



Replacing the Bradley

Finding a new fighting vehicle for the U.S. Army, 1964–2024

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Animal Company had been on a security run in the middle of the city, just west of Checkpoint 296, when a massive explosion detonated virtually underneath one of their Bradleys. The result had been what the military refers to as a “catastrophic” kill, meaning that the vehicle had been essentially destroyed, and several crew members killed. A second vehicle, maneuvering to come to the aid of the first, had been hit by another IED, resulting in a mobility kill and several wounded soldiers. 2-69 [2nd Battalion, 69th Armored Regiment] needed as many friendlies on the ground as soon as possible to secure the east and west flanks of the blast site, and provide security while the vehicles were recovered and casualties evacuated to the nearest secure US medical facility for proper care. For the first time since our arrival, the American battalion was coming to us [an Iraqi battalion] not to include us as part of a coalition, but in true and desperate need for help. When I asked Major Bob Ashe, the 2-69 XO [executive officer], how many he needed, he didn’t hesitate: “Every one you can send.”

— Colonel Erik Peterson USMCR, unpublished memoir, recounting events of 10 October 2005.

That day in Ramadi, the first Bradley armored fighting vehicle struck had no survivors. Casualties meant remains to recover. The blast and incendiary effect of the explosive had melted the aluminum hull to a height of just five feet—a surreal and unforgettable sight.²

The Question of Mechanized Infantry

The trenches of the First World War in Europe were fought over largely by cannon artillery and foot regiments of what we today call *light infantry*. The term may be misleading, for the lightness is unrealized by the troopers who must carry all their weapons, ammunition, and kit on their backs. Without vehicles, so-called light infantry are easier to transport by air and sea, but they lack the

long-range mobility of motorization once they land, and the protection that armored vehicles provide. From the Battle of Amiens in 1918, the potential of tracked vehicles to increase the tempo of battle was clear.³ Such *tanks* (initially a British codename to discourage German intelligence) “provided the infantry a means to quickly breach tactical obstacles such as wire, and provided suppressing fire support to cover their movement, as well as destroying enemy strong points. Tanks also conserved the infantry force by physically protecting them.”⁴

After the war, the British Army and others continued to experiment with *motorized* infantry in trucks. A cargo truck could easily carry a squad of a dozen or so, or perhaps rather more. By the Second World War, many armies were fielding *mechanized* infantry in tracked vehicles with their own armor.⁵ Taking on armor reduced the number of passengers who could fit inside, lest the vehicle become too large a target, and too large for crossing bridges. After war, armies were adding a cannon and later a missile launcher directly to the troop-carrying vehicle, to create a hybrid of *armored infantry*. Adding weapons further reduced the passenger capacity, with most modern designs eventually accommodating six-to-nine *dismounts*, as the troops in the back were sometimes called.

The nature of the troops was thus becoming unclear. Troops could conceive of themselves as infantry under armor, or as a kind of light tank troops carrying some dismounts for support. As early as 1940, the Infantry, Artillery, and Armor branches of the US Army were arguing over who would control just the towed anti-tank guns.⁶ How the operators conceived of themselves would strongly influence how they would fight. Troops equipped with tracked vehicles armed with automatic cannons and missile launchers, and calling themselves mechanized or armored, could organize their fighting style around the guns and missiles as their primary weapons.⁷ Eventually, multiple typologies emerged in modern military parlance, including *light*, *motorized*, *mechanized*, and *armored* infantry, all of which would overlap to some degree.⁸ By the 1970s, the United States, British, Canadian, and Australian Armies more or less “had gravitated towards the foot-soldier-centric model, whereas Europeans favored the vehicle-centric solution.”⁹

Arguments also arose across borders—at least in the English language—over what to call the vehicles. Tankers without infantry did not care for the infantry calling their vehicles *tanks*, and in English and French (*char*), they mostly complied. In German and Swedish, by contrast, an armored vehicle for the infantry was still called a *panzer* or *panser*. In English, the two most widely used terms were *armored personnel carrier* (APC) and *infantry fighting vehicle* (IFV). The design of an APC would generally emphasize capacity and transportability over firepower and protection, as a sort of battle taxi for transporting dismounting infantry to the field. In contrast, the design of an IFV would generally emphasize firepower and protection over capacity, for fighting under armor with the heavy weapons.

The mobility question was and remains further divided into on-road and off-road mobility.¹⁰ *Ceteris paribus*, wheels provided higher road speeds and longer ranges (through better fuel economy), while tracks provided higher off-road speeds and more compact designs. Wheels also afforded

lower maintenance costs, greater commonality with commercial off-road vehicles, and greater resistance against land mines (see below).

Developing, Fielding, and Upgrading the Bradley

In 1964, the chief of research and development in the U.S. Department of Defense directed development of a *mechanized infantry combat vehicle* (MICV) for the U.S. Army, which would transport eleven troops under armor, with protection from radiation and biological and chemical weapons, at enough speed to accompany the tanks (of the Armor branch of the service), with enough amphibious capability to ford rivers, and with firing ports so that the troops could fire their rifles from inside. Notably, the Army's existing and widely exported M113 vehicle (see Figure 1) fit all those requirements except the last. Any of the 11 passengers (alongside the crew of two) in an M113 would need to open the top hatches to fire their weapons.¹¹



Figure 1: An M113 of the Israel Defense Force patrolling in Lebanon in 1984. Source: Israel Press and Photo Agency.

In 1983, nineteen years after the basic requirements had been set, the Bradley M2 Infantry Fighting Vehicle (IRV) and M3 Cavalry Fighting Vehicle (CFV) entered service with the Army (see Figure 2). Named for General Omar Bradley of the Second World War, the tracked M2 carried a crew of three and six dismounts. The vehicle was armed with a rotating turret mounting a 25 mm automatic

cannon, a 7.62 mm machine-gun, and an anti-tank missile launcher. The M3 was essentially the same vehicle, except that as a reconnaissance and screening (cavalry) vehicle, it carried more missile reloads, more cannon and machine gun ammunition, and just two dismounts. Two firing ports were provided towards the rear, though with a special shortened version of the Army's M16 machine carbine which was intended to remain with the vehicle. Through the 1990s, the Army's supplier, FMC (Food Machinery Corporation) had produced 4,671 M2 IFVs and 2,083 M3 CFVs.¹² This number, built for a much larger Army during the Cold War, would later provide ample excess hulls for remanufacturing (see below). Indeed, the Army's contractor produced no wholly new Bradleys after the mid-1990s.



