 17 countries, under-barrel grenade launchers are the most widely produced version. The US M203 replaced the M79 in 1969, and is now the most broadly produced and traded grenade launcher in the world. Canada, Egypt, South Korea, and Taiwan all produce launchers that are directly licensed from or closely resemble the M203. Out of about 20 countries that have produced automatic grenade launchers, a little more than half continue to do so.

Current advances in grenade launchers afford users lighter systems with greater accuracy. The German XM320 is under development to replace the US M203. Operators benefit from a lighter launcher that has a safer and more modern firing system than its predecessor. The new model enables soldiers to attach the launcher in seconds without any tools. Moreover, it is designed to use all current 40 x 46 mm ammunition (side-loading and long cartridges) that the previous M203 model was incapable of accommodating (Gourley, 2006). Likewise, the US XM25 Individual Airburst Weapon System, currently under development by Alliant Techsystems as part of the Objective Individual

Combat Weapon (OICW) programme, features a time-fused grenade controlled by a computer. Before firing, the shooter determines the range by using a laser rangefinder. Then the computer calculates the trajectory and sets the time fuse so the grenade explodes at the pre-selected range up to 500 m (ATK, 2007). Although slated to replace the US MK19 Automatic Grenade Launcher, this weapon has been delayed several times and has yet to enter production (Kucera, 2006).

Rocket/grenade launchers and mortars

Unguided 'anti-tank' rocket launchers (including RPGs)



RPG-7

Unguided rocket launchers cover a wide range of multi-purpose weapons that discharge an unguided rocket and are armed with various warheads to engage and defeat a variety of targets. These weapons, which may be reloadable or disposable after a single use, typically are designed to be operated by one person.

The numerous roles designed for this type of light weapon defy a generalized description of their ranges and effectiveness. In the anti-armour role, the ubiquitous RPG-7 has an effective range of about 330 m against moving targets and 500 m against stationary targets, but generally cannot defeat main battle tanks (Jane's, 2007c, pp. 476–78). Newer models such as Spain's Alcotan-100 achieve longer ranges and are fitted with a variety of warheads that are effective against explosive reactive armour as well as bunkers and other structures. Besides engaging armoured vehicles and bunkers, versions of these weapons are also employed against people. These technological differences are expressed through the prices of these weapons' launchers: an RPG-7 costs USD 1,900–2,200 and the Alcotan-100 sells for more than USD 11,000 (FI, 2007a).

The appearance of armoured vehicles during WWI, followed by tanks equipped with more resilient armour in WWII, created demand for a light and portable infantry weapon, which continues to this day although the targets are more varied. The first shoulder-fired rocket launchers, all introduced in the early 1940s, were the US M1, better known as the 'Bazooka', the German Panzerfaust, and the British PIAT (Gander, 2000, pp. 88–100). After the Soviet army captured blueprints for the Panzerfaust in 1945, it developed the RPG-2, which closely resembled its German counterpart. Since WWII, Germany, the Russian Federation, and the United States have developed upgrades for their rocket launcher systems every decade or so. Although commonly called rocket-propelled grenades (RPGs), which happens also to be the acronym for the popular Soviet-designed weapon (Ruchnoy Protivotankovyy Granatomyot), many newer models bear little resemblance to the RPG-2 or RPG-7. The US M72 LAW (light anti-tank weapon), which followed the Bazooka, and the Swedish AT4, for example, are shoulder-launched, but differ from RPGs in that they are single-use weapons in which the projectile is pre-packaged.

Improvements to unguided rocket launcher warheads make these weapons more powerful against a wider range of targets than older munitions. The US MK 118 Mod 0 High Explosive Dual-Purpose (HEDP) warhead, for example, is designed to detonate at different times depending on the material of the target. For soft targets such as concrete and sandbags there is a fuse delay, which allows the rocket deep penetration before detonation. In contrast, the warhead explodes immediately upon impact with harder targets such as armoured vehicles (FI, 2007a).

Unguided rocket launchers are widely produced and widely procured. More than 35 countries have produced unguided rocket launchers. Of these about half have ceased production over the last few decades. As of 2006, at least

11 countries had produced licensed copies of the RPG-7, accounting for more than 13 million units produced worldwide (FI, 2007a). RPGs' low price,[32] wide availability, small size, and light weight make them attractive to non-state actors.

Future developments primarily involve improvements to the rocket's warhead. In line with current combat conditions, new designs are aimed at increasing explosive strength and penetration, while reducing the launcher size and the amount of back blast that often accompanies such improvements. The Swedish Next-generation Light Anti-tank Weapon (NLAW), expected to enter service by 2009, is the first single-soldier rocket system that is capable of destroying any type of main battle tank (MBT), and is small enough to operate in cramped quarters as a bunker buster (Saab).