Figure 2: An M2 Bradley moving along a road during Exercise Reforger in 1985. Source: U.S. Army.

The vehicle was generally resistant to machine-gun bullets, but much less so to landmines. The Bradley's aluminum armor (like that of the preceding M113) had adequate shatter resistance, but less shearing strength than steel. The vehicle was not resistant to cannon or missile fire, as this would have required a vehicle that was far less air-transportable. Even with the weight reduction afforded by aluminum, the Bradley could only ford rivers after attachment of floating devices around the hull, and could only be transported through the air by a four-engined jet cargo aircraft—generally a C-141 Starlifter or C-5 Galaxy. (The C-141 was replaced starting in the 1990s with the C-17 Globemaster III, which improved transportability somewhat.) These aircraft would provide intercontinental range for a few Bradleys, notably in 1990 immediately after the onset of the Persian Gulf War. However, the U.S. Air Force had far fewer in its inventory than the C-130 Hercules, a four-engined turboprop which could carry the M113 at transcontinental range.

In effect, in selecting a final design, the Army had prioritized firepower and ballistic protection over transportability and blast protection, a prioritization achieved after “incredible amounts of bureaucratic muddle and intra-service chest-thumping within the Army” throughout the late 1970s. The contradictions inherent in producing a common mount for both infantry and cavalry troops had led to a compromise vehicle. The Army dealt with the problems through changes in doctrine, leveraging the capabilities and guarding the limitations of the vehicles, and through developments in technology.¹³ From 1985, new M2s and M3s were built in an A1 version, with a newer missile launcher and sight; a gas particulate filter unit for better protection against radiological, chemical, and biological agents; and the sealing of the M3’s firing ports.¹⁴ From 1988, M2s and M3s were built in an A2 version, with a new engine, and stronger armor with protection against 30 mm

armor-piercing rounds and the shoulder-fired rocket-propelled grenades (RPGs) of opposing infantry. Adding armor also ended the possibility of river-fording with floatation devices. However, reorganizing the internal space freed up room for a seventh dismount in each vehicle. This brought the capacity closer to the Army’s preferred size of a squad: nine troops, who still needed to be awkwardly spilt amongst the vehicles (see Figure 3). Most European armies simply reduced their squad size to whatever would fit in their vehicles.

Regardless of limitations, Bradley units served very well in the Persian Gulf War, destroying more Iraqi tanks (largely at long range with their missile launchers) than the M1 Abrams tanks accompanying them in armored formations. After the war, following lessons learned in combat, the Army contracted with FMC to upgrade 1,423 Bradley A2s into an A2 ODS (“Operation Desert Storm”) configuration, with the addition of an eye-safe carbon dioxide laser rangefinder, a global

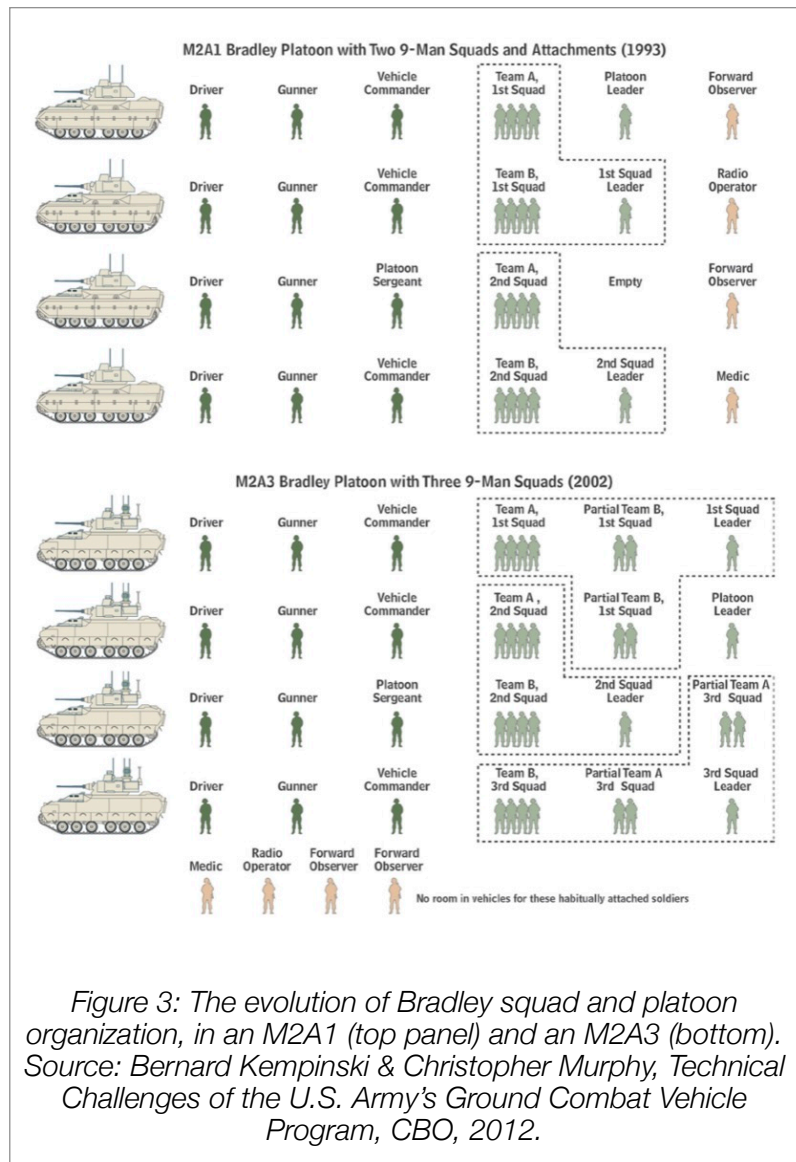


Figure 3: The evolution of Bradley squad and platoon organization, in an M2A1 (top panel) and an M2A3 (bottom). Source: Bernard Kempinski & Christopher Murphy, *Technical Challenges of the U.S. Army's Ground Combat Vehicle Program*, CBO, 2012.

positioning system receiver and compass, a combat identification system for guarding against fratricidal fire, and a thermal viewer for the driver.