60 mm mortar

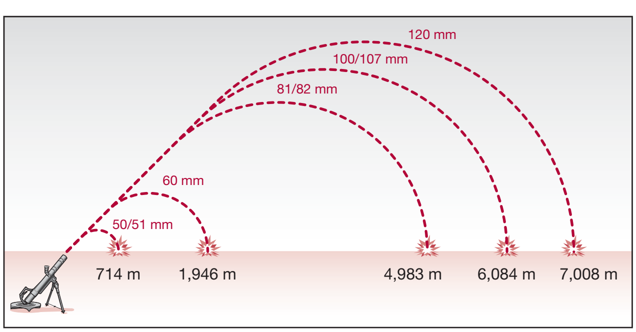
Mortars

Mortars are generally smooth-bored indirect-fire weapons that enable the operator to fire from small deep pits, behind hills, or in ravines. A mortar's high-trajectory fire makes the weapon effective against similar enemy positions. There are, generally speaking, three categories of mortar: 'light' (up to 79 mm), 'medium' (80–99 mm), and 'heavy' (100 mm and above). With traditional ammunition these mortars can engage targets less than 100 m. from the firer's position to more than 7 km away (see Figure 1.1). Specialized ammunition has augmented these weapons' operational capacity in terms of both range and lethality (see below). Some light mortars can be carried and operated by a single person. But most mortars are crew-served weapons; one soldier carries the launch tube and fire-control unit, another carries the base plate, and a third carries the bipod or tripod. This three-person team can carry the requisite munitions for smaller mortars (a 60 mm mortar bomb weighs around 1 kg, for example), but larger systems typically require additional team members or light vehicles to transport the munitions (Jane's, 2007c, pp. 511–85, 707–63).

The mortar is one of the oldest forms of artillery, and its basic design has not changed much in the past 50 years. The weapon was likely used as long ago as the siege of Constantinople in 1453. Modern-day versions are based on a 1915 design by the British engineer, Wilfred Stokes. He invented what became known as the 3 in. (76.2 mm) muzzle-loading Stokes mortar for British use during WWI (Jane's, 1979, p. 405). Such mortars won wide acceptance in part because they were cheap and easy to make. In the lead-up to WWII, two firms—Britain's Stokes and France's Thomson-Brandt—became the leading mortar manufacturers of that time. Then, during the war, numerous countries began to manufacture 120 mm mortars. There have since been metallurgical advances to produce lighter launch tubes and political requirements for a mortar just under 100 mm.[33]

Nearly 50 countries have manufactured one or more types of mortars, making it the most widely produced light weapon. Only around 30 of these countries, however, continue to produce or partially produce one or more types of mortar (Jane's, 1975; 1985; 2007c). Partial producers include Canada and New Zealand, which manufacture mortar

Figure 1.1 **Mean maximum ranges for 50 mm to 120 mm mortars with standard munitions**



Source: Wilkinson (2008)

Box 1.6 Mortar developments: precision guidance and extended ranges

Traditionally, mortars have been 'guided' only in the sense that with skill one could calculate the distance, and in which direction, a mortar shell would travel. A spotter could relay information to the individual or team firing the weapon, and subsequent refinements would enable the target to be effectively engaged—often with a salvo of mortars. In recent years, however, munitions have been developed that permit a single mortar to obtain a degree of precision previously impossible to achieve—and at distances previously beyond reach.

Four types of precision guidance system exist for mortars. As these systems have been developed since the late 1990s, it is perhaps misleading to speak of them as comprising separate 'generations'. But their developments mirror those of MANPADS in the sense that early systems used infrared technology and more recent systems use radio frequencies (RFs), laser-beams, and fibre optics. IR (and RF) systems have the advantages of fire-and-forget targeting, but can mistake similar 'signatures' for the intended objective. Systems using laser beams can provide the user with a higher degree of reliability but require someone within a kilometre of the target and with an unobstructed view to illuminate the mark so that the projectile can latch on to it. A system utilizing fibre-optic technology allows the operator to be far from the target (or the launch site). Global positioning system (GPS) software is also being used—sometimes on its own and also in conjunction with other forms of terminal guidance. The first precision mortar system—the 120 mm IR-guided Saab Bofors Strix—entered service in 1994 (and had an unexceptional range of 7 km). Other precision mortars since produced or under development include the British ODAM, French ALFO, Israeli Fireball, Russian Gran, and US PGMM. These subsequent models employ the different guidance systems noted above and range in size from 60 to 120 mm, with some systems having more than one version.

Most precision mortars are also equipped with technological improvements that extend their ranges. Changes include booster rockets, deployable fins, and extendable wings. It is not uncommon for ranges to be extended two or more times the distance of traditional mortars. (Some mortars that do not employ terminal guidance have extended ranges using similar features.)

Source: Bonomo et al. (2007, pp. 20–38)

fire control units but do not produce complete mortars or their requisite ammunition. Canada offers a full line of mortar sight units. New Zealand is one of the few countries that have developed a computer system that utilizes global positioning system (GPS) technology. This allows operators at secured posts to engage targets from single or multiple mortar locations (Jane's, 2004, pp. 550–52, 555). Computerized fire-control systems not only reduce the time needed to calculate necessary changes to aim the mortar but in some cases can adjust the mortar tube automatically (Bonomo et al., 2007, pp. 34–37). Given their availability, longevity, ease of operation, and low cost, mortars appeal to non-state armed groups (as noted above, by their use in Former Yugoslavia and in Liberia). More recently, in September 2007, an unidentified Sudanese armed group used mortars, among other small arms and light weapons, to kill ten African Union peacekeepers in Darfur (CNN, 2007).