The Future Scout and Cavalry System

In 1994, after experiencing the downturn in military spending following the end of the Cold War, FMC merged its armaments business with BMY, the armaments division of the Harsco Corporation, and spun off the consolidation as United Defense Limited Partnership (UDLP). In 1997, the company was taken private in a leveraged buyout by the Carlyle Group.

Along the way, the Army was sensing that while the M3 Bradley was an excellent tank destroyer, it was too large and obvious for reconnaissance. In late 1995, senior officials of the Army began discussing the idea of a new cavalry vehicle. In March 1996, the Armor Center at Fort Knox, Kentucky recommended that the Army begin developing a new, smaller tracked scout vehicle, but with a heavier cannon for greater lethality against projected improvements in enemy armor.¹⁵ In October 1996, the U.S. and British Armies agreed to combine their interests in new scout vehicles into a single program.¹⁶ By January 1998, plans were more firm. The American side, seeking 1,095 vehicles, would call the vehicle the Future Scout and Cavalry System (FSCS). The British, seeking 335 vehicles, would call it the TRACER, for "Tactical Reconnaissance Armoured Combat Equipment Requirement."¹⁷

In January 1999, the British Ministry of Defence, chosen to manage the project, awarded technology development contracts to two multinational consortia, one composed of Lockheed Martin and BAE Systems, and the other of GEC Marconi and several other firms.¹⁸ However, budgetary challenges led the U.S. Army to withdraw from the project in December 1999. Funding was briefly restored the next year, but in October 2001, the U.S. and the U.K. agreed to terminate the program, in favor of their respective Future Combat System (FCS, see below) and Future Rapid Effects System (FRES, pronounced *frez*) projects.¹⁹ The U.S. Army had a lackluster experience with its deployment of heavy armor (including Bradleys) to Albania, as part of Task Force Hawk, in support of the 1999 Kosovo War.²⁰ More poignantly, heavy armor was not at all in use at the time to overthrow the Taliban in Afghanistan.

The Stryker

Experiences on campaigns as these after the Cold War spurred considerable thinking in the U.S. and other armies on how to provide greater capability to light infantry.²¹ In 1999, calling for lighter-weight vehicles for his forces, U.S. Army Chief of Staff General Eric Shinseki argued that "our heavy forces are too heavy and our light forces lack staying power." Shinseki wanted heavy forces that were "more strategically deployable, and more agile with a smaller footprint" but also light forces that were "more lethal, survivable, and tactically mobile."²² The Army Staff soon set a goal for the deployment of a motorized or mechanized brigade of about 3,500 troops, anywhere in the world,

within 96 hours of an initial order. Sober analysis soon suggested that the goal would be difficult to attain, as airfields in many of the regions of interest around the world were austere, and incapable of supporting heavy transport aircraft and cargo handling.²³ The U.S. General Accounting Office concluded in 2003 that deploying a single brigade would take 5 to 14 days, depending on its location and destination, and require over one-third of the U.S. Air Force's C-17 and C-5 transport fleets.²⁴ The Army soon dropped the goal.²⁵

While setting his sights on a more ambitious future program (see below), Shinseki and his aides conceived a procurement program for a fleet of Interim Armored Vehicles (IAVs), based on the design of a vehicle already in service with land forces somewhere in the world, which could thus be procured without waiting for a design and development phase. At a conference in October 1999, he explained the concept as the conveyance for a “medium-weight force” that would be especially useful in counterinsurgency, but also capable against heavier enemies.²⁶ In theory, the Army was open to any vehicle, but Shinseki himself signaled a strong preference for a wheeled one.



Figure 4: the U.S. Stryker LAV-III. Source: U.S. Army.

After holding a competition in 2000, the Army selected a version of the LAV (Light Armored Vehicle) III, the Canadian Army's version of the built Piranha-III, designed and initially built by Motorwagenfabrik AG (MOWAG) of Switzerland. The LAV-III was eventually widely exported, like the old M113, but unlike the Bradley, which was only ever sold to Kuwait.²⁷ The U.S. Army named its version the Stryker, after two unrelated U.S. soldiers who had posthumously received the Medal

of Honor (see Figure 4). The American LAVs, like the Canadian vehicles, would be manufactured in Ontario by General Dynamics Land Systems (GDLS) and General Motors Defense. (General Dynamics would acquire GM Defense in 2003, though GM would re-found its own defense division in 2017.) The U.S. version removed the manned turret and 25 mm cannon for a remote-controlled 12.7 mm machine-gun and room for two additional dismount. The Canadian seven-passenger vehicle thus became an American nine-passenger, with room for the U.S. Army's entire preferred squad. The Stryker also added thicker frontal armor for resistance against 14.5 mm machine-guns, a common weapon supplied during the Cold War to Soviet allies around the world. The vehicle would be air-transportable by C-130, but only for about 500 miles with all its fuel and ammunition.



Figure 5: The Stryker vehicle "General Lee" lies on its side after surviving a buried IED blast in 2007. The vehicle was recovered and served several more missions until another bomb finally put it out of action. Photo by courtesy of the U.S. Army's 2nd Stryker Brigade.

During the campaigns of the 2000s in Afghanistan and Iraq, both Canadian and American LAV-IIIIs held up reasonably well against land mines and improved explosive devices (IEDs). Wheeled vehicles offer a natural an edge in resisting underbody explosions, as one or more wheels can shear off in the blast while leaving the rest intact, allowing the vehicle to limp off the battlefield.²⁸ American Strykers repeatedly did so in Iraq on as few as two functioning tires, but with a Bradley or an M113, "lose a track, and it's done."²⁹ The Strykers were performing well as early as 2004, surviving attacks from at least 55 IEDs, 24 RPGs, and a 500-pound car bomb without a fatality

(see Figure 6).³⁰ These were, rather than anti-tank missiles and large-caliber cannons, the weapons affordable and portable by insurgents worldwide.