Besides the improvements to control units noted above, other important developments concern the mortar construction and munitions. For example, light carbon fibre composite barrels are being developed that could enable a single person to transport and operate a mortar as large as 120 mm. New designs are permitting systems to be deployed more easily. Mortar shells are also undergoing significant changes and are no longer constrained by 'simple' ballistics (see Box 1.6).

CALCULATING VALUES AND VOLUMES FOR LIGHT WEAPON PRODUCTION

What is the volume and value of production of the light weapons identified in this chapter? Manufacturers and government officials are not particularly open about individual or overall sales figures. Analysts who follow the industry closely are more inclined to forecast future growth for a specific product and that system's or that company's potential overall market share than they are to discuss actual recipients, numbers sold, and unit values. Measures to encourage transparency in reporting have been adopted by organizations such as the Economic Community of West African States (ECOWAS) and the Organization for Security and Co-operation in Europe (OSCE). Yet, even when reporting is kept confidential among peers, the information that states choose to share tends to be selective and partial.

How then does one determine the number of light weapons produced and their value?

To date, the Small Arms Survey has utilized customs data to ascertain the value of the authorized transfer of certain weapons. This sheds some light on production values and volumes, but is an imperfect indicator at best. Customs data does not distinguish between newly produced weapons and those that may represent excess stockpiles or second-hand goods. Moreover, customs data tracks trans-border transactions, not domestic acquisitions. A further limitation that concerns light weapons (and not small arms) is that some existing categories include both light weapons and major conventional weapon systems, and cannot be disaggregated. For these and other reasons, estimates of the volumes and values of new production can be based on customs data only in exceptional cases.

Information that states choose to share tends to be selective and partial.

General media and trade reports sometimes provide the details of a sale. While in some instances this can shed light on the value and volume of production and transfer, there are limits to the use of such information. Often the information provided refers to 'packages' including different types of weapons, support equipment, and spare parts. It is not unusual for a single order to encompass numerous missiles of different ranges, warheads, guidance systems, and platforms. Furthermore, the number of spare parts will often differ between contracts. One country may buy sufficient spare parts for the expected time of operation of a particular system, but another may buy only an initial set of spare parts. A repeat customer may require fewer spare parts than a new purchaser. Offsets (see Box 1.5) can also affect a system's unit sales value. For guided weapons, the ratio between a firing post (FP), containing the launch control unit (LCU), thermal sights, and tripod, and the missiles it fires will differ among recipients. As the LCU is considerably more expensive than the individual missile, this creates challenges to calculating values. This is a partial, but representative, list of concerns.[34]

Despite these challenges, the Survey believes that sufficient information exists to make some general calculations and provide rough estimates that will shed light on a matter that has until now remained mostly in the shadows. For example, there are methods for estimating the mix of firing posts and missiles in a contract even where specific information is not available. A useful ratio can be generated from knowledge of doctrine and previous procurement. General price data for these components is sometimes reported. One can extrapolate from a small number of examples to make some general statements about other sales for which less information is available. And it might be possible to make some assumptions about how that weapon has fared in comparison with competing countries and systems to get a sense of the price a system can fetch in a competitive market.

Moreover, one can estimate the number of systems produced and delivered on a yearly basis by averaging a recipient's expected deliveries over the duration of a contract. Distinguishing launchers from missiles (in instances where the two are distinct and the launcher is reusable) is also often possible or can be estimated based on doctrine or examples of certain countries. By adding the estimated annual total units delivered and multiplying the total firing posts and missiles by an average price, one can shed considerable light on both the value and the volume of production for that system. With a view to testing some of these estimation techniques, we have developed a production worksheet for the Spike anti-tank guided weapon (see Table 1.3).

We have based our assessment of Spike ATGW production on a thorough review of open source information. Where we had no information on procurement rates for specific years, we assumed transfers of firing posts and missiles to

Table 1.3 Production worksheet for the Spike ATGW based on reported sales and estimates (2001–05)

Recipient	Contract signed	Period of delivery	Totals		Deliveries of firing posts (FPs) and missiles (Ms), in units									
			FPs	Ms	2001		2002		2003		2004		2005	
					FPs	Ms	FPs	Ms	FPs	Ms	FPs	Ms	FPs	Ms
Chile	2003	2003-06	20	1,000					25	250	25	250	25	250
Czech Rep.	2006	2007-12	80	80										
Finland	2000	2001-05	120	1,000	24	200	24	200	24	200	24	200	24	200
Finland	2005	2008-09	?	?										
Israel	1990s	1995- ?	?	?	0	50	0	50	0	50	0	50	0	50
Italy	2005	2007-11	50	500										
Netherlands	2001	2001-05	250	2,400	50	480	50	480	50	480	40	480	50	480
Poland	2003	2004-13	264	2,675							2	20	24	60
Romania	1997	1999-2002	200	200	50	50	50	50						
Romania	1998	2002-05	80	160			20	40	20	40	20	40	20	40
Singapore	1999	2001-06	100	1,000			16	167	16	167	16	167	16	167
Slovenia	2006	2007-09	35	500										
Spain	2006	2008- ?	260	2,600										
Totals					**124**	**780**	**160**	**987**	**135**	**1,187**	**127**	**1,207**	**159**	**1,247**