Bradleys had a less impressive record against the Iraqi insurgents, who destroyed 148 between April 2003 and June 2008.³¹ In 2004, General Peter Schoomaker, Shiseki's successor as chief of staff, averred that he wanted to "field Stryker in every unit we have over there" [in Iraq].³² Over the next several years, Strykers came to replace Bradley fighting vehicles and even Abrams tanks in some seven brigades—about a third of the Army's armored formations.

The Future Combat System(s)

Alongside Stryker, the Army was pursuing an effort to reequip *all* its formations, except its parachute and helicopter brigades, in "the largest and most ambition planned acquisition program" in its history. Termed the *Future Combat Systems*, this would consume almost all of the service's research and development budget for ground systems.³³ The plural noun was consciously chosen "to emphasize the trendy system-of-systems information architecture of the concept." However, "to considerable extent, the concept always sounded like LAV-III Stryker vehicles with more electronic content, making for a hard sell."³⁴ In keeping with the electronic emphasis, in 2002, the Army chose a team of Boeing and SAIC—neither of which had ever built an armored vehicle—as the prime contractor. Boeing and SAIC soon began subcontracting to both BAE Systems and GDLS, the two main U.S. producers of armored vehicles. The Army's concept insisted that the huge fleet of FCS vehicles would all share a common chassis for ease of producibility and field maintenance, regardless of payload requirements.

However, almost immediately, "the underpinning principle—protection through speed and networked intelligence—was seriously questioned by the Army's own consultants."³⁵ Indeed, at the height of the campaigns in Afghanistan and Iraq, mine protection seemed an afterthought in the Army's requirements. In light of what was being learned in the war, one British member of Parliament in debate described the design of analogous but less ambitious FRES as "prehistoric."³⁶ Seven years into its FCS program, the U.S. Army had received no working prototypes, perhaps because its requirements remained ill-defined and constantly changing. In May 2009, without even waiting for the long-delayed prototypes, Secretary of Defense Robert Gates cancelled the program. By and large, the demise of the FCS was hailed by field-grade officers in combat units.³⁷ The Army initially spun out the howitzer version of the vehicle—the Non-Line-of-Sight Cannon (NLOS-C)—as a separate program, but soon cancelled that too.

Mine-Resistant, Ambush-Protected (MRAP) vehicles.

In cancelling FCS, Gates specifically noted that the idea, "developed nine years ago, does not include a role for our recent \$25 billion investment in the MRAP vehicles being used to good effect in today's conflicts." The *Mine-Resistant, Ambush-Protected* vehicles (MRAPs, pronounced *em-*

raps) were a type of wheeled armored vehicle, not merely adapted for counterinsurgency, but specifically designed for it (see Figure 6). With high over-the-road speed and ample internal capacity, MRAPs could speed plenty of infantry to possible trouble. With high ground clearance and steel armor, they would resist mine-blasts better than any other type of vehicle. The armor was generally proof against small arms as well. In return, they sacrificed firepower (none were armed with anything more than a machine gun) and resistance to any heavier ballistic threat. Earlier versions—those prior to the American MRAP All-Terrain Vehicle (M-ATV) and Joint Light Tactical Vehicle—were generally not impressive off-road.³⁸



Figure 6: A column of MRAP vehicles in Iraq in 2005: a Cougar and a Buffalo from Force Protection Industries, followed by an RG31 from BAE Systems. Photograph courtesy of Colonel Eric Peterson, U.S. Marine Corps Reserve.

In July 2009, the Army was examining MRAPs for a permanent place alongside tanks and other tracked vehicles in the heaviest of field units, for their mine-resistance and carrying capacity.³⁹ Yet by the mid-2010s, few Army formations retained MRAPs in the tables of equipment. Perhaps some sense of *berührungsangst*—a wariness or apprehension about contact—limited the US Army's interest in the material tools of counterinsurgency.⁴⁰ The US Army had already lived through its partial Canadianization—a transformation into a mounted rifles outfit—in its contentious procurement of the Strykers. In its worst institutional fears, the MRAP portended a further constabulary zombification, a permanent reassignment to counterinsurgency and peacekeeping. Even if the MRAP's assignment to infantry units was modular, its organizational adoption was dreaded as an architectural change, in which the cure would be worse than the disease.⁴¹

MRAPs would eventually serve in the Ukrainian ground forces, as their better mine protection and higher road speed was useful in some tactical situations. The vehicles were also less expensive to

repair than tracked vehicles. Without heavy weapons, though, dismounting troops would require screening from tanks.⁴²

The Ground Combat Vehicle

In 2009, immediately after cancellation of then FCS, the Army began planning for a wholly new and prosaically named *Ground Combat Vehicle*. The full set of requirements for the GCV was a government secret, but included the off-road mobility of the Bradley, the over-the-road mobility of the Stryker, the blast protection of an MRAP, ballistic protection better than that of a Bradley, more firepower than a Bradley, seating for twelve (commander, driver, gunner, and nine passengers), and air-transportability by C-17 aircraft. This last parameter placed effective upper weight limit on the vehicle at 70 tons. The requirements for protection and size drove it to at least 60 tons.

The next year, the Decker-Wagner Report to the Secretary of the Army recounted a grim record of the service's material acquisition efforts.⁴³ In the preceding 30 years, the service had started, but then cancelled, eight major armored vehicle programs: the Armored Family of Vehicles, the Line-of-Sight Anti-Tank missile vehicle, the M8 Buford Armored Gun System, the Armored System Modernization program, the FSCS, the Crusader armored howitzer, FCS, and the subsequently pared-down NLOS-C.⁴⁴

After several cycles of analyzing alternatives, revising requirements, and considering proposals, the Army awarded development contracts in August 2011 to both BAE and GDLS. In May 2012, hoping for a non-developmental program, or perhaps hoping to justify a developmental one, the Army tested two foreign vehicles in trials at Fort Bliss and the adjacent White Sands Missile Range in Texas and New Mexico: Israel's Namer, built by Israel Military Industries, and Sweden's CV90-35, built by the Hägglunds subsidiary of BAE Systems.



Figure 7: Soldiers of the U.S. 29th Infantry Regiment maneuver around an Israeli Namer during their assessment at Fort Bliss, Texas. Photograph by First Lieutenant Tyler Ginter.

The Namer (see Figure 7), which continues to equip much of the Israeli infantry today, is built actually on the same chassis as Israel's Merkava (Chariot) Mark 4 tanks. The Namer offered the off-road mobility of a Merkava (roughly comparable to that of a Bradley), excellent blast protection with its heavily armored floor, and the ballistic protection of a Merkava—just with a lower profile. Shedding the turret meant that weight could be reinvested in armor, so the Namer was actually better protected than a Merkava.⁴⁵ On the other hand, the Namer only carried firepower for close combat—machine guns, a grenade launcher, and the same 60 mm mortar as the Merkava. The Namer carried a crew of three and nine passengers, and weighed 63.5 tons.⁴⁶ It was also very noisy, which hindered its ability to approach with stealth on the battlefield.⁴⁷ The U.S. had some experience with building the vehicle, as some 600 Namer hulls were built over several years at the U.S. Army's own factory, the Joint Systems Manufacturing Center, run by GDLS in Lima, Ohio.⁴⁸



Figure 8: A Swedish CV-9035 under assessment at Fort Bliss. Photo courtesy of the U.S. Army.

At 35 tons, the CV90-35 Mark III (see Figure 8) was much lighter. If air-transportability mattered, this meant that two CV90s could be carried almost as far as a single Namer. The Swedish vehicle also brought a 35 mm cannon, with much greater range, accuracy, and killing power than the 25 mm of the Bradley. At the close combat ranges expected in the forests of northern Scandinavia, the Swedish Army thought it enough to disable a Russian tank. With a balanced design and a European sensibility about mechanized forces, however, the CV90 carried but six passengers. At the time, the U.S. Army was so wedded to the concept of the nine-man squad that the service commissioned RAND to write a study justifying it.⁴⁹

In November 2012, the two contractors in the development program provided estimates of the final weight of their vehicles: depending on the degree of added armor packages GDLS's vehicle would

weight 64 to 70 tons, and BAE Systems' 70 to 84 tons. In November 2013, BAE had managed to reduce the weight of its design to between 60 and 70 tons—still as much as an Abrams tank.⁵⁰

In February 2014, Defense Secretary Chuck Hagel canceled the GCV, at the Army's request.⁵¹ Heidi Shuy, the Army's procurement executive, explained that the program was actually progressing well technologically, but that the Army lacked the funding in its future budgets to procure the vehicles.⁵² For even though the Ground Combat Vehicle would only constitute 10 percent of the Army's ground combat vehicle fleet, it would have required 80 percent of the Army's combat vehicle funding over the next several years.⁵³

A Next-Generation Combat Vehicle, Optionally Manned?

In November 2016, the Army tried again, establishing a program for a Next-Generation Combat Vehicle (NGCV). The Army moved somewhat slowly, only standing up a formal office in June 2018. That October, the Army re-designated the NGCV as the Optionally-Manned Fighting Vehicle (OMFV), and broadened the term NGCV to include the OMFV, AMPV (see below), and "Mobile Protected Firepower" programs.⁵⁴

In March 2019 the Army issued a request for proposals (RFP) which included "100 rigid requirements."⁵⁵ Two teams were willing to supply prototype vehicles: a joint venture between the American firm Raytheon and the German armored vehicle manufacturer Rheinmetall, with a version of the latter's Lynx KF31 IFV; and GDLS, with a version of the Griffin III developed from its long line of ASCOD (Austrian-Spanish Cooperation Development) vehicles. In October 2019, the Raytheon-Rheinmetall team was disqualified for failing to meet a deadline to ship the prototype to the Aberdeen Proving Ground in Maryland by the required date. A local German government had held up the permits for moving the vehicle by flatbed truck.⁵⁶ BAE Systems and the Korean firm Hanwa had been invited, but both had chosen earlier not to participate, asserting that meeting all the requirements would not be physically possible. The sole remaining competitor, GDLS, was subsequently disqualified because its prototype was too heavy to meet requirement that two fit in a single C-17.⁵⁷

At the same time, the Army was rethinking its requirements to emphasize European battlefields, but the few vehicles that the Air Force could fly quickly across the Atlantic would be questionably useful against the Russian Army.⁵⁸ In this context, the heavier GDLS vehicle could have had a competitive edge, as it carried a 50 mm cannon in a turret that could elevate to 85 degrees, for striking targets atop tall buildings—a requirement hitherto unseen in IFV specifications.⁵⁹

Army officials were also concerned that Textron, Raytheon and Rheinmetall's planned partner for domestic production, was "not well thought of for quality or innovation in manufacturing."⁶⁰ Weight was also disconcerting, as the Lynx was yet heavier than the Griffin III. Even without concern for air-transport, too much armor would mean that the vehicle could not pass over "rickety Soviet-era bridges in Eastern Europe," across that "vast plain riven by rivers." Only a few of the bridges over

the Vistula River in eastern Poland could handle more than 55 tons. NATO tanks generally weighed about 60 tons, but Soviet tanks like the T-72, just 45 tons. So, as well-known trade journalist Sydney Freedberg argued, “spending billions to replace the Bradley with a new infantry fighting vehicle that can’t cross most Eastern European bridges would appear to be unwise.”⁶¹

Thus, as one anonymous industrial official lamented to Freedberg in January 2020, the Army had seemingly “learned nothing from FCS.”⁶² That month, the Army did at least cancel the solicitation, though without widespread confidence in its capacity for managing procurement, or for thinking through its strategy.⁶³ As one think-tanker and future Air Force procurement official argued,

*The struggles of OMFV reflect the same challenge that the Army has faced for years with developing a next-generation infantry fighting vehicle. The Army has sought a leap-ahead in technology that can deliver high levels of protection with tactically and strategically relevant mobility. This leap has not been forthcoming, and the tension between what the Army is seeking and what industry can deliver hasn’t been resolved.*⁶⁴