Key: FP = firing post; M = missile (MR, LR, and ER models); ? = insufficient data to base estimate
Source: Berman (2008)

be constant over the course of a multi-year delivery period. As Spike firing posts and missiles are easily interchangeable among firing platforms, we include in our analysis Spikes that may be mounted on 8 x 8 armoured wheeled vehicles (such as the Austrian Pandur or the Finnish Patria), or the tracked armoured infantry fighting vehicles (such as the Romanian MLI-84), or on helicopters (such as the Augusta A129). In other words, the fact that the weapon is man-portable or designed to function on a light vehicle is of greater significance for our purposes than the recipient's particular doctrine and intended use.

We base our calculations on an assessment of Spike missile costs by Forecast International, specifically that the MR (medium-range) version costs USD 97,000, the LR (long-range) version USD 115,000, and the ER (extended-range) version USD 129,500 (FI, 2007c). We assume that the firing post costs around USD 250,000. As the majority of missiles are of the LR and ER versions, for the purposes of our calculations we take USD 125,000 to be the average value of a Spike missile. Thus, between 2001 and 2005 the average annual sales value for this system may be estimated to be USD 170.4 million (i.e. 705 firing posts at USD 250,000 a piece for a total of USD 176.2 million, and 5,408 missiles at USD 125,000 each for a total of USD 676 million divided by five). This does not take into account production of spare parts and supporting equipment such as simulation systems. Spare parts can involve fairly large production values particularly for systems that have been in use for some time. There is, however, very little information on production of spare parts.

These figures are for sales values. Thus they include production costs, as well as taxes and profits. In the case of the Spike, parts of which are produced in many countries, it is difficult to say how much individual companies earn from production. It is important to underscore that almost every customer nation requires some form of compensation ('offset') for the purchase, usually a combination of direct and indirect offsets. In Poland, for example, Mesko is responsible for much of that country's procurement, just as General Dynamics Santa Bárbara Sistemas (GDSBS) will build components to fulfil the Spanish order, or the German firms Diehl BGT Defence (DBD) and Rheinmetall Defence Electronics (RDE) as part of the EuroSpike consortium play a leading role in supporting sales elsewhere in Europe. Since all these companies produce parts for many other weapon systems, it is difficult to obtain any further information from public company data.

Light weapons pose a demonstrable threat to societies and states.

Collecting data on the Spike is a first step towards generating a more complete picture of the production of light weapons. Next steps might include an analysis of Spike's competitors such as the Javelin, the TOW, and the MILAN, which could shed light on the Spike's market share and therefore allow one to gauge the larger market for anti-tank guided weapons from detailed knowledge of a single system. Each weapon system could be analysed separately and aggregated if sufficient information existed. It could also be possible to make an appraisal of the market based on information on quantities of ATGWs sold together with an assessment of the average value of this type of weapon system. Or, if prices were known for other ATGWs along with their comparable characteristics, then parametric cost estimation could be used to generate the broader picture for production values of this type of weapon. Parametric cost estimation, which is well established, is an especially promising technique for calculating unknown prices on the basis of physical characteristics, such as weight, range, accuracy, and complexity. With the use of known values and major physical characteristics that are closely linked to price differences, a price function could be estimated that could then be used to arrive at figures for individual weapons whose prices are not known. The multiplication of prices and quantities would result in estimates of sales values.

Such approaches—though meritorious—are beyond the scope of this initial exercise. For the purposes of generating an initial estimate of the market for ATGWs, we have taken Forecast International's projected market share for the Spike for the period 2007–11—roughly 15 per cent—and accepted that it broadly reflected the period 2001–05. With the Spike's annual sales for 2001–05 estimated to be USD 170.4 million, as noted above, this gives us a projected total for the anti-tank guided weapon market to have averaged USD 1.1 billion (i.e. USD 170.4 million x 6.67) for this five-year period.

CONCLUSION

In this chapter we have largely accepted the approach and categorization of the 1997 UN Panel of Experts when it comes to 'light weapons'. Focusing on portability as the overarching criterion, we have amended the Panel's listing to include mortars up to 120 mm, and various craft-produced materiel such as improvised explosive devices and man-portable rail-launched rockets.

Light weapons pose a demonstrable threat to societies and states. Their potential for causing political and economic instability and exacerbating armed violence is very real. The temporary cessation of British Airways flights to Kenya because of a perceived threat underscored MANPADS' effects even when they were not used. A single mortar shell fired into a crowded market in Sarajevo killed and wounded more than a hundred people. A one-day barrage of shells against the Liberian capital Monrovia resulted in thousands of casualties. RPGs and IEDs are responsible for the majority of US casualties in Iraq.

Some actions can be taken to counter the threat posed by some light weapons and help reduce the extent to which they proliferate, but some dangers cannot be neutralized or meaningfully mitigated. For example, technological countermeasures can be developed to impede a missile's ability to acquire or defeat its target (although perhaps not always in an economically viable manner). Moreover, improving states' abilities to manage their stockpiles of these weapons, combating their illicit trade, and strengthening oversight of licensing agreements can make a positive difference. Certain materials for producing light weapons, however, are available commercially and cannot easily be monitored or restricted. And it is nearly impossible to defend against some light weapons such as limpet mines, anti-materiel rifles, or indirect-fire weapons.