Another think-tanker and former Pentagon official observed that

*The program does not align well with a China and Pacific-focused strategy. Although OMFV is high in the Army priorities, it will have a hard time gaining traction with the strategists in [the Office of the Secretary of Defense]. They will give priority to long-range strike capabilities. The Army budget will be squeezed and there will be intense competition for modernization dollars. OMFV will need to compete with all [35] Army development programs and is not mature enough to have developed a broad coalition in Congress.*⁶⁵

Formally designated—the XM30 MICV

In February 2020, the Army restarted the competition.⁶⁶ In early March, Army Secretary Ryan McCarthy told the press that the decision to cancel and restart “was received very well” in the Congress.⁶⁷ Later that month, however, both Representative Pete Visclosky, Democrat from Indiana, chairman of the House defense appropriations subcommittee, and Representative Ken Calvert, Republican from California, subcommittee ranking member, were grilling Army officials over the program in a hearing.⁶⁸

Industry may have been more impressed. The same anonymous official who cited FCS just months before asserted “they finally get it. It’s a big improvement over their previous attempt. It’s a great start, and I’m cautiously optimistic.”⁶⁹ For after its initial failure, the Army “reconfigured the effort” to a commercially common procurement process in which suppliers could explain to buyers the realm of the possible.⁷⁰ The Army also substantially restricted the technologies to existing concepts. All subsystems and components would need to have attained at least Technology Readiness Level (TRL) 6, which meant that a model or prototype had been demonstrated “in the relevant environment”—in this case, on the ground in the field. The TRL scale had been developed by

NASA in the 1970s, and the Defense Department, at the recommendation of the General Accounting Office, had been using it in most technological development programs since 1999.⁷¹

In the Army's draft RFP for concepts in December 2020, the Army described "characteristics and not requirements," but broadly prioritized.⁷² Foremost was survivability—but only against the cannons of opposing IFVs, and not the heavier cannons of tanks. Next was mobility, followed in order by growth potential, lethality, weight, logistical needs, transportability, manning, and training. Manning was indeed a *characteristic*, in that the Army chose not to mandate a specific number of passengers. Similarly, the Army did "not designate the type and caliber of the main weapon." In theory, contractors could have proposed a missile launcher or even laser in lieu of a cannon.⁷³

The draft RFP only included a few "hard-and-fast requirements". The vehicle would be drive-by-wire, with a "highly modular and highly open architecture." In this first phase, the Army sought "digital concepts" rather than prototypes.⁷⁴ Betting on automation, the Army insisted on a crew of only two.⁷⁵ Reducing crew size had been a general objective since 1991, but only recently had the technology for 360-degree visual sensors and automated target recognition become sufficiently mature.⁷⁶ General James McConville, the Army chief of staff, likened the technological advances to that of telephone handsets. The Bradley had been developed in the era of touch-tone, rotary-dial phones; later vehicles featured improvements in their internal information systems, but only like the incremental improvements of cordless phones. Modern mobile phones were cameras, computers, and more—truly transformational improvements for their users.⁷⁷

The Army also removed all classified data from the solicitation to allow foreign companies to participate fully, and reduced the volume of paperwork required for submissions—the number of individual items on the contract data requirements list (CDRL—pronounced *see-drill*) by 80 percent.⁷⁸ At about the same time, the Army dropped the idea of developing its own design internally, which was bothering industry.⁷⁹ Bill Greenwalt, a former Pentagon industrial policy chief, argued at the time that the concept "raised a plethora of conflict of interest, protection of intellectual property, and favoritism issues."⁸⁰ Jeffrey Langhout, the director of the Army's Ground Vehicle Systems Center, said that the idea "turned out to be almost impossible."⁸¹

With all these changes, Army Assistant Secretary Bruce Jette noted that the original competitors initially agreed to resubmit—and that with a broader RFP, at least one more serious competitor as well.⁸² In this next round:

Rheinmetall teamed with Textron and Raytheon, with a new version of the Lynx, the KF41. The vehicle was already in production for the Hungarian Army, which had ordered 218 units to be built in Hungary.⁸³ The Australian Army had also chosen the Lynx 41 and Hanwha's Redback (see below) as candidates in its Land 400 infantry fighting vehicle program.⁸⁴

GDLS offered a version of the Griffon III that was lighter than its previous design. GD's team included the new General Motors Defense, which had particular expertise in electric drive for heavy vehicles.⁸⁵

Oshkosh Defense offered a Redback infantry fighting vehicle from South Korea's Hanwha Defense. The Oshkosh-Hanwha team include Israel's Rafael and Plasan, the U.S. branch of the British engineering firm QinetiQ, and the American automotive engineering firm Pratt & Miller, which Oshkosh was in the process of acquiring.

BAE Systems, after initially announcing a teaming with the U.S. branch of Israel's Elbit Systems, chose not to bid. The firm announced that it simply too much work with the AMPV program (see below) and other military projects.

In June 2023, for a follow-on design competition with government funding, the Army selected two "bids with substantial foreign participation": Rheinmetall's Lynx KF41 and GDLS's Griffon III. Designs would be due in 2023, followed by physical prototypes in 2025. The Army planned to choose a single supplier in 2027 to delivery actual operational vehicles own 2028.⁸⁶ The Army also announced that the vehicle would be known as the XM30 Mechanized Infantry Combat Vehicle (MICV).⁸⁷



Figure 9: Soldiers of the 9th Cavalry Regiment complete field testing of the Armored Multi-Purpose Vehicle at Fort Hood, Texas, in September 2018. Photograph by Major Carson Petry.

AMPV

While the Bradley had replaced the M113 as a conveyance for the infantry and cavalry troops, M113s were continuing to serve as command posts, armored ambulances, and in several other second-echelon roles. The old vehicles, however, were sufficiently vulnerable that they were rarely

driven into danger in Iraq and Afghanistan. As the U.S. Army was winding down its involvement in the Iraq War, it began seeking a replacement.

In 2014, BAE Systems, the successor company of the original designer and builder of the Bradley, won the contract with a design which would remanufacture existing Bradleys into turretless, prosaically-named *Armored Multi-Purpose Vehicles* (AMPVs; see Figure 9). With lessons from the wars, AMPVs were better protected, particularly from land mines, than the Bradleys on which they were based. The vehicles were priced at under \$2 million each, substantially because the Army was supplying the old Bradleys free of charge.⁸⁸ In comparison, in 2021, the Army was continuing to buy remanufactured M2A4 Bradleys from BAE for about \$4 million each.⁸⁹

The latter proved an easier task. BAE's factory in York, Pennsylvania had not built a wholly new vehicle in decades, and its initial difficulties in manufacturing AMPVs led the Army Secretary to decline to certify the program's progress to the Congress.⁹⁰ Most of the York factory was eventually devoted to AMPVs and Amphibious Combat Vehicles for the U.S. Marine Corps.⁹¹ First deliveries to Army units came in March 2023, and the BAE attained its planned full rate of production in September 2023.⁹² At a trade show in March 2024, BAE showed a "universal top plate" for an AMPV that could accommodate 30 different types of existing combat vehicle turrets, including some with a heavier gun than the Bradley's.⁹³

The Russo-Ukrainian War

In 2023, the U.S. government began providing M1A1 Abrams tanks and M2A3 Bradley fighting vehicles to Ukraine, for after all, those vehicles had originally been designed to fight the Soviet Army. (The M1A1 was an earlier, less heavily armored version of the Abrams more likely to successfully navigate the bridges of Ukraine and Russia.) The transfer provided a "tremendous opportunity to collect operationally relevant sensor data" for developing a wide range of technologies for mechanized ground forces.⁹⁴ Simple counting of casualties was quite revealing as well. In the first two years of the war, the Russians lost 8,800 armored vehicles.⁹⁵ Losses were so severe that the Russian Army was refurbishing for combat service T-54 and T-55 tanks, which had first been produced by the Soviet Union in 1948.⁹⁶

Early in the war, direct fire by tanks was only causing about one percent of casualties (serious damage or destruction), to all vehicles, Russian and Ukrainian. The leading killers were indirect fire by cannon artillery (about a third of vehicle casualties) and the dense belts of land mines on both sides (about a quarter). That is, over half of casualties were taken in strikes from above or below, and not against the heavy armor on the sides of vehicles. As one industry source put it, "we spent so much time in Iraq and Afghanistan handling the underbody, [that] they're still hitting mines and detracking, [but] crews are surviving."⁹⁷ Indeed, at that point, only about six percent of Russian fatalities in the war had been amongst men from tank regiments.⁹⁸ This further suggests that while many vehicles were destroyed, their crews were mostly escaping. With enough damage, crews would abandon their vehicles, which would then become sitting targets for drones.⁹⁹

Later in the war, more than two-thirds of the Russian tank casualties were from Ukrainian drones, possibly indicating an increased reliance on unmanned aircraft amidst Ukraine's critical ammunition shortages. Drones were inexpensive and could precisely place armor-piercing grenades atop ground vehicles, where the armor was necessarily much thinner.¹⁰⁰ While small drones were not a substitute for long-range artillery, they were very effective near the battlefield.¹⁰¹ This should not have been surprising, as “the latest generation of anti-armor guided weapons”—the American Javelin, the Anglo-Swedish NLAW, the Israeli Spike, and the Swedish RB56 BILL—were all top-attack weapons.¹⁰² Indeed, during the 2020 Second Nagorno-Karabakh War, 70 percent of tank kills were from drones.¹⁰³

By early 2023, the main use of tanks in the war was as well-protected mobile artillery, raiding enemy positions with shellfire, sometimes with spotting by drones. This was not an efficient use of the asset. With comparatively short-ranged, direct-fire weapons, the tanks were often killed by autonomous and indirect-fire weapons before they could take aim. The battlefield dynamic was not wholly lost on American observers. As Brigadier General Mark Clingan of the U.S. Marine Corps assessed at a conference in 2023, “I have seen no evidence that Western tanks would fare any better against the Russians than Russian tanks have fared against the Ukrainians.” On the other hand, at least two Bradleys fared very well, in a widely distributed video, destroying a T-90, one of the Russian Army's newest tanks, with repeated hits from their 25 mm cannons.¹⁰⁴

In the summer of 2024, the Ukrainians' Kursk Offensive was led by their well-regarded 82nd Airborne Brigade, mounted in donated Strykers. The Ukrainians seized more territory in Russia than the Russians had in Ukraine that year, taking hundreds of Russian prisoners. This time, according to researchers at the Kyiv Post, “losses seemed to be heaviest in the tank regiments.”¹⁰⁵

Adaptations and Alternative Futures

Such results, as Major General (retired) Mick Ryan of the Australian Army was writing in March 2024, indicated that the Russian Army would

*need to continue adapting its employment of armored vehicles, [whether] main battle tanks, IFVs, APCs and other armored support vehicles, to ensure they [were] survivable in an environment where drones are ubiquitous and can rapidly detect, swarm around and destroy tanks and other armored fighting vehicles.*¹⁰⁶

By 2024, many North American and European land forces were pursuing a variety of paths for recapitalizing their armored vehicles fleets.

Greece, chronically short on funding, was considering upgrading its rather old Leopard 1A5 tanks, which had not been significantly modified in 30 years. German armaments manufacturer Krauss-Maffei Wegmann (KMW), partner to Rheinmetall in the Leopard 1 and 2 programs, partnered with local Greek supplier EODH and Spanish electronics firm Duma to propose enhancements in

mobility, lethality, protection, and wholly new digital electronics. The Italian firm Leonardo proposed to upgrade the 1A5s with new turrets like those on its Centauro eight-wheeled tank destroyers.¹⁰⁷

As was often the case, Canada remained unclear about its plans. Having donated eight of its 82 Leopard 2s to Ukraine, the Ministry of National Defence was contemplating a life-extension program for the rest, and possible replacement of the eight. However, commitments to purchase F-35 fighter jets and P-8 patrol planes for the Royal Canadian Air Force, and new *River*-class destroyers for the Royal Canadian Navy, left little money for the Army.¹⁰⁸