Fifty-nine countries either have produced one or more of the eight types of guided and unguided light weapons covered in this chapter, or have manufactured components or system upgrades for these types of weapon. More than half of these countries have undertaken production of guided weapons or their components: 28 currently produce MANPADS or their components, and 25 produce ATGWs or significant parts thereof. Generally speaking, light weapon systems are becoming cheaper to produce and acquire, easier to operate and transport, and more capable of engaging their targets at greater distances. The number of countries capable of producing light weapons far exceeds those that presently do so. For many of the light weapons covered in this chapter the technology required to manufacture them is simple to acquire, and 'barriers' to entry into such markets are self-imposed. It is simply cheaper and easier to procure the weapon from others than to undertake production on one's own.

The value of light weapons production exceeds several billion dollars annually. This chapter has focused on assessing just one of the UN Panel's eight light weapons item types: anti-tank guided weapons. We estimated that the annual sales for ATGWs averaged USD 1.1 billion for the period 2001–05. While much of this production results in local procurement and stockpiling, a sufficient percentage is sold to foreign customers to suggest that the long-standing estimate of USD 4 billion (Small Arms Survey, 2006, p. 67) for the authorized trade in small arms, light weapons, and their ammunition may be an underestimate.

Relatively few countries possess the know-how and industrial capacity to develop and produce on their own the most technologically sophisticated systems, but this does not stop them from obtaining the necessary capabilities. Many guided weapons considered advanced in the 1980s are now widely produced through reverse engineering or licensed production. If history is any indication, then it is only a matter of time before many countries produce new technologies such as guided mortars, which would have serious security implications, especially if they fell into the hands of terrorist groups.

Moreover, light weapon systems are widely held among non-state armed groups. Politicized reporting and the opaqueness of the black market make it difficult to ascertain the exact number of armed groups in possession of such materiel. But sufficient evidence exists to establish that dozens of such groups hold numerous guided light weapons. At least two groups have also obtained .50 calibre (12.7 mm) anti-materiel rifles (from civilians in the United States, where it is legal to purchase them). Many of these groups also produce their own light weapons, including mortars as well as grenade and rocket launchers. The sophistication of these weapons is growing, as is the threat they pose. Improvised explosive devices have proven effective against the most advanced armour. Man-portable rockets have increased in range, and it is believed to be only a matter of time before advances in the design of their propellant will enable them to be fired in large numbers rather than in small batches.

The combination of increased lethality and portability, together with reduced training requirements and barriers to production, suggests that greater attention should be paid to light weapons.

ANNEXE 1.1

Guided light weapons reportedly held by non-state armed groups, 1996–2007*

Country or territory/area in which groups are active	Non-state armed group ■ Active as of Dec. 2007 ■ Defeated, dormant, or seized/joined government as of Dec. 2007	MANPADS									ATGWs								
		Unspecified	SA-7	SA-14	SA-16/SA-18	Redeye	Stinger	HN-5	Blowpipe	Other**	Unspecified	AT-3 Sagger	AT-4 Spigot	AT-5 Spandrel	AT-13 Saxhorn-2	AT-14 Spriggan	Toophan	Raad-T	Other**
Afghanistan	■ Jamiat-e-Islami		●	●															
	■ Jumbish-e-Milli		●																
	■ Northern Alliance (NA)										●								
	■ Taliban		●				●	●	●										
Algeria	■ Armed Islamic Group (GIA)						●												
	■ Salafist Group for Preaching and Combat (GSCP)		●																
Angola	■ National Union for the Total Independence of Angola (UNITA)		●	●	●	●	●												●
Chad	■ Union of Forces for Democracy and Development (UFDD)		●																
Colombia	■ National Liberation Army (ELN)	●					●												
	■ Revolutionary Armed Forces (FARC)		●	●	●	●	●												
Côte d'Ivoire	■ Patriotic Movement of Côte d'Ivoire (MPCI)	●																	
Democratic Republic of the Congo	■ Unspecified				●		●												
	■ National Congress for the Defense of the Congolese People (CNDP)						●												
Ethiopia	■ Oromo Liberation Front (OLF)	●																	
Guinea	■ Unspecified		●																
Iraq	■ Unspecified	●	●	●	●					●									●
Kashmir	■ Harkat ul-Ansar (HUA)		●																
	■ Hizbul Mujahideen (HM)						●												
Kenya	■ Unspecified		●																
Kosovo	■ Kosovo Liberation Army (UÇK)		●																
Lebanon	■ Hezbollah		●	●	●		●			●		●	●	●	●	●	●	●	●
	■ Popular Front for the Liberation of Palestine-Gen. Command (PFLP-GC)	●	●																
Liberia	■ Liberians United for Reconciliation and Democracy (LURD)		●																