Lithuania, Poland, Czechia, Italy, Romania, and the Netherlands were all ordering new tanks.¹⁰⁹ The Poles in particular had ordered 1,000 tanks of four varieties: Leopard 2s, M1A1 Abrams, M1A2 Abrams, and K2s from South Korea's Hyundai Rotem.¹¹⁰ The Royal Netherlands Army was reestablishing a tank unit, after 10 years with only mechanized infantry units as armor.¹¹¹ Poland, Romania, Slovenia, and Czechia were similarly ordering new infantry fighting vehicles.¹¹² The Czechs, strong supporters of the Ukrainians, were buying new CV90s while sending their older CV90s to the eastern front.¹¹³ Similarly, the Germans, with their accomplished armored vehicle industry, were sending old, refurbished Marder IFVs to Ukraine, while at least pledging money to recapitalize the Bundeswehr.¹¹⁴

The Ukrainians were interested in building CV90s locally with help from Sweden, as well as Armored Modular Vehicles, eight-wheeled infantry carriers from Finland's Patria.¹¹⁵ The Ukrainians were also building their own new eight-wheeled IFV, the Khorunzhy. Based on the layout of the Soviet BTR-60, the new vehicle was upgraded with a diesel engine, frontal resistance to machine-gun fire, all-around resistance to smaller arms, and the mine-resistance of an MRAP.¹¹⁶ Ukraine had no plans for new tanks *per se*.¹¹⁷

In contrast, France, Germany, and Italy had plans for a new generation of tanks.¹¹⁸ Italy in particular urgently sought to replace its fleet of Ariete tanks, a domestic project from the 1980s whose vehicles had fallen into considerable disrepair.¹¹⁹

In March 2021, after spending nine years and £400 million trying to upgrade the British Army's tracked Warrior IFVs, which lacked stabilized cannons and decent mine protection, the Ministry of Defence cancelled the program, choosing instead to fully replace the fleet with over 600 Dutch-German Boxer wheeled IFVs.¹²⁰ Indeed, the British Army had a terrible reputation for managing its procurement, having failed to introduce almost any new ground equipment in the preceding 20 years.¹²¹ Initial operating capability for the Boxer, which had long been in production for other armies, was expected in 2025. A counterintuitive view from the British think-tank the Centre for Geostrategy held that the British Army did not need any heavy tanks, and specifically because of the Russo-Ukrainian War. The Russians had lost so many, the Poles were buying so many, and no one was confident that tanks were all that effective anyway, so Britain could concentrate elsewhere.¹²² As expensive as armored vehicles were, a land force built from mechanized infantry and reconnaissance units might be just as effective, but much less costly.¹²³

Amongst all the European armies, only Norway was distinctly trading away from armored vehicles, forgoing a plan for 18 new Leopard 2A8s to instead buy more air defenses.¹²⁴

In 2021, the U.S. Marine Corps had retired all 452 of its M1A1 Abrams tanks, and without replacement, as part of a plan to focus on archipelagic warfare. The Marines were replacing the rather old and repeatedly refurbished tracked armored amphibious vehicles for its infantry units with new Italian-designed wheeled armored amphibious vehicles.¹²⁵ Otherwise, they too were emphasizing new air defenses, and buying Norwegian-designed anti-ship missiles.

There was reason to wonder about the right way forward. As the Israeli military historian Azar Gat argued in the U.S. Army's *Armor* magazine in 2023,

all the preceding changes [seen on modern battlefields] are products of the same fundamental technology that has been advancing since the middle of the 20th Century: the exponential growth in electronic computational power. Note how this technological revolution has transformed naval and air warfare. At sea, the heavily armored, big-gun capital ships have vacated the scene, and warfare is carried out offensively by electronic guided missiles and defensively by electronic disruption and interception systems. Similarly, air warfare, once based on the kinetic capabilities of planes and their armament, now relies primarily on electronically guided weapons and electronic defensive systems...

The medium in which land warfare takes place is far more complex than those of the sea and air, because of both the numbers involved and land's complex topographical features... However, tanks will no longer be able to reach kinetic gun range from each other. They will be discovered and attacked at much longer ranges. This is no different than with the mighty battleships of World War II's Pacific Theatre, which never came within firing range of each other... heavy armor has similarly reached the limits of its ability to withstand precision, tandem hollow-charge, fire-and-forget munitions, which target the tank's top.

Heavy armor is no more necessary for land fighting vehicles than the 350-400mm steel armor of the past is necessary for warships today. It is a disadvantage. Indeed, relying on electronic detection and interception systems enables a drastic reduction in the armor of fighting vehicles for what is necessary against small arms, shrapnel and blast. Hence an expected reduction in their weight to about 10 to 25 tons; a parallel reduction in engine size and weight; and design re-orientation to electronically guided defensive and offensive systems.¹²⁶

Israel was continuing its project to upgrade Merkava 4 tanks to the Merkava 4 "Barak" (Lightning) standard, which featured better top-protection than perhaps any other armored vehicle. That resistance had already proven helpful during the Gaza War.¹²⁷ However, like Ukraine, and the USMC, Israel lacked plans for a wholly new tank.

Similarly, Mark Cancian, a retired Marine Corps colonel at the Center for Strategic and International Studies in Washington DC, observed in an interview that

If the Army went to the Office of the Secretary of Defense or Congress and said, 'We want to start a new tank program based on what we're seeing in Ukraine,' most people would say, 'That's not what we see'.¹²⁸

Thomas Stapleton, consultant to industry and a former congressional fellow, argued at a National Defense Industrial Association meeting in August 2024 that the prognosis for even a new infantry combat vehicle in the United States was not good. The Army, has noted, had experienced a

flatline budget for the last four years. That's before they get hit with inflation. The Pentagon is the largest consumer of petroleum in the world. We do things like feed a million and a half people a year. That bill's gone up 30 percent; all of the bills along the supply chain have gone up 20, 30 percent, so the Pentagon is getting hit very hard. [A well-deserved pay-raise for soldiers also] squeezes out all the investment accounts. So the things that we care about... the [research, development, test and evaluation] accounts and the investment accounts, are getting squeezed by inflation, congressional mandates, generic inflation on all the incendiary items that we buy and purchase and use. If I were a betting man, I would bet on the legacy and enduring systems.

One of two new developments might be funded, he thought: the Future Long Range Assault Aircraft, a program with Bell Aircraft to build tilt-rotor transports like the Marines' V-22 Osprey, and the XM30 MICV.

One of those could make it. I don't think they both make it, but one of them could.¹²⁹

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