Macedonia	■ National Liberation Army (NLA)		●		●							●							
Moldova	■ Unspecified		●	●															
Myanmar	■ United Wa State Army (UWSA)		●					●											
Northern Ireland	■ Irish Republican Army (IRA)		●																
Occupied Palestinian Territory	■ Islamic Resistance Movement (Hamas)						●												
	■ Palestinian Authority (PA)		●				●					●							
Pakistan	■ 'Army of the Pure': Lashkar-e-Tayyiba (LeT)	●																	
Russian Federation	■ Chechen rebels		●		●		●		●										
Saudi Arabia	■ Al-Qaeda		●																
Sierra Leone	■ Armed Forces Revolutionary Council (AFRC)		●						●				●						
	■ Revolutionary United Front (RUF)		●	●					●				●		●				
Somalia	■ Shabaab	●	●		●						●								
	■ Islamic Courts Union (ICU)	●	●		●						●								
	■ Somali National Alliance (SNA)	●																	
	■ Transitional National Government (TNG)										●								
	■ Transitional Federal Government (TFG)										●								
	■ United Somali Congress/Somali Salvation Alliance (USC/SSA)	●																	
Spain	■ Basque Homeland and Freedom (ETA)		●																
Sri Lanka	■ Liberation Tigers of Tamil Eelam (LTTE)		●	●			●	●											
Sudan	■ Sudan People's Liberation Army (SPLA)		●																
Turkey	■ Kurdistan Workers' Party (PKK)		●				●												
Uganda	■ Lord's Resistance Army (LRA)		●								●								
TOTALS	Specific system reported to be, or have been, in groups' stockpiles	10	31	8	9	2	14	3	4	2	6	3	3	1	2	1	1	1	3
	Number of groups believed to be holding, or to have held, this type of weapon	42									13								

* This Annexe reflects the assumption that if a group reportedly fired a missile during the period under review, it probably has (or had) additional examples of the same system.

** The category 'other' includes reports of the Misagh (or Mithaq) in service with Iraqi armed groups, and the Vanguard and Misagh among Hezbollah's MANPADS holdings. As for ATGWs, Hezbollah is believed to possess the MILAN and TOW; these weapons are also reported to have been in service with UNITA.

Source: Lazarevic (2008)

ANNEXE 1.2

Global overview of countries producing light weapons (1947–2007)

Producer		Type of light weapon																
No.	Country	MANPADS			ATGWs			HMGs/AAGs		Mortars			Grenade launchers			Recoilless rifles/guns	Anti-materiel rifles	Rocket launchers
		LBR	IR	CLOS	MCLOS	SACLOS	FaF	12.7 mm	14.5–20 mm	<79 mm	80–99 mm	100–120 mm	Hand-held	Under-barrel	Automatic			
1	Argentina				●	■				●	●	●	●			●		
2	Australia																●	
3	Austria									■	■	■				●	■	●
4	Belarus			◣														
5	Belgium							■	●	■	●		■				○	●
6	Bosnia and Herz.									●	●	●				●		●
7	Brazil				●	■				■	■	●				●		●
8	Bulgaria		■		●	■		■	■	●	■	■	■	■		■		■
9	Canada					◣				◣	◣	◣		●	◣			
10	Chile									■	■	■						
11	China		■		■	■		■	■	■	●	●	■	■	■	■	■	■
12	Croatia									■	■	●	●	●		●	■	●
13	Cuba																■	
14	Czech Republic		■						●	●	●		■			●	●	■
15	Denmark		◣								●	●						
16	Egypt		■			●				■	■	■		■	●			■
17	Finland						◣			●	●	■				●	○	●
18	France		■		○	■			●	■	■	■	■	■		●	■	●
19	Georgia									●	●	●						■
20	Germany	◣	■		●	●	■		■				■	■	■	●		■
21	Greece		●					○		■	■	■		●	■	●	●	●
22	Hungary										●	●					■	
23	India		◣		●	■	■	■		●	■	●				■		■
24	Indonesia									■	■			■	■		■	
25	Iran		■		■	■		●		■	■	■				■		■
26	Iraq									●	●	●			●			●
27	Israel		◣			■	■			■	■	■	■					■
28	Italy				●	●					■				●	●		

29	Japan		■		●	■	■				●					■		
30	Kazakhstan							●										
31	Macedonia																	■
32	Netherlands		●				◣											
33	New Zealand									◣	◣	◣						
34	Nigeria									●	●							●
35	North Korea		■			●			●									
36	Norway	◣			◣													■
37	Pakistan	■	■		●	■		■		■	■	●		■	●	■		■
38	Philippines									●	●				●			
39	Poland		■		●		◣	■	○	■	●		■	■	■		■	●
40	Portugal									●	■							
41	Romania		■			■		■	●	■	■	■		■	■	●		■
42	Russia		■		●	■		■	●		■	●	■	■	■	●	■	■
43	Serbia		●			■		■		●	●	●			■	●	■	■
44	Singapore		■				●	■		●	●	●	■	■	■			●
45	Slovak Republic		■			■					●				●			●
46	Slovenia																●	
47	South Africa					■				■	■		■	■	■		■	■
48	South Korea		■							■	■			■		●		
49	Spain					■	■			●	●	●			■	●		■
50	Sweden	■			●	■	○	●			●	●				■		■
51	Switzerland		■		●	■				●	●	●	■	■			■	●
52	Taiwan				●			■		■	●			■				
53	Thailand									■	■	●						●
54	Turkey		◣		●		○			■	■	■	■	●	■			■
55	Ukraine		◣		◣	◣	◣	●			●						●	
56	United Kingdom	■		■	●	■		■		●	●	■	●	■		●	■	●
57	United States		■		●	■	■	○		■	■	■	■	■	■	■	■	■
58	Vietnam		■								■							
59	Zimbabwe									●								
TOTALS* (at least one type)		5	27	2	20	26	11	16	9	40	48	33	17	21	20	25	19	36
			31			33		20			49			31				

* Totals refer to countries that have undertaken partial or full production of the light weapon in question at one point over the past 60 years. A system that was still reportedly in research and development in 2007 is not included.

Key: AAG = anti-aircraft gun; HMG = heavy machine gun; ■ = (essentially) full production; ◣ = partial/assembly production; ○ = research and development; ● = production complete/dormant/status unclear

Source: Berman and Leff (2008)

ABBREVIATIONS

ATGW	Anti-tank guided weapon
CLOS	Command to line-of-sight
EFP	Explosively formed projectile (or penetrator)
FaF	Fire and forget
FARC	Revolutionary Armed Forces of Colombia
GPMG	General-purpose machine gun
GPS	Global positioning system
IED	Improvised explosive device
IR	Infrared
LCU	Launch control unit
MANPADS	Man-portable air-defence system(s)
MBT	Main battle tank
MCLOS	Manual command to line-of-sight
MILAN	Missile d'Infanterie léger antichar
NATO	North Atlantic Treaty Organization
NLAW	Next-generation Light Anti-tank Weapon
QCB	Quick-change barrel
RF	Radio frequency
RPG	Ruchnoy Protivotankovyy Granatomyot; Rocket-propelled grenade
SACLOS	Semi-automatic command to line-of-sight
TFG	War-front workshops
TOW	Tube-launched, optically tracked, wire-guided missile
WWI	First World War
WWII	Second World War

ENDNOTES

1 This section focuses on the definition developed by the UN Panel of Governmental Experts in its 1997 report (UNGA, 1997). For a discussion of other definitions, see Small Arms Survey (2005, pp. 123–27; 2006, pp. 103–04).

2 In December 1997 the Convention on the Prohibition of the Use, Stockpiling, Production and Transfer of Anti-Personnel Mines and on Their Destruction (commonly known also as the Mine Ban Treaty or the Ottawa Convention) was concluded and opened for signature. It entered into force the following year. See <http:www.icbl.org>

3 The word 'operated' here does not include ancillary (although often necessary) personnel, including spotting or security details that usually accompany the deployment of light weapons, such as MANPADS and mortars.

4 By contrast, the US High Mobility Multi-purpose Wheeled Vehicle (widely known as a Humvee) and the British Land Rover can transport more than twice that payload. The Toyota Hilux, a 4 x 4 civilian vehicle that is ubiquitous in UN peace operations, and has been seized by rebel groups in numerous missions, has a payload greater than a UAZ-3151.

5 Thirteen countries—Burma, China, Cuba, India, Iran, Nepal, North Korea, Pakistan, Russia, Singapore, South Korea, the United States, and Vietnam—are believed still to produce anti-personnel mines or have yet to indicate that they will refrain from further such activity (LM, 2007, p. 13).

6 Some 30 countries are reported to have produced anti-vehicle landmines: Argentina, Austria, Belgium, Brazil, Chile, China, Czech Republic, Denmark, France, Germany, Greece, Hungary, Italy, Japan, the Netherlands, Pakistan, Peru, Poland, Portugal, Romania, Slovak Republic, South Africa, the former Soviet Union, Spain, Sweden, Thailand, the United Kingdom, the United States, and the former Yugoslavia (see Hiznay and Goose, 2000; HRW, 2002).

7 However, 120 mm mortar ammunition is heavy, which brings into question the utility of this system.

8 Pistols and revolvers that fire calibres in excess of 10 mm have also appeared in both civilian and military markets in recent years. These weapons include the .50 calibre (12.7 mm) Action Express-chambered 'Desert Eagle' pistol developed by Israel Military Industries (IMI) and the .50 calibre Smith and Wesson 'Model 500' series of revolvers. While these weapons have similar calibres to some heavy machine guns and anti-materiel rifles, the case length of the ammunition that they employ is considerably shorter, resulting in lower-velocity ballistics.

9 This chapter does not, therefore, consider the Finnish Lapua Magnum rifle to be a light weapon even though it fires a .338 in. (8.6 mm) cartridge, which is significantly larger, and capable of engaging targets from greater distances more effectively, than the 7.62 mm rifles that are traditionally conceived of as 'small arms'.

10 See Pézard and Anders (2006).

11 The company that sells this item, Machine Guns New Zealand, advises that a full-scale six-barrel model will soon be available. See <http://www.machineguns.co.nz/products.shtml>

12 Vickers did produce 12.7 mm machine guns, but an Internet search yielded no evidence that replicas of this particular model are being produced.

13 The type of ground, as well as the type and size of warhead, will affect the mortar's lethality.

14 EFPs have reportedly been used in just three per cent of all roadside bombings against US soldiers, but have resulted in 17 per cent of US fatalities through such attacks (Atkinson, 2007d). According to *The New York Times,* EFPs accounted for fully one-third of the deaths of US soldiers killed in action in Iraq in July 2007 (Gordon, 2007).

15 For example, Afghan rebels reportedly used MANPADS to shoot down more than 250 Russian and Afghan aircraft in the 1980s (Kuperman, 1999, p. 246). More recently, in August 2002 a Russian military Mi-26 transport helicopter was hit with a MANPADS missile in Khankala, on its approach to Grozny, the capital of Chechnya, killing 85 of the 117 soldiers on board (Fiszer, 2002).

16 While the terrorists that day failed to down the civilian aircraft, they succeeded in attacking an Israeli-owned hotel in Mombasa, killing ten Kenyans and three Israeli tourists (Lacey, 2002). But it was the subsequent threats to civilian aviation that continued to make international headlines and make Kenya a less attractive holiday destination for prospective tourists.

17 This statement was made by the Kenyan Tourist Board despite the loss in tourism experienced after the August 1998 US embassy bombing in Kenya that resulted in hundreds of deaths.

18 Al-Qassam rockets, like most craft-produced weapons noted here, differ slightly as they are not mass-produced with precision equipment and moulds. Each small production facility produces the weapons slightly differently.

19 Information on this aspect was gathered from two main sources: a presentation given by Colombian intelligence and law enforcement and presentations at a Conference on Small Arms and Light Weapons organized by the United Nations Center for Peace, Disarmament and Development in Latin America and the Caribbean UN-Lirec and the Government of Panama, Panama, 13–15 November 2002; and an interview with Colombian intelligence and law enforcement experts held in Bogotá, Colombia in July 2003.

20 The rocket was named after an LTTE officer who died in combat. Written correspondence with Seunghwan Yeo, 13 February 2008. The authors would like to thank Seunghwan Yeo, a master's student in the Coexistence and Conflict program at Brandeis University, for sharing a draft of his master's thesis on the conflict in Sri Lanka with us and for his insights into the LTTE's craft production of small arms, light weapons, and explosive devices.

21 Short-range surface-to-air-missiles denote those with maximum ranges of less than 10,000 m. Medium- and long-range surface-to-air-missiles have maximum ranges up to ten times the distance of short-range models (TGC, 2007).

22 Some modern missiles use a combination of laser beam-riding technology and IR homing for locking on to the target at different stages in flight (Jane's, 2006a).

23 Slant range is the 'line of sight' distance between the weapon and target (in contrast to the vertical altitude of the target).

24 Only about ten per cent of SA-7s fired during the Vietnam War actually destroyed their intended target. Most successful attacks were against small planes and helicopters. Such weapons would have a hard time downing larger aircraft such as 747s, 757s, and 767s, with engines built to endure several thousand kilograms of thrust (Dunnigan, 2007a).

25 Strela is Russian for 'arrow'. Moscow designated it the 9K32M, but this text refers to it as the North Atlantic Treaty Organization (NATO) designated SA-7 or Grail, by which it is commonly known. Copies of the weapon are known as the Hongying 5 or HN-5 in China, the Anza in Pakistan, the Ayn-al-Saqr in Egypt, and the CA-94M in Romania (Jane's, 2006a, pp. 3–50).

26 For example, a Greek industrialist affiliated with the licensed production of the Stinger shared proprietary information on the missile to the Soviets (Anastasi, 1987a; 1987b).

27 The authors wish to thank Adrian Wilkinson for his insights into these dynamics.

28 In 28 major battles during the 1980s, ATGWs were used against tanks 4 per cent of the time (in a defensive role), whereas they were used for offensive fire 75 per cent of the time (TGC, 2007).

29 A Canadian soldier firing a .50 calibre rifle (a McMillan Tac-50) reportedly successfully engaged an enemy combatant at 2,430 m in Afghanistan in 2002, besting a record for sniping in combat that had stood for more than a quarter of a century (Friscolanti, 2006).

30 The US Fifty Caliber Shooters Association (FCSA), for example, boasts more than 4,000 members from more than 20 countries since it was established in 1985 (FCSA, 2007).

31 The Davis Gun was used by the Air Force for ground attack. Hitting a tank from the sky at high speeds was difficult. Only a direct hit could neutralize a tank, and direct hits were rare (Gander, 2000, p. 178).

32 It is not uncommon for variants of the RPG-7 to sell for as little as USD 10 in many of the world's arms bazaars (Dunnigan, 2007b).

33 In an effort to abide by restrictions on state production and holdings of mortars 100 mm and larger under the 1990 Treaty on Conventional Armed Forces in Europe (CFE Treaty) while attaining heightened capabilities, Poland and the Slovak Republic have produced a 98 mm mortar.

34 Additional examples include sales that may involve upfront payment for after-sale services. Warranties can also make a difference in price: a customer asking for a multi-year warranty will have to pay more than one accepting weapons without a warranty. As well, ordering weapons in bulk tends to reduce unit costs. Some contracts call for trainers or simulators, which can be very expensive, while others do not. And so on.

